File No. 130315

Committee Item No. 8
Board Item No. 8

COMMITTEE/BOARD OF SUPERVISORS

AGENDA PACKET CONTENTS LIST

Committee: Rules Date 4/18/13

Board of Supervisors Meeting Date 5/7/13

Cmte	Board	
☐	☐	Motion
☐	☐	Resolution
☒	☒	Ordinance
☐	☐	Legislative Digest
☐	☐	Budget Analyst Report
☐	☐	Legislative Analyst Report
☐	☐	Youth Commission Report
☐	☐	Introduction Form (for hearings)
☐	☐	Department/Agency Cover Letter and/or Report
☐	☐	MOU
☐	☐	Grant Information Form
☐	☐	Grant Budget
☐	☐	Subcontract Budget
☒	☒	Contract/Agreement
☐	☐	Award Letter
☐	☐	Application
☐	☒	Public Correspondence

OTHER (Use back side if additional space is needed)

☒	☒	Stipulation regarding Entry of Final Judgement
☒	☒	Exhibits A-Z
☐	☐	
☐	☐	
☐	☐	

Completed by: Linda Wong Date 4/15/13

Completed by: L.W. Date 5/2/13

An asterisked item represents the cover sheet to a document that exceeds 25 pages. The complete document is in the file.

[Settlement of Lawsuit - CTIA - The Wireless Association]

Ordinance authorizing settlement of a lawsuit filed by CTIA against the City and County of San Francisco; the lawsuit was filed on July 23, 2010, in United States District Court, Northern District of California, Case No. 3:10-cv-03224 (WHA); entitled CTIA - The Wireless Association v. City and County of San Francisco; the material terms of said settlement are that: CTIA and the City will enter into a stipulated Final Judgment for the CTIA, including declaratory relief and a permanent injunction against enforcement of the Cell Phone Right-to-Know Law; the City will cease all litigation over the Cell Phone Right-to-Know Law; and, CTIA will waive its claims for attorney's fees.

Be it ordained by the People of the City and County of San Francisco:

Section 1. The City Attorney is hereby authorized to settle the action entitled "CTIA - The Wireless Association v. City and County of San Francisco," United States District Court, Northern District of California, Case No. 3:10-cv-03224 (WHA), on substantially the same terms as set forth in the Settlement Agreement on file with the Clerk of the Board of Supervisors in File No. 130315, which is incorporated by reference and declared to be a part of this ordinance as if set forth fully herein. The Settlement Agreement provides that: CTIA and the City will enter into a stipulated Final Judgment for the CTIA, including declaratory relief and a permanent injunction against enforcement of the Cell Phone Right-to-Know Law (Environment Code Chapter 11, adopted by Ordinance No. 155-10 and as amended by Ordinance No. 165-11) and implementing regulations; the City will cease litigation over the Cell Phone Right-to-Know Law; and, CTIA will waive its entitlement to any attorney's fees and costs it could seek in any court as a result of being a prevailing party in the litigation. A copy of the stipulated Final Judgment is on file with the Clerk of the Board of Supervisors in File

Supervisors in File No. 130315, which is incorporated by reference and declared to be a part of this ordinance as if set forth fully herein.

Section 2. The above-named action was filed in United States District Court, Northern District of California, on July 23, 2010 and the following parties were named in the lawsuit: CTIA - The Wireless Association, plaintiff; the City and County of San Francisco, defendant.

APPROVED AS TO FORM AND RECOMMENDED:

DENNIS J. HERRERA
City Attorney

VINCE CHHABRIA
Deputy City Attorney

RECOMMENDED:

DEPARTMENT OF THE ENVIRONMENT

MELANIE NUTTER
Director

n:\govlit\li2013\110121\00837589.doc

Settlement Agreement

This Settlement Agreement (this "Agreement") is made by and between CTIA-The Wireless Association ("CTIA"), on the one hand, and the City and County of San Francisco (the "City"), on the other hand. Signatories to this Agreement are individually referred to as a "Party" and jointly as the "Parties."

RECITALS

WHEREAS, in 2010, CTIA filed a lawsuit against the City and County of San Francisco ("City") seeking to invalidate the City's Cell Phone Right-to-Know law, Ordinance No. 155-10 *CTIA v. City and County of San Francisco*, No. 10-3224 (N.D. Cal) (the "Litigation"), which was subsequently amended by Ordinance No. 165-11 (attached as Exhibits A and B) ("Ordinance"), and which was implemented by Regulations and Materials adopted by the Department of Environment, including those scheduled to become effective on September 30, 2011 (attached as Exhibit C);

WHEREAS, CTIA secured on October 27, 2011 a partial preliminary injunction from the United States District Court for the Northern District of California, and, following cross-appeals, secured a favorable Ninth Circuit decision, holding that the Ordinance, Regulations and Materials, including a "factsheet" revised at the District Court's direction (attached as Exhibit D) (all materials collectively referred to as "Display Materials"), should be preliminarily enjoined in their entirety under the First Amendment, *CTIA v. City and County of San Francisco*, 2012 WL 3900689 (Nos. 11–17707, 11–17773) (Sept. 20, 2012);

WHEREAS, the City filed a Petition for Rehearing En Banc which was denied on February 27, 2013, and the Ninth Circuit's mandate issued on March 11, 2013 with an award of costs to CTIA;

WHEREAS, CTIA is entitled to seek attorneys' fees from the United States Court of Appeals for the Ninth Circuit and the United States District Court for the Northern District of California, as a prevailing party on its First Amendment claim within the meaning of 42 U.S.C. 1988 and filed a petition for fees on March 13, 2013 in the United States Court of Appeals for the Ninth Circuit to comply with filing deadlines and preserve its right to seek fees in the event a settlement was not reached and ratified by the City Board of Supervisors;

WHEREAS, the parties have reached a settlement, subject to approval by the San Francisco Board of Supervisors, to terminate, compromise, and resolve expeditiously all aspects of the Litigation;

TERMS OF SETTLEMENT

1. **Recitals.** The foregoing recitals are incorporated into and made a part of this Agreement.

2. **Board of Supervisors Approval.** This Agreement is contingent upon approval by the San Francisco Board of Supervisors, and shall only be effective on the date an ordinance

approving the Agreement becomes effective, either as a result of signature by the Mayor or a veto override by the Board. The City agrees to make its best efforts to obtain final Board and Mayoral action on an ordinance approving this agreement by June 1, 2013.

3. **Agreements by CTIA and the City.**

(a) CTIA agrees it will waive its entitlement to any attorney's fees and costs it could seek in any court as a result of being a prevailing party in the Litigation. This includes withdrawing the March 13, 2013 fee petition pending before the United States Court of Appeals for the Ninth Circuit after the entry of final judgment as described herein.

(b) The City agrees that it will cease and refrain from further litigation over the Ordinance, Regulations, or Display Materials, including any attempt to seek further review of the Ninth Circuit ruling by the Supreme Court of the United States.

(c) The City represents that it is not presently considering legislation or regulatory action that would impose any requirement on any private person or entity to disclose or display any information regarding radiofrequency energy from cell phones.

(d) The City will consent to the entry of final judgment for CTIA, including declaratory relief and a permanent injunction against all aspects of the Ordinance, Regulations and Display Materials by the District Court in the form attached as Exhibit E, and that it will join CTIA in filing such stipulation and proposed order and any motion or other papers necessary to effectuate such stipulation within three (3) business days after the ordinance approving this Agreement becomes effective.

(e) The parties expressly agree that if the Board of Supervisors does not adopt an ordinance approving the Agreement, or if that Ordinance does not become effective, either as a result of signature by the Mayor or a veto override by the Board, within 90 days of its execution, CTIA may, at its option, terminate this Settlement Agreement, and CTIA may seek its attorneys' fees.

4. **Execution.** This Agreement may be executed in multiple counterpart originals, each of which shall constitute one and the same document and shall be deemed an original. Each of the signatories of this Agreement represents and warrants that he or she is authorized to execute this Agreement and to bind his or her respective Party.

5. **Entire Agreement.** This Agreement represents the entire agreement between the Parties relating to the subject matter described herein and supersedes any other prior or contemporaneous negotiations, representations, agreements and understandings, oral or written, relating to the Litigation.

6. **No Inference From Drafting.** This Agreement was negotiated between the Parties at arms' length. Each Party had the opportunity to consult with counsel. None of the Parties will be entitled to have any language herein construed against the other because of the identity of the drafter.

7. **Laws of the State of California.** This Agreement, and any dispute related to or arising under this Agreement, shall be governed by and construed under California law.

IN WITNESS WHEREOF,

The City and County of San Francisco

By: _____ Date: 3/21/13

Vince Chhabria, Counsel to the City

CTIA-The Wireless Association

By: _____ Date: 3/21/13

Andrew G. McBride, Counsel to CTIA.

EXHIBIT A

AMENDED IN BOARD
6/15/10

FILE NO. 100104 ORDINANCE NO. 155-10

[Cell Phones; Retailers' Duty to Disclose Specific Absorption Rate Values.]

Ordinance amending the San Francisco Environment Code by adding Chapter 11, Sections 1100 through 1106 ~~1105~~, to require retailers to disclose Specific Absorption Rate values for cell phones, and making environmental findings.

Note: Additions are *single-underline italics Times New Roman*; deletions are ~~*strikethrough italics Times New Roman*~~. Board amendment additions are double underlined. Board amendment deletions are ~~strikethrough normal~~.

Be it ordained by the People of the City and County of San Francisco:

Section 1. Findings.

(a) Government agencies and scientific bodies in the European Union (EU) and Israel have recognized the potential harm of long-term exposure to radiation emitted from cell phones and, as a result, have issued warnings about their use, especially their use by children.

(b) The United States Federal Communications Commission ("the FCC") has established a maximum allowable Specific Absorption Rate ("SAR") rating that manufacturers must disclose to the government when offering a portable wireless device (cell phone) for sale. The SAR is a value that corresponds to the relative amount of radiofrequency energy absorbed in the head or body of a user of a wireless handset. At the time of adoption of this ordinance, the FCC limit for public exposure from cellular telephones is an SAR level of 1.6 watts per kilogram (1.6 W/kg) for spatial peak (local) SAR, such as SAR in the user's head, as averaged over any 1 gram of tissue.

(c) The SAR values for different makes and models of cell phones differ widely, but consumers are not able to make informed purchasing decisions because there is no

requirement that the retailer provide the applicable SAR values to the consumer at the point when the consumer is deciding between various makes and models.

(d) Cell phones are an important communication tool, especially during emergencies, and radiation exposure from cell phones can be reduced by using a speakerphone or a headset, or by sending text messages.

Section 2. The San Francisco Environment Code is hereby amended by adding Chapter 11, Sections 1100 through 1108 ~~1105~~, to read as follows:

CHAPTER 11: CELL PHONE DISCLOSURE REQUIREMENTS

SEC. 1100. TITLE.

This Chapter may be known as the "Cell Phone Right-to-Know Ordinance."

SEC. 1101. DEFINITIONS.

For the purposes of this Chapter, the following terms shall have the following meanings, unless the context requires otherwise:

(a) "Cell phone" means a portable wireless telephone device that is designed to send or receive transmissions through a cellular radiotelephone service, as defined in Section 22.99 of Title 47 of the Code of Federal Regulations. A cell phone does not include a wireless telephone device that is integrated into the electrical architecture of a motor vehicle.

(b) "Cell phone retailer" means any person or entity within the City which sells or leases cell phones to the public or which offers cell phones for sale or lease. "Cell phone retailer" shall include a "formula cell phone retailer." "Cell phone retailer" shall not include anyone selling or leasing cell phones over the phone, by mail, or over the Internet. "Cell phone retailer" shall also not include

anyone selling or leasing cell phones directly to the public at a convention, trade show, or conference, or otherwise selling or leasing cell phones directly to the public within the City for fewer than 10 days in a year.

(c) "Cell phone service provider" means a telecommunications common carrier authorized to offer and provide cellular service for hire to the general public.

(d) "Director" means the Director of the Department of the Environment, or his or her designee.

(e) "Display materials" means informational or promotional materials posted adjacent to a sample phone or phones on display at the retail location that describe or list the features of the phone. "Display materials" shall not include any tag, sticker, or decal attached to a cell phone by the manufacturer, the manufacturer's packaging for a cell phone, or materials that list only the price and an identifier for the phone.

(f) "Formula cell phone retailer" means a cell phone retailer which sells or leases cell phones to the public, or which offers cell phones for sale or lease, through a retail sales establishment located in the City which, along with eleven or more other retail sales establishments located in the United States, maintains two or more of the following features: a standardized array of merchandise; a standardized facade; a standardized decor and color scheme; a uniform apparel; standardized signage; or a trademark or service mark.

(g) "SAR value" means the maximum whole-body and spatial peak Specific Absorption Rate for a particular make and model of cell phone as registered with the Federal Communications Commission. (See, generally, Section 2.1093 of Title 47 of the Code of Federal Regulations.)

/ / /

/ / /

/ / /

SEC. 1102. REQUIREMENTS FOR CELL PHONE SERVICE PROVIDERS.

(a) Beginning September 1, 2010, any cell phone service provider that sells its service through a retailer in the City must provide a list of those retail locations to the Department of the Environment in a form determined by the Department. The service provider must update the list annually. The Department shall adopt regulations governing the form and submission of the lists.

(b) Beginning November 1, 2010, any cell phone service provider that sells its service through a retailer in the City must provide those retailers with the SAR value for each make and model of cell phone sold or leased at that location in connection with cell phone service from the provider. The service provider must update the information it provides to retailers whenever new makes and models of cell phones covered by the service provider are added or old makes and models dropped, or whenever the service provider receives new information on the SAR values of any of the phones.

(c) If a cell phone service provider is unable to provide this information (in subsection b) to retailers in the City, then the Department of Environment upon the request of the service provider shall provide assistance in procuring that information.

SEC. 1103. REQUIREMENTS FOR CELL PHONE RETAILERS.

(a) If a cell phone retailer posts display materials in connection with sample phones or phones on display, the display materials must include these three elements:

(1) The SAR value of that phone and the maximum allowable SAR value for cell phones set by the FCC;

(2) A statement explaining what a SAR value is; and,

(3) A statement that additional educational materials regarding SAR values and cell phone use are available from the cell phone retailer.

The Department of the Environment shall adopt regulations specifying the content and format for the elements required by this subsection (a), and shall develop a template for those elements. The

elements shall be printed in a space no smaller than 1 inch by 2.625 inches. The SAR values and header text shall be printed in type no smaller than the size and readability equivalent of "Arial" 11 point, and the copy text shall be printed in type no smaller than the size and readability equivalent of "Arial" 8 point.

Formula cell phone retailers must comply with the requirements of this subsection (a) beginning February 1, 2011. All other cell phone retailers must comply by February 1, 2012.

(b) If a cell phone retailer does not post display materials in connection with sample phones or phones on display, the retailer must display, in a prominent location within the retail location visible to the public, a poster that includes these three elements:

(1) The SAR value of each make and model of cell phone offered for sale or lease at that retail location and the maximum allowable SAR value for cell phones set by the FCC;

(2) A statement explaining what a SAR value is; and,

(3) A statement that additional educational materials regarding SAR values and cell phone use are available from the cell phone retailer.

The Department of the Environment shall adopt regulations specifying the content and format for the elements required by this subsection (b), and shall develop a template for those elements. The store poster shall be no smaller than 8.5 inches by 11 inches.

Formula cell phone retailers must comply with the requirements of this subsection (b) beginning February 1, 2011. All other cell phone retailers must comply by February 1, 2012.

(c) The Director may, in his or her discretion, authorize a retailer to use alternate means to comply with the requirements of subsections (a) and (b). The Director shall authorize such alternate means through the adoption of a regulation after a noticed hearing; and no retailer may sell or lease cell phones to the public or offer to sell or lease cell phones to the public using any alternate means of compliance with this Chapter unless specifically authorized to do so in advance in writing by the Director.

SEC. 1104. DEPARTMENTAL FACTSHEETS; ASSISTANCE WITH COMPLIANCE.

(a) Following a public hearing, the Department of the Environment, in consultation with the Department of Public Health, shall develop a supplemental factsheet regarding SAR values and the use of cell phones, as well as templates for display materials and store posters required by this Chapter. The Department of the Environment shall hold the initial public hearing by September 1, 2010, and complete the supplemental factsheet by November 1, 2010. The supplemental factsheet shall be no larger than 8.5 inches by 11 inches.

(b) By November 1, 2010, the Department of the Environment shall issue regulations specifying the contents and format for the elements required by Section 1103, subsections (a) and (b), for display materials and store posters, respectively. By that date, the Department of the Environment shall also adopt templates for display materials and store posters.

(c) The Department shall develop content for all of these materials that is based on and consistent with the relevant information provided by the FCC or other federal agencies having jurisdiction over cell phones, explaining the significance of the SAR value and potential effects of exposure to cell phone radiation. The materials shall also inform customers of actions that can be taken by cell phone users to minimize exposure to radiation, such as turning off cell phones when not in use, using a headset and speaker phone, or texting.

SEC. 1105. IMPLEMENTATION AND ENFORCEMENT.

(a) Notwithstanding those provisions of Section 1103(a) and (b) applicable to formula cell phone retailers, requiring them to make certain disclosures and statements in connection with cell phone sales and leases, the City shall not enforce those provisions until May 1, 2011. During the period between the operative date for those requirements, February 1, 2011, and May 1, 2011, the Department of the Environment shall conduct an education and assistance program for formula cell

phone retailers, and shall visit the retailers and assist them with meeting the requirements of the subsections.

(b) Notwithstanding those provisions of Section 1103(a) and (b) applicable to all cell phone retailers other than formula cell phone retailers, requiring them to make certain disclosures and statements in connection with cell phone sales and leases, the City shall not enforce those provisions until August 1, 2012. During the period between the operative date for those requirements, February 1, 2012, and August 1, 2012, the Department of the Environment shall conduct an education and assistance program for those cell phone retailers, and shall visit the retailers and assist them with meeting the requirements of the subsections.

(c) The City Administrator shall issue a written warning to any person he or she determines is violating provisions of this Chapter or any regulation issued under this Chapter. If 30 days after issuance of the written warning the City Administrator finds that the person receiving the warning has continued to violate the provisions of the Chapter or any regulation issued under this Chapter, the City Administrator may impose administrative fines as provided below in subsections (d), (e), and (f).

(d) Violation of this Chapter or any regulation issued under this Chapter shall be punishable by administrative fines in the amount of:

(1) Up to $100.00 for the first violation;

(2) Up to $250.00 for the second violation within a twelve-month period; and,

(3) Up to $500 for the third and subsequent violations within a twelve-month period.

(e) Except as provided in subsection (d), setting forth the amount of administrative fines, Administrative Code Chapter 100, "Procedures Governing the Imposition of Administrative Fines," as may be amended form time to time, is hereby incorporated in its entirety and shall govern the imposition, enforcement, collection, and review of administrative citations issued by the City Administrator to enforce this Chapter or any regulation issued under this Chapter. Violation of this

Chapter is not a misdemeanor, and the Board of Supervisors intends that the requirements of this Chapter be enforced only through administrative fines as provided in this Section.

(f) For purposes of this Chapter, each individual item that is sold or leased, or offered for sale or lease, contrary to the provisions of this Chapter or any regulation issued under this Chapter shall constitute a separate violation.

SEC. 1106. DISCLAIMER.

In adopting and implementing this Chapter, the City and County of San Francisco is assuming an undertaking only to promote the general welfare. It is not assuming, nor is it imposing on its officers and employees, an obligation for breach of which it is liable in money damages to any person who claims that such breach proximately caused injury.

Section 3. **Additional Provisions.**

~~(a) Disclaimer. In adopting and implementing this Chapter, the City and County of San Francisco is assuming an undertaking only to promote the general welfare. It is not assuming, nor is it imposing on its officers and employees, an obligation for breach of which it is liable in money damages to any person who claims that such breach proximately caused injury.~~

(a) ~~(b)~~ **Conflict with State or Federal Law.** This Chapter shall be construed so as not to conflict with applicable federal or State laws, rules or regulations. Nothing in this Chapter shall authorize any City agency or department to impose any duties or obligations in conflict with limitations on municipal authority established by State or federal law at the time such agency or department action is taken.

(b) ~~(c)~~ **Severability.** If any of the provisions of this Chapter or the application thereof to any person or circumstance is held invalid, the remainder of those provisions, including the application of such part or provisions to persons or circumstances other than those to which it

is held invalid, shall not be affected thereby and shall continue in full force and effect. To this end, the provisions of this Chapter are severable.

(c) ~~(d)~~ **Environmental Findings.** The Planning Department has determined that the actions contemplated in this ordinance are in compliance with the California Environmental Quality Act (Cal. Pub. Res. Code §§ 21000 et seq.). Said determination is on file with the Clerk of the Board of Supervisors in File No. 100104 and is incorporated herein by reference.

APPROVED AS TO FORM:
DENNIS J. HERRERA, City Attorney

See File for Signature

By: _____
THOMAS J. OWEN
Deputy City Attorney

City and County of San Francisco
Tails
Ordinance

City Hall
1 Dr. Carlton B. Goodlett Place
San Francisco, CA 94102-4689

File Number: 100104 **Date Passed:** June 22, 2010

Ordinance amending the San Francisco Environment Code by adding Chapter 11, Sections 1100 through 1108, to require retailers to disclose specific absorption rate values for cell phones, and making environmental findings.

June 08, 2010 Board of Supervisors - CONTINUED ON FIRST READING

Ayes: 9 - Alioto-Pier, Campos, Chiu, Chu, Daly, Elsbernd, Mar, Maxwell and Mirkarimi
Noes: 2 - Avalos and Dufty

June 15, 2010 Board of Supervisors - AMENDED, AN AMENDMENT OF THE WHOLE BEARING NEW TITLE

Ayes: 11 - Alioto-Pier, Avalos, Campos, Chiu, Chu, Daly, Dufty, Elsbernd, Mar, Maxwell and Mirkarimi

June 15, 2010 Board of Supervisors - PASSED ON FIRST READING AS AMENDED

Ayes: 10 - Alioto-Pier, Avalos, Campos, Chiu, Chu, Daly, Dufty, Mar, Maxwell and Mirkarimi
Noes: 1 - Elsbernd

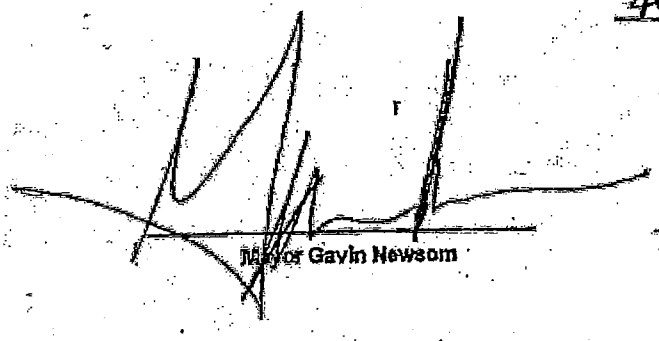
June 22, 2010 Board of Supervisors - FINALLY PASSED

Ayes: 9 - Avalos, Campos, Chiu, Chu, Daly, Dufty, Mar, Maxwell and Mirkarimi
Noes: 1 - Elsbernd
Excused: 1 - Alioto-Pier

File No. 100104

I hereby certify that the foregoing Ordinance was FINALLY PASSED on 6/22/2010 by the Board of Supervisors of the City and County of San Francisco.

Angela Calvillo
Clerk of the Board



Mayor Gavin Newsom

July 1, 2010
Date Approved

EXHIBIT B

FILE NO. 110656

Amendment of the Whole – 7/11/11
ORDINANCE NO. 165-11

[Environment Code—Cell Phone Disclosure Requirements]

Ordinance amending the San Francisco Environment Code Sections 1101 through 1105 to require cell phone retailers to provide their customers with information regarding how to limit exposure to the radiofrequency energy emitted by cell phones in place of the mandatory disclosure of Specific Absorption Rate values for cell phone models.

NOTE: Additions are *single-underline italics Times New Roman*; deletions are ~~*strike-through italics Times New Roman*~~. Board amendment additions are double-underlined; Board amendment deletions are ~~strikethrough normal~~.

Be it ordained by the People of the City and County of San Francisco:

Section 1. **Findings.**

1. It is the policy of the City and County of San Francisco to adhere to the Precautionary Principle, which provides that the government should not wait for scientific proof of a health or safety risk before taking steps to inform the public of the potential for harm.

2. There is a debate in the scientific community about the health effects of cell phones.

3. Numerous studies have identified evidence of an increased risk of brain cancer and other illnesses as a result of cell phone use, as well as heightened health concerns for children and pregnant women.

4. Leading epidemiologists who have studied the effects of radiofrequency energy absorbed from cell phones have recommended that the public be informed of the potential for adverse health effects from long-term cell phone use, particularly for children. See Cardis and Sadetski, "Indications of possible brain-tumour risk in mobile-phone studies: Should we be concerned?," Journal of Occupational and Environmental Medicine, Jan. 24, 2011.

5. Most cellular phone user manuals disclose, in fine print, that if a user holds a phone too close to his or her body, his or her phone may exceed the radiofrequency energy exposure limitation set by the Federal Communications Commission ("FCC").

6. FCC regulations presently do not require cell phone manufacturers to measure the amount of radiofrequency energy an average user will absorb from each model of cell phone. The amount of radiofrequency energy a user will absorb from a particular model of cell phone depends on numerous factors, including how the phone is used, the frequency on which it operates and the communication system it uses (for example, CDMA technology or GSM technology).

7. The Board urges the FCC and the scientific community to develop a metric for measuring the actual amount of radiofrequency energy an average user will absorb from each model of cell phone. Such a metric would better enable consumers concerned about the potential effects of radiofrequency emissions to compare cell phone models and make informed purchasing decisions.

8. The Board finds that until such a metric is developed, it is in the interest of the public health to require cell phone retailers to inform consumers about the potential health effects of cell phone use, and about measures they can take to reduce their exposure to radiofrequency energy from cell phones. The purpose of this legislation is to improve and strengthen the disclosures required under the original Cell Phone Right-to-Know Ordinance to better achieve this public health purpose.

/ / /

/ / /

/ / /

Section 2. The San Francisco Environment Code is hereby amended by amending Sections 1101 through 1105, to read as follows:

SEC. 1101. DEFINITIONS.

For the purposes of this Chapter, the following terms shall have the following meanings, unless the context requires otherwise:

(a) "Cell phone" means a portable wireless telephone device that is designed to send or receive transmissions through a cellular radiotelephone service, as defined in Section 22.99 of Title 47 of the Code of Federal Regulations. A cell phone does not include a wireless telephone device that is integrated into the electrical architecture of a motor vehicle.

(b) "Cell phone retailer" means any person or entity within the City which sells or leases cell phones to the public or which offers cell phones for sale or lease. ~~*"Cell phone retailer" shall include a "formula cell phone retailer."*~~ "Cell phone retailer" shall not include anyone selling or leasing cell phones solely over the phone, by mail, or over the internet. "Cell phone retailer" shall also not include anyone selling or leasing cell phones directly to the public at a convention, trade show, or conference, or otherwise selling or leasing cell phones directly to the public within the City for fewer than 10 days in a year.

(c) "Cell phone service provider" means a telecommunications common carrier authorized to offer and provide cellular service for hire to the general public.

(d) "Director" means the Director of the Department of the Environment, or his or her designee.

(e) "Display materials" means informational or promotional materials posted adjacent to a sample phone or phones on display at the retail location that describe or list the features of the phone. "Display materials" shall not include any tag, sticker, or decal attached to a cell phone by the manufacturer, the manufacturer's packaging for a cell phone, or materials that list only the price and an identifier for the phone.

~~(f) "Formula cell phone retailer" means a cell phone retailer which sells or leases cell phones to the public, or which offers cell phones for sale or lease, through a retail sales establishment located in the City which, along with eleven or more other retail sales establishments located in the United States, maintains two or more of the following features: a standardized array of merchandise; a standardized facade; a standardized decor and color scheme; a uniform apparel; standardized signage; or, a trademark or service mark.~~

~~(g) "SAR value" means the maximum whole body and spatial peak Specific Absorption Rate for a particular make and model of cell phone as registered with the Federal Communications Commission. (See, generally, Section 2.1093 of Title 47 of the Code of Federal Regulations.)~~

SEC. 1102. REQUIREMENTS FOR CELL PHONE SERVICE PROVIDERS.

~~(a) Beginning September 1, 2010, any~~ Any cell phone service provider that sells its service through a retailer in the City must provide a list of those retail locations to the Department of the Environment in a form determined by the Department. The service provider must update the list annually. The Department shall adopt regulations governing the form and submission of the lists.

~~(b) Beginning November 1, 2010, any cell phone service provider that sells its service through a retailer in the City must provide those retailers with the SAR value for each make and model of cell phone sold or leased at that location in connection with cell phone service from the provider. The service provider must update the information it provides to retailers whenever new makes and models of cell phones covered by the service provider are added or old makes and models dropped, or whenever the service provider receives new information on the SAR values of any of the phones.~~

~~(c) If a cell phone service provider is unable to provide this information (in subsection b) to retailers in the City, then the Department of Environment upon the request of the service provider shall provide assistance in procuring that information.~~

SEC. 1103. REQUIREMENTS FOR CELL PHONE RETAILERS.

(a) Beginning 15 days after the Department of the Environment adopts the regulations required under Section 1104(d) ~~1104(b)~~*, cell phone retailers must display in a prominent location visible to the public, within the retail store, an informational poster developed by the Department of the Environment as referenced in Section 1104.*

(b) Beginning 15 days after the Department of the Environment adopts the regulations required under Section 1104(d) ~~1104(b)~~*, cell phone retailers must provide to every customer that purchases a cell phone a free copy of an informational factsheet developed by the Department of the Environment as referenced in Section 1104. A copy of this factsheet must also be provided to any customer who requests it, regardless of whether they purchase a cell phone or not.*

(c) ~~*(a)*~~ *Beginning 30 days after the Department of the Environment adopts the regulations required under Section* 1104(d) ~~1104(b)~~*, if If* a cell phone retailer posts display materials in connection with sample phones or phones on display, the display materials must include these three informational statements, whose contents, and size, and format as printed, shall be determined by the Department of the Environment ~~elements~~:

(1) A statement explaining that cell phones emit radiofrequency energy that is absorbed by the head and body;

(2) A statement referencing measures to reduce exposure to radiofrequency energy from the use of a cell phone; and,

(3) A statement that the informational factsheet referenced in subsection (b) is available from the cell phone retailer upon request.

~~*(1) The SAR value of that phone and the maximum allowable SAR value for cell phones set by the FCC;*~~

~~*(2) A statement explaining what a SAR value is; and,*~~

~~(3) A statement that additional educational materials regarding SAR values and cell phone use are available from the cell phone retailer.~~

~~The Department of the Environment shall adopt regulations specifying the content and format for the elements required by this subsection (a), and shall develop a template for those elements. The SAR values and header text shall be printed in type no smaller than the size and readability equivalent of "Arial" 11 point, and the copy text shall be printed in type no smaller than the size and readability equivalent of "Arial" 8 point.~~

~~Formula cell phone retailers must comply with the requirements of this subsection (a) beginning May 1, 2011. All other cell phone retailers must comply by February 1, 2012.~~

~~(b) If a cell phone retailer does not post display materials in connection with sample phones or phones on display, the retailer must display, in a prominent location within the retail location visible to the public, a poster that includes these three elements:~~

~~(1) The SAR value of each make and model of cell phone offered for sale or lease at that retail location and the maximum allowable SAR value for cell phones set by the FCC;~~

~~(2) A statement explaining what a SAR value is; and,~~

~~(3) A statement that additional educational materials regarding SAR values and cell phone use are available from the cell phone retailer.~~

~~The Department of the Environment shall adopt regulations specifying the content and format for the elements required by this subsection (b), and shall develop a template for those elements. The store poster shall be no smaller than 8.5 inches by 11 inches.~~

~~Formula cell phone retailers must comply with the requirements of this subsection (b) beginning May 1, 2011. All other cell phone retailers must comply by February 1, 2012.~~

(d) ~~(c)~~ The Director may, in his or her discretion, authorize a retailer to use alternate means to comply with the requirements of subsections (a), *(b) and (c)* ~~and (b)~~. The Director shall authorize such alternate means through the adoption of a regulation after a noticed

hearing, and no retailer may sell or lease cell phones to the public or offer to sell or lease cell phones to the public using any alternate means of compliance with this Chapter unless specifically authorized to do so in advance in writing by the Director.

~~*(d) Retailers shall provide any customer who requests one with a free copy of the supplemental factsheet prepared by the Department of the Environment under Section 1104(a), as referenced in subsections (a)(3) and (b)(3).*~~

SEC. 1104. ***REQUIREMENTS FOR THE DEPARTMENT OF THE ENVIRONMENT*** ~~***DEPARTMENTAL FACTSHEETS; ASSISTANCE WITH COMPLIANCE.***~~

(a) Following a public hearing, the Department of the Environment, in consultation with the Department of Public Health, shall develop: ~~*a supplemental factsheet regarding SAR values and the use of cell phones, as well as templates for display materials and store posters required by this Chapter.*~~

(1) An informational poster, as referenced in Section 1103(a);

(2) An informational factsheet, as referenced in Section 1103(b); and,

(3) A set of statements that must be included in display materials, as referenced in Section 1103(c).

(b) The materials shall inform consumers of issues pertaining to radiofrequency energy emissions from cell phones and actions that can be taken by cell phone users to minimize exposure to radiofrequency energy, such as turning off cell phones when not in use, using a headset and speaker phone, or using the phone to send text messages ("texting").

(c) The Director may by regulation require the inclusion of additional information in the poster, the factsheet, and/or the statements required in connection with display materials.

~~The Department of the Environment shall hold the initial public hearing by September 1, 2010, and complete the supplemental factsheet by November 1, 2010. The supplemental factsheet shall be no larger than 8.5 inches by 11 inches~~.

(d) ~~(b) By November 1, 2010,~~ *Within 15 days after the effective date of this ordinance or as soon thereafter as is practicable,* the Department of the Environment shall, *after a noticed public hearing,* issue regulations specifying the contents, *size,* and format for ~~the elements~~ *the poster, the factsheet, and the statements required in connection with display materials as referenced in subsection (a), and provide templates of them for use by retailers.*

(1) The informational poster shall be a maximum size of 11 inches by 17 inches;

(2) The informational factsheet shall be a maximum size of 5.5 inches by 11 inches (half-sheet of paper); and,

(3) The informational statements shall be printed in a space no smaller than 1 inch by 2.625 inches.

~~required by Section 1103, subsections (a) and (b), for display materials and store posters, respectively. By that date, the Department of the Environment shall also adopt templates for display materials and store posters.~~

~~(c) The Department shall develop content for all of these materials that is based on and consistent with the relevant information provided by the FCC or other federal agencies having jurisdiction over cell phones, explaining the significance of the SAR value and potential effects of exposure to cell phone radiation. The materials shall also inform customers of actions that can be taken by cell phone users to minimize exposure to radiation, such as turning off cell phones when not in use, using a headset and speaker phone, or texting.~~

(c) Should the scientific community or the FCC develop a new metric to measure the actual amount of radiofrequency energy an average user will absorb from each model of cell phone, the

Department of the Environment shall make recommendations to the Board of Supervisors for amendments to this Chapter to require notification to the public of this metric at the point of sale.

SEC. 1105. ~~*IMPLEMENTATION AND*~~ ENFORCEMENT.

~~*(a) During the period leading up to May 1, 2011, the Department of the Environment shall conduct an education and assistance program for formula cell phone retailers regarding the provisions of Section 1103(a), (b), and (d), and shall visit the retailers and assist them with meeting the requirements of the subsections.*~~

~~*(b) Notwithstanding those provisions of Section 1103(a), (b) and (d) applicable to all cell phone retailers other than formula cell phone retailers, requiring them to make certain disclosures and statements in connection with cell phone sales and leases, the City shall not enforce those provisions until August 1, 2012. During the period between the operative date for those requirements, February 1, 2012, and August 1, 2012, the Department of the Environment shall conduct an education and assistance program for those cell phone retailers, and shall visit the retailers and assist them with meeting the requirements of the subsections.*~~

(a) ~~*(c)*~~ The City Administrator shall issue a written warning to any person he or she determines is violating provisions of this Chapter or any regulation issued under this Chapter. If 30 days after issuance of the written warning the City Administrator finds that the person receiving the warning has continued to violate the provisions of the Chapter or any regulation issued under this Chapter, the City Administrator may impose administrative fines as provided below in subsections *(b), (c) and (d)* ~~*(d), (e), and (f)*~~.

(b) ~~*(d)*~~ Violation of this Chapter or any regulation issued under this Chapter shall be punishable by administrative fines in the amount of:

(1) Up to $100.00 for the first violation;

(2) Up to $250.00 for the second violation within a twelve-month period; and,

(3) Up to $500.*00* for the third and subsequent violations within a twelve-month period.

(c) ~~(e)~~ Except as provided in subsection *(b)* ~~(d)~~, setting forth the amount of administrative fines, Administrative Code Chapter 100, "Procedures Governing the Imposition of Administrative Fines," as may be amended form time to time, is hereby incorporated in its entirety and shall govern the imposition, enforcement, collection, and review of administrative citations issued by the City Administrator to enforce this Chapter or any regulation issued under this Chapter. Violation of this Chapter is not a misdemeanor, and the Board of Supervisors intends that the requirements of this Chapter be enforced only through administrative fines as provided in this Section.

(d) ~~(f)~~ For purposes of this Chapter, each individual item that is sold or leased, or offered for sale or lease, contrary to the provisions of this Chapter or any regulation issued under this Chapter shall constitute a separate violation.

Section 3. **Additional Provisions.**

(a) **Disclaimer.** In adopting and implementing this Chapter, the City and County of San Francisco is assuming an undertaking only to promote the general welfare. It is not assuming, nor is it imposing on its officers and employees, an obligation for breach of which it is liable in money damages to any person who claims that such breach proximately caused injury.

(b) **Conflict with State or Federal Law.** This Chapter shall be construed so as not to conflict with applicable federal or State laws, rules or regulations. Nothing in this Chapter shall authorize any City agency or department to impose any duties or obligations in conflict with limitations on municipal authority established by State or federal law at the time such agency or department action is taken.

(c) **Severability.** If any of the words, phrases, clauses, sentences, sections, or provisions of this ordinance or the application thereof to any person or circumstance are held invalid, the remainder of this ordinance's words, phrases, clauses, sentences, sections, or provisions, including the application of such part or provisions thereof to persons or circumstances other than those to which it is held invalid, shall not be affected thereby and shall continue in full force and effect. To this end, the provisions of this ordinance are severable.

(d) **Environmental Findings.** The Planning Department has determined that the actions contemplated in this ordinance are in compliance with the California Environmental Quality Act (Cal. Pub. Res. Code §§ 21000 et seq.). Said determination is on file with the Clerk of the Board of Supervisors in File No. 110656 and is incorporated herein by reference.

APPROVED AS TO FORM:
DENNIS J. HERRERA, City Attorney

By: _____
THOMAS J. OWEN
Deputy City Attorney

City and County of San Francisco
Tails
Ordinance

City Hall
1 Dr. Carlton B. Goodlett Place
San Francisco, CA 94102-4689

File Number: 110656 **Date Passed:** July 26, 2011

Ordinance amending the San Francisco Environment Code Sections 1101 through 1105 to require cell phone retailers to provide their customers with information regarding how to limit exposure to the radiofrequency energy emitted by cell phones in place of the mandatory disclosure of Specific Absorption Rate Values for cell phone models.

July 11, 2011 City Operations and Neighborhood Services Committee - AMENDED, AN AMENDMENT OF THE WHOLE BEARING SAME TITLE

July 11, 2011 City Operations and Neighborhood Services Committee - RECOMMENDED AS AMENDED

July 19, 2011 Board of Supervisors - PASSED, ON FIRST READING

Ayes: 11 - Avalos, Campos, Chiu, Chu, Cohen, Elsbernd, Farrell, Kim, Mar, Mirkarimi and Wiener

July 26, 2011 Board of Supervisors - FINALLY PASSED

Ayes: 11 - Avalos, Campos, Chiu, Chu, Cohen, Elsbernd, Farrell, Kim, Mar, Mirkarimi and Wiener

File No. 110656

I hereby certify that the foregoing Ordinance was FINALLY PASSED on 7/26/2011 by the Board of Supervisors of the City and County of San Francisco.

Angela Calvillo
Clerk of the Board

Mayor Edwin Lee

8/3/11
Date Approved

EXHIBIT C

San Francisco Department of the Environment Regulations SFE 11-07-CPO
Requirement for cell phone retailers to provide information to their customers regarding how to limit their exposure to cell phone radiofrequency energy
Ordinance No. 165-11, Adopted July 11, 2011

Regulation Effective Date: September 30, 2011

A. Authorization

San Francisco Environment Code Chapter 11:

SEC. 1103. REQUIREMENTS FOR CELL PHONE RETAILERS.

(a) Beginning 15 days after the Department of the Environment adopts the regulations required under Section 1104(d), cell phone retailers must display in a prominent location visible to the public, within the retail store, an informational poster developed by the Department of the Environment as referenced in Section 1104.

(b) Beginning 15 days after the Department of the Environment adopts the regulations required under Section 1104(d), cell phone retailers must provide to every customer that purchases a cell phone a free copy of an informational factsheet developed by the Department of the Environment as referenced in Section 1104. A copy of this factsheet must also be provided to any customer who requests it, regardless of whether they purchase a cell phone or not.

(c) Beginning 30 days after the Department of the Environment adopts the regulations required under Section 1104(d), if a cell phone retailer posts display materials in connection with sample phones or phones on display, the display materials must include these three informational statements, whose contents, and size, and format as printed, shall be determined by the Department of Environment:

(1) A statement explaining that cell phones emit radiofrequency energy that is absorbed by the head and body;

(2) A statement referencing measures to reduce exposure to radiofrequency energy from the use of a cell phone; and,

(3) A statement that the informational factsheet referenced in subsection (b) is available from the cell phone retailer upon request.

(d) The Director may, in his or her discretion, authorize a retailer to use alternate means to comply with the requirements of subsections (a), (b) and (c). The Director shall authorize such alternate means through the adoption of a regulation after a noticed hearing, and no retailer may sell or lease cell phones to the public or offer to sell or lease cell phones to the public using any alternate means of compliance with this Chapter unless specifically authorized to do so in advance in writing by the Director.

A-13

SEC. 1104. REQUIREMENTS FOR THE DEPARTMENT OF THE ENVIRONMENT

(a) Following a public hearing, the Department of the Environment, in consultation with the Department of Public Health, shall develop:

(1) An informational poster, as referenced in Section 1103(a);

(2) An informational factsheet, as referenced in Section 1103(b); and,

(3) A set of statements that must be included in display materials, as referenced in Section 1103(c).

(b) The materials shall inform consumers of issues pertaining to radiofrequency energy emissions from cell phones and actions that can be taken by cell phone users to minimize exposure to radiofrequency energy, such as turning off cell phones when not in use, using a headset and speaker phone, or using the phone to send text messages ("texting").

(c) The Director may by regulation require the inclusion of additional information in the poster, the factsheet, and/or the statements required in connection with display materials.

(d) Within 15 days after the effective date of this ordinance or as soon thereafter as is practicable, the Department of the Environment shall, after a noticed public hearing, issue regulations specifying the contents, size, and format for the poster, the factsheet, and the statements required in connection with display materials as referenced in subsection (a), and provide templates of them for use by retailers.

(1) The informational poster shall be a maximum size of 11 inches by 17 inches;

(2) The informational factsheet shall be a maximum size of 5.5 inches by 11 inches (half-sheet of paper); and,

(3) The informational statements shall be printed in a space no smaller than 1 inch by 2.625 inches.

(e) Should the scientific community or the FCC develop a new metric to measure the actual amount of radiofrequency energy an average user will absorb from each model of cell phone, the Department of the Environment shall make recommendations to the Board of Supervisors for amendments to this Chapter to require notification to the public of this metric at the point of sale.

B. Policy or Findings

According to the World Health Organization (WHO),

- Mobile phone use is ubiquitous with an estimated 4.6 billion subscriptions globally.
- The electromagnetic fields produced by mobile phones are classified by the International Agency for Research on Cancer as possibly carcinogenic to humans.
- Studies are ongoing to more fully assess potential long term effects of mobile phone use.
- WHO will conduct a formal risk assessment of all studied health outcomes from radiofrequency fields exposure by 2012.

Leading epidemiologists who have studied the effects of radiofrequency energy absorbed from cell phones have recommended that the public be informed of the potential for adverse health effects from long-term cell phone use, particularly for children.

Cell phones are an important communication tool, especially during emergencies, and radiation exposure from cell phones can be reduced by using a speakerphone or a headset, or by sending text messages.

C. Applicability

This regulation applies to all San Francisco cell phone retailers, defined by the San Francisco Environment Code Chapter 11, Section 1101 as:

> (b) "Cell phone retailer" means any person or entity within the City which sells or leases cell phones to the public or which offers cell phones for sale or lease. "Cell phone retailer" shall not include anyone selling or leasing cell phones over the phone, by mail, or over the internet. "Cell phone retailer" shall also not include anyone selling or leasing cell phones directly to the public at a convention, trade show, or conference, or otherwise selling or leasing cell phones directly to the public within the City for fewer than 10 days in a year.

D. Requirements

- SEC. 1103(a): Informational poster. See poster (Attachment A).

The attached poster is formatted to fit standard paper size of 11 x 17 inches. The cell phone retailer must display the poster identical to attachment A (in size, content, format and graphics).

The Department will provide hardcopy posters to cell phone retailers and make replacements available upon request. The cell phone retailers are responsible for contacting the Department to obtain the poster and future replacements in order to ensure compliance with this law. The request for posters can be made in two ways:

- In person at The Department of the Environment, M-F (9AM to 5PM):
  11 Grove St. San Francisco, CA 94102
- A written request to:
  - Toxics Reduction Program, SF Department of the Environment, 11 Grove St. San Francisco, CA 94102; Or
  - cellphone@sfenvironment.org

- SEC. 1103(b): Department factsheet. See factsheet template (Attachment B).

The attached supplemental factsheet template is formatted to fit standard paper size 8.5 x 11 inches, with two 8.5 x 5.5 inches sized factsheets per sheet. Cell phone retailers are required to provide this factsheet to customers upon request and with every cell phone sale. The factsheet provided to customers must be identical in content, format, color and graphics.

The Department shall make the factsheet template available in PDF or Microsoft Word format for printing by cell phone retailers. The Department shall provide starter kits to retailers with 50 factsheets each, and retailers are responsible for making color copies for distribution thereafter.

- SEC. 1103(c): Statements to include in display materials. See label template (Attachment C)

The attached sticker template is formatted to fit on Avery standard 5160-address labels. The font type and size are Futura size 12. A cell phone retailer may print and paste stickers on cell phone display materials or include the content of the sticker in cell phone display materials in a manner that preserves the font size, type and meets the space requirement of no smaller than 1 x 2.625 inches.

The Department shall make the sticker template available in PDF or Microsoft Word format for printing by cell phone retailers.

E. Attachments

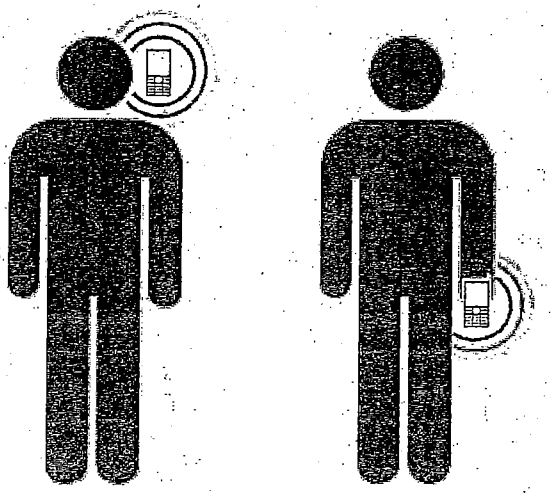
Attachment A: Informational poster
Attachment B: Informational factsheet
Attachment C: Sticker template for inclusion of informational statements in display materials

The Director of the Department of the Environment hereby adopts these regulations as of the date specified below.

Approved:

Melanie Nutter 9/30/11
Melanie Nutter Date
Director, Department of the Environment

You can limit exposure to Radio-frequency (RF) Energy from your cell phone.



Although studies continue to assess potential health effects of mobile phone use, the World Health Organization has classified RF Energy as a possible carcinogen.

This material was prepared solely by the City and County of San Francisco and must be provided to consumers under local law.

09/11

If you are concerned about potential health effects from cell phone RF Energy, the City of San Francisco recommends:

- **Limiting cell phone use by children**
  Developing brains and thinner skulls lead to higher absorption in children.
- **Using a headset, speakerphone or text instead**
  Exposure decreases rapidly with increasing distance from the phone.
- **Using belt clips and purses to keep distance between your phone and body**
  Do not carry on your body to at least meet the distance specified in your phone's user manual
- **Avoiding cell phones in areas with weak signals (elevators, on transit, etc.)**
  Using a cell phone in areas of good reception decreases exposure by allowing the phone to transmit at reduced power.
- **Reducing the number and length of calls**
  Turn off your cell phone when not in use.

Learn More:

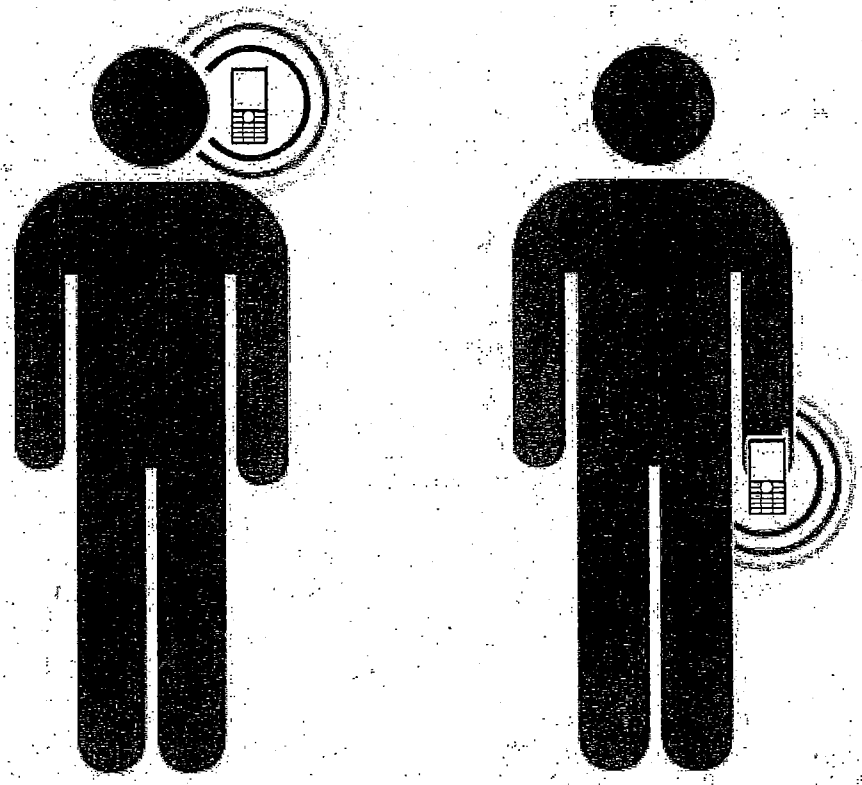
SF Department of the Environment @ SFEnvironment.org/cellphoneradiation • (415) 355-3700
Federal Communications Commission @ FCC.gov/cgb/consumerfacts/mobilephone.html
World Health Organization @ WHO.int/mediacentre/factsheets/fs193/en/

This material was prepared solely by the City and County of San Francisco and must be provided to consumers under local law.

09/11

A-17

Cell Phones Emit Radio-frequency Energy



Studies continue to assess potential health effects of mobile phone use.

If you wish to reduce your exposure, the City of San Francisco recommends that you:

- Keep distance between your phone and body
- Use a headset, speakerphone, or text instead
- Ask for a free factsheet with more tips

SF Environment
Our home. Our city. Our planet.
A Department of the City and County of San Francisco

Learn More:

SF Department of Environment @ SFEnvironment.org/cellphoneradiation
Federal Communications Commission @ FCC.gov/cgb/consumerfacts/mobilephone.html
World Health Organization @ WHO.int/mediacentre/factsheets/fs193/en/

09/11

This material was prepared solely by the City and County of San Francisco and must be provided to consumers under local law.


Your head and body absorb RF Energy from cell phones
If you wish to reduce your exposure, ask for San Francisco's free factsheet.

EXHIBIT D

You can limit exposure to Radio-frequency (RF) Energy from your cell phone.

Although all cell phones sold in the United States must comply with RF safety limits set by the Federal Communications Commission (FCC), no safety study has ever ruled out the possibility of human harm from RF exposure.

This material was prepared solely by the City and County of San Francisco and must be provided to consumers under local law.

11/11

RF Energy has been classified by the World Health Organization as a possible carcinogen (rather than as a known carcinogen or a probable carcinogen) and studies continue to assess the potential health effects of cell phones. **If you are concerned about potential health effects from cell phone RF Energy, the City of San Francisco recommends:**

- **Limiting cell phone use by children**
  Average RF energy deposition for children is two times higher in the brain and up to ten times higher in the bone marrow of the skull compared with cell phone use by adults.
- **Using a headset, speakerphone or text instead**
  Exposure decreases rapidly with increasing distance from the phone.
- **Using belt clips and purses to keep distance between your phone and body**
  Do not carry on your body to at least meet the distance specified in your phone's user manual.
- **Avoiding cell phones in areas with weak signals (elevators, on transit, etc.)**
  Using a cell phone in areas of good reception decreases exposure by allowing the phone to transmit at reduced power.
- **Reducing the number and length of calls**
  Turn off your cell phone when not in use.

Learn More: **SF Department of the Environment** @ SFEnvironment.org/cellphoneradiation • (415) 355-3700
Federal Communications Commission @ FCC.gov/cgb/consumerfacts/mobilephone.html
World Health Organization @ WHO.int/mediacentre/factsheets/fs193/en/

This material was prepared solely by the City and County of San Francisco and must be provided to consumers under local law.

11/11

A-20

EXHIBIT E

UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

SAN FRANCISCO DIVISION

CTIA - THE WIRELESS ASSOCIATION®,

Plaintiff,

v.

THE CITY AND COUNTY OF SAN FRANCISCO, CALIFORNIA,

Defendant.

Case No. 3:10-cv-03224 WHA

STIPULATION REGARDING ENTRY OF FINAL JUDGMENT

Date: XXXX X, 2013
Time: XX
Courtroom: Courtroom 9, 19th Floor

Pursuant to Fed. R. Civ. P. 54; N.D. Cal. Civ. R. 7-12, the Parties submit this Stipulation Regarding Entry of Final Judgment.

RECITALS

1. On October 4, 2011, Plaintiff CTIA-The Wireless Association filed a Second Amended Complaint for Declaratory and Injunctive Relief against Defendant the City and County of San Francisco ("City"), challenging the City's Cell Phone "Right-to-Know" Ordinance, File No. 100104, Ordinance No. 155-10, as amended by Ordinance No. 165-11 (collectively, the "Ordinance"), and Regulations and Display Materials promulgated by the Department of Environment, San Francisco Department of the Environment, *see* SFE 10-02-CPO, SFE 10-03-CPO, and SFE 11-07-CPO and attachments.

2. On October 4, 2011, Plaintiff filed a motion seeking a preliminary injunction against the Ordinance, Regulations and Display Materials.

3. On October 27, 2011, after briefing and a hearing, this Court granted a partial preliminary injunction.

4. The parties cross-appealed (Nos. 11-17707, 11-17773) and the Ninth Circuit decided the appeals in favor of CTIA on September 10, 2012, holding that the Ordinance, Regulations and Display Materials should be preliminarily enjoined in their entirety under the First Amendment.

6. The United States Court of Appeals denied the City's Petition for Rehearing En Banc on February 27, 2013.

7. The Ninth Circuit's mandate issued on March 11, 2013, with an award of costs to CTIA.

8. CTIA filed petitions for award of attorneys' fees before this Court and before the Ninth Circuit as the prevailing party on its constitutional claim under 42 U.S.C. § 1988. As part of a comprehensive settlement of litigation between the Parties, CTIA has agreed to withdraw all requests for attorneys' fees connected with this matter.

STIPULATION

The parties hereby stipulate that no further litigation is necessary or appropriate and

jointly move this Court to enter, in the form attached, Final Judgment, including a Declaratory Ruling and Permanent Injunction, to fully resolve this case.

Dated this Xth day of _____, 2013

Dated: _____ X, 2013

JONES DAY

By: /s/ Craig E. Stewart

Craig E. Stewart
Attorneys for Plaintiff
CTIA – The Wireless Association®
Dated: July 12, 2012

Dated: _____ X, 2013

DENNIS J. HERRERA, State Bar #139669
City Attorney
WAYNE SNODGRASS, State Bar #148137
VINCE CHHABRIA, State Bar #208557
Deputy City Attorneys
City Hall, Room 234
#1 Dr. Carlton B. Goodlett Place
San Francisco, California 94102-4682
Telephone: (415) 554-4674
Facsimile: (415) 554-4699
E-Mail: vince.chhabria@sfgov.org

By: _____
Vince Chhabria

Attorneys for Defendant
The City And County Of San Francisco, California

IT IS SO ORDERED.

Dated: _____

_____
William H. Alsup
United States District Judge

UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

SAN FRANCISCO DIVISION

CTIA - THE WIRELESS ASSOCIATION®,

Plaintiff,

v.

THE CITY AND COUNTY OF SAN FRANCISCO, CALIFORNIA,

Defendant.

Case No. 3:10-cv-03224 WHA

[PROPOSED] FINAL JUDGMENT, DECLARATORY RULING AND PERMANENT INJUNCTION FOR PLAINTIFF

Date: _____ X, 2013
Time: XX
Courtroom: Courtroom 9, 19th Floor

[PROPOSED] FINAL JUDGMENT

The Court has reviewed the Parties' Stipulation Regarding Entry of Final Judgment and concludes that it is appropriate for the Court to enter this Final Judgment for Plaintiff, a Declaratory Ruling, and Permanent Injunction.

PURSUANT TO STIPULATION, IT IS HEREBY ORDERED, ADJUDGED, AND DECREED that:

1. The City's Cell Phone Right to Know Ordinance, and any implementing regulations and materials promulgated by the City Department of Environment thereunder, including any versions of same revised in the course of this litigation, are **DECLARED TO BE INVALID** under the First Amendment to the United States Constitution.

2. Defendant and each of its officers, principals, agents, servants, employees, successors and assignees, are **PERMANENTLY ENJOINED** from enforcing the City of San Francisco's Cell Phone Right to Know Ordinance and any regulations and materials promulgated thereunder, including any versions of same revised in the course of this litigation.

3. This Final Judgment, Declaratory Ruling, and Permanent Injunction are applicable to the Cell Phone Right to Known Ordinance, as adopted on July 1, 2010, amended on January 7, 2011 and July 26, 2011, and approved by the Mayor on August 3, 2011 (Ordinance Nos. 155-10 and 165-11), which were the subject of the above-captioned litigation, and any and all regulations and materials promulgated thereunder, including any versions of same revised in the course of this litigation.

Dated: _____ X, 2013

JONES DAY

By: /s/ Craig E. Stewart

Craig E. Stewart
Attorneys for Plaintiff

CTIA – The Wireless Association®

Dated: _____ X, 2013

DENNIS J. HERRERA, State Bar #139669
City Attorney
WAYNE SNODGRASS, State Bar #148137
VINCE CHHABRIA, State Bar #208557
Deputy City Attorneys
City Hall, Room 234
#1 Dr. Carlton B. Goodlett Place
San Francisco, California 94102-4682
Telephone: (415) 554-4674
Facsimile: (415) 554-4699
E-Mail: vince.chhabria@sfgov.org

By: _____
Vince Chhabria

Attorneys for Defendant
The City And County Of San Francisco, California

IT IS SO ORDERED.

Dated: _____

_____
William H. Alsup
United States District Judge

VORTIS™
TECHNOLOGY INC.

Next generation antenna architecture

Interferometric array antenna structure optimizing power and minimizing interference

Enhances Mobile Phone Performance, Mitigates Energy Loss to Human Body and Enables Hearing Aids

Date: 01Apr13

FCC 130315

Received in Committee 4/18/13 JW

Bay Area Technology Firm Improving Cell Phone Technology!

Bringing 21st Century Technology to Improve Quality, Performance and Compliance!

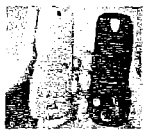
Vortis Technology Inc. (VTI) is addressing growing concerns about cell phone performance and the health impact of radio frequencies (RF) next to the head and hand with the first patented near-field micro-interferometric array antenna branded as Vortis.

This revolutionary new array antenna technology for cell phones has been tested and verified by Motorola and others showing an order of magnitude reduction in RF energy absorbed by your head and hand when in use.

This unprecedented result is achieved using the science of Interferometry for near-field re-shaping of RF-fields radiating from a cell phone's antenna to focus them forward and reward of the user (figure "8" Patter) that improves the cell phone seven ways from performance to energy savings to safety and better hearing for hard of hearing people.

Our 19 shareholders are launching Vortis and seeking $300,000 capital investments to embed Vortis into the first cell phone using our existing supply base and customer discussions toward one Smart Phone and one Flip Phone!

This next generation cell phone antenna technology not only removes wasted energy to the users head, it enhances signal strength, gain and signal to noise ratios to produce new standards for cell phone performance we call: **GPS+**



Green

Because when you don't waste half the radiated energy to the users' head, you save it.
30-50% increase in talk time, less batteries in landfills, save billions of hours charging.

Power

Performance and Efficiency increases Total Radiated Power, resulting in fewer dropped calls, less noise, increased range, better call quality and faster downloads. Reshaping makes is safer:

Safety

Vortis redirects energy away from head. Making it safer, especially for women and children.
Apple says hold cell phone 5/8 inch from your head, the only way they can meet safety standard!

+ : Hearing Aid Compatible, 18 million hearing aids US, 10K people a day turn 65

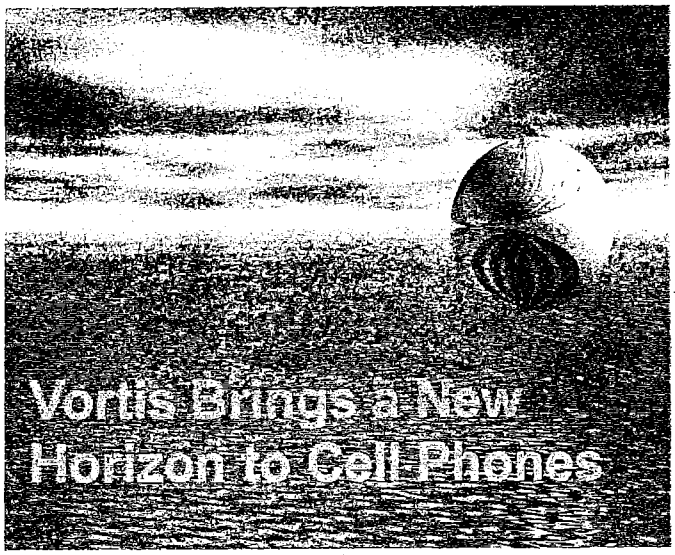
Of the 6.92 Billion users worldwide, we intend capturing 5-15% of individual markets.

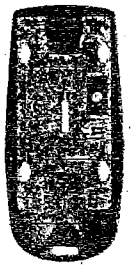
This is 21st Century technology replacing 19th Century technology in cell phones today and bringing forth a solution to the fastest growing question in humanity: "Can you hear me now?"

Vortis is so Green, it makes other Greens Blue because it's Green, Powerful and Safer Plus!

James R. Johnson, 650 595 8888 Vortis Technology Inc., (VTI) 865 Laurel Street, San Carlos, CA 94070
---Please Like us at -- www.facebook.com/VortisGreenPowerfulSaferCellphoneAntenna Fax: 650-594-8453

Campaign Elements & Discussion!

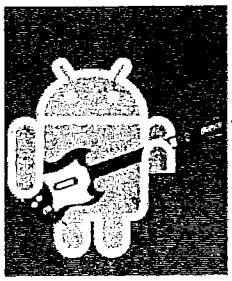




Vortis Inside!

"Our Advertising & PR Specialists can customize Art & Ads for You!"

Corporate PR



This Android Rocks!

What is a Vortis?

VORTIS Technology

Reduced Energy Loss

Cell phones lose as much as 30% or more of the energy to the users head. This is wasted energy and causes interference with hearing aids. The Vortis array reduces this energy loss and redirects the energy towards the cell sites where it is needed the most.

Typical cellular phone radiation pattern when operating next to the head.

Vortis cellular phone radiation pattern below when operating next to the head.

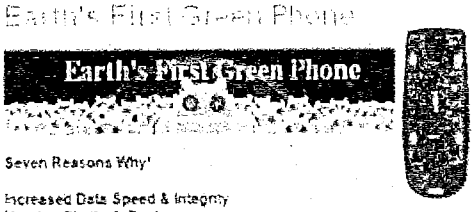
Notice the increased coverage!

Sweet Spot

Because hearing aids and settings vary, the user will experience a "sweet spot" where the interference will drop the most.

Looking from the top down, you can see the sweet spot shown in blue.

Earth's First Green Phone



Seven Reasons Why!

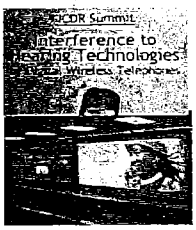
Increased Data Speed & Integrity
Hearing Clarity & Quality
Greenest Technology with 30% More Energy to Double Battery Life
Global Harmony to Highest Standards
Safer and More Effective
Strongest, most Powerful Gain for less Dropped Calls
Greater Coverage

What is a Vortis?

Why aren't you using a Vortis?

Corporate Responsibility Begins With Best Practices!

This IS the Android you're Looking For!



Innovations in Technology

A Clearer Connection

All Things Google: The 'Droid you're looking for

By Alex M. Jarvis

I'll admit that I bought into the Android idea early: I was an avid user of Google, liked the idea of an open-source handset, and really wanted something powerful other then the iPhone (mostly just to spite my faculty advisor). Since my January 2009 purchase, the Google Android mobile phone platform has matured significantly. It has gone through three (humorous) pastry themed) major updates, and has spread from the original hardware on T-Mobile to encompass a wide range of devices on almost every major cellphone network in the United States (the holdout is AT&T, but I'm sure they aren't too worried about their smartphone selection). I had started out with a G1 – not the most rugged or powerful phone, but a decent device – and have recently upgraded to the Nexus One. In my two semesters using it, it has become clear that Android is ready for the classroom arena.

Android is for drinkers of the Google Kool-aid, in no insignificant ways: while the device could reasonably function to some degree without a Google account, to really get to the meat of the software, you need to sign up. This isn't a problem for most people, but it bears mentioning. The good news is that this "Sign in once" feature (you sign in to your google account when you first activate the phone, and then never again) opens you to a large array of inter-app communication.

The best apps are all made by Google, and they flow nicely into each other. A position on a map can be added to a Google calendar event, which can be then sent to another user, all linked through the device. It's clear Google wants the center of your organizational tools to exist in the cloud, with the Android device as one window of access. This idea was further expanded on in update 2.0, "Eclair", where a universal contact API allowed a single contact to be recognized across any app that adopts it. Combined with a simple organizational structure, you have a one-stop-shop for communicating with peers, students, faculty, or anyone in need of organization. Facebook, Google Voice, SMS, Gmail, and certain Twitter apps have shared this functionality.

Integrates naturally in nearly all form factors

File # 130315

AUTHOR QUERY FORM

ELSEVIER	**Journal:** PATPHY **Article Number:** 766	**Please e-mail or fax your responses and any corrections to:** **E-mail:** corrections.esch@elsevier.thomsondigital.com **Fax:** +353 6170 9272

Dear Author,

Please check your proof carefully and mark all corrections at the appropriate place in the proof (e.g., by using on-screen annotation in the PDF file) or compile them in a separate list. Note: if you opt to annotate the file with software other than Adobe Reader then please also highlight the appropriate place in the PDF file. To ensure fast publication of your paper please return your corrections within 48 hours.

For correction or revision of any artwork, please consult http://www.elsevier.com/artworkinstructions.

Any queries or remarks that have arisen during the processing of your manuscript are listed below and highlighted by flags in the proof. Click on the 'Q' link to go to the location in the proof.

Location in article	Query / Remark: click on the Q link to go Please insert your reply or correction at the corresponding line in the proof
	Please complete and update the reference given here (preferably with a DOI if the publication data are not known): [1]. For references to articles that are to be included in the same (special) issue, please add the words 'this issue' wherever this occurs in the list and, if appropriate, in the text.
Q1	Please confirm that given names and surnames have been identified correctly.
Q2	Please check the hierarchy of the section headings.
Q3	Please check the citation of references throughout the text.
Q4	Please update Ref. [1].
	Please check this box or indicate your approval if you have no corrections to make to the PDF file ☐

Thank you for your assistance.

PATPHY 7661–7

ELSEVIER

Pathophysiology xxx (2013) xxx–xxx

ISP PATHOPHYSIOLOGY

www.elsevier.com/locate/pathophys

Swedish review strengthens grounds for concluding that radiation from cellular and cordless phones is a probable human carcinogen

Devra Lee Davis[a,*], Santosh Kesari[b], Colin L. Soskolne[c,d], Anthony B. Miller[e], Yael Stein[f,g]

[a] Environmental Health Trust, P.O. Box 58, Teton Village, WY 83025, USA

[b] University of California San Diego, Division of Neuro-Oncology, Department of Neurosciences, University of California, San Diego School of Medicine, USA

[c] Department of Public Health Sciences, School of Public Health, University of Alberta, 3-266 Edmonton Clinic Health Academy, 11405-87 Avenue, Edmonton, AB T6G 1C9, Canada

[d] Faculty of Health, University of Canberra, Australia

[e] Dalla Lana School of Public Health, University of Toronto, Canada

[f] Department of Anesthesiology and Critical Care Medicine, Hebrew University-Hadassah Medical Center, Jerusalem, Israel

[g] Clinical Research Associate in Environmental and Social Epidemiology, WHO Collaborating Center for Capacity Building Braun School of Public Health and Community Medicine Hebrew University-Hadassah, Jerusalem, Israel

Received 11 January 2013; received in revised form 22 January 2013; accepted 28 January 2013

Abstract

With 5.9 billion reported users, mobile phones constitute a new, ubiquitous and rapidly growing exposure worldwide. Mobile phones are two-way microwave radios that also emit low levels of electromagnetic radiation. Inconsistent results have been published on potential risks of brain tumors tied with mobile phone use as a result of important methodological differences in study design and statistical power. Some studies have examined mobile phone users for periods of time that are too short to detect an increased risk of brain cancer, while others have misclassified exposures by placing those with exposures to microwave radiation from cordless phones in the control group, or failing to attribute such exposures in the cases. In 2011, the World Health Organization, International Agency for Research on Cancer (IARC) advised that electromagnetic radiation from mobile phone and other wireless devices constitutes a "possible human carcinogen," 2B. Recent analyses not considered in the IARC review that take into account these methodological shortcomings from a number of authors find that brain tumor risk is significantly elevated for those who have used mobile phones for at least a decade. Studies carried out in Sweden indicate that those who begin using either cordless or mobile phones regularly before age 20 have greater than a fourfold increased risk of ipsilateral glioma. Given that treatment for a single case of brain cancer can cost between $100,000 for radiation therapy alone and up to $1 million depending on drug costs, resources to address this illness are already in short supply and not universally available in either developing or developed countries. Significant additional shortages in oncology services are expected at the current growth of cancer. No other environmental carcinogen has produced evidence of an increased risk in just one decade. Empirical data have shown a difference in the dielectric properties of tissues as a function of age, mostly due to the higher water content in children's tissues. High resolution computerized models based on human imaging data suggest that children are indeed more susceptible to the effects of EMF exposure at microwave frequencies. If the increased brain cancer risk found in young users in these recent studies does apply at the global level, the gap between supply and demand for oncology services will continue to widen. Many nations, phone manufacturers, and expert groups, advise prevention in light of these concerns by taking the simple precaution of "distance" to minimize exposures to the brain and body. We note than brain cancer is the proverbial "tip of the iceberg"; the rest of the body is also showing effects other than cancers.

Keywords: Brain cancer; Mobile phone; Non-ionizing radiation; Microwave radiation; Epidemiology; Case–control; Misclassification; Precautionary advice; WHO; IARC; Human carcinogen; 2A; 2B; Acoustic neuroma; Acute lymphoblastic leukemia; Acute lymphocytic leukemia; Acute myelogenous leukemia lymphoid leukemia; Supply of oncologists; Health services

* Corresponding author.

E-mail addresses: ddavis@ehtrust.org (D.L. Davis), skesari@ucsd.edu (S. Kesari), colin.soskolne@ualberta.ca (C.L. Soskolne), ab.miller@sympatico.ca (A.B. Miller), yael.stein1@mail.huji.ac.il (Y. Stein).

0928-4680/$ – see front matter © 2013 Elsevier Ireland Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.pathophys.2013.03.001

1. Background

Chronic disease epidemiologists studying the etiology of rare diseases necessarily study people's past reported or documented exposures over decades to determine how exposure differed between those who succumbed to illness and those who did not. In so doing, epidemiologists rely on a variety of tools having both strengths and limitations.

Examining general time trends of disease and ages of diagnosis can yield hypotheses about *historical* changes in underlying causal factors, but cannot be relied on to predict *future risks*. For example, the relatively rapid growth in lung cancer in women in industrial countries in the 1970s and 1980s provided a broad and long-predicted indication of the impact of smoking. Similarly, reports in the 1980s of surges in rare ailments such as Kaposi's sarcoma in men under age 30 tied to HIV/AIDS, or rare vaginal adenocarcinoma in pre-adolescent girls whose mothers had taken the hormone di-ethylstibestrol early in pregnancy, have provided important clues about avoidable etiologic factors.

As a matter of public policy, societies around the world are paying the price now for having ignored earlier warnings of public health experts about the need to curtail tobacco, asbestos, vinyl chloride, DES, or to take steps to prevent HIV/AIDS transmission. The costs for treating the ravaging diseases caused by these avoidable environmental health threats have skyrocketed, while the estimated costs of strategies to prevent them pale in comparison.

2. Swedish analysis confirms brain cancer risks from mobile phone radiation

An important new article by the Swedish group of investigators led by Hardell et al. [1] provides a valuable contribution to the epidemiological literature that makes the case for creating preventive policies now to reduce harmful risks associated with mobile (cellular) and cordless phones, and other forms of wireless radiation. On May 21, 2011, a committee of 30 invited scientists from 15 different countries working on behalf of the International Agency for Research on Cancer (IARC) of the World Health Organization reviewed key studies on the topic and characterized exposure to radiofrequency radiation associated with mobile phone use as Group 2B carcinogen—i.e. possibly carcinogenic to humans [2]. This is the same category as the pesticide DDT, gasoline engine exhaust, burning coal and dry cleaning chemicals, and jet fuel—compounds that are subject to serious regulation and control around the world today.

By reviewing key epidemiological studies, some of which have been published since the IARC review, addressing methodological critiques of their own and other studies, and reporting the results of a meta-analysis of their own and the IARC coordinated Interphone study, Hardell et al. provide new and compelling evidence for IARC to re-evaluate its classification of "a possible carcinogen", with a view to changing that assessment of electromagnetic radiation from mobile phones, cordless phones, and other wireless devices at least to a "probable human carcinogen," i.e. Group 2A.

This important review concentrates on the data relating to long-term use of mobile and cordless phones from the handful of case–control studies that have been conducted on the association of mobile phone use with brain tumors, addresses arguments that have questioned the validity of past studies, extended the period of follow-up from first exposures, explains the limited nature of time-trend analyses of rare events such as brain cancer, and provides a cogent analysis of the need for precautionary steps to be taken at this time.

In their article, the Hardell group makes the controversies in this field of enquiry accessible. Being a broad-based state-of-the-art and state-of-knowledge review, their article could serve as an excellent teaching tool in epidemiology graduate programmes. The thoroughness of their documented responses to critiques, includes re-analysis of their own and other data sets and makes possible the rejection of alleged of bias in their own studies' selection/exclusion criteria. Further, the methodological comparisons across the various studies over time, and the observation that, as the exposure period increases, so too do the risk estimates, are compelling for public health action. Finally, the way that the Group was able to integrate exposures both to cordless and mobile phone or cellphone use constructively advances this field of investigation.

3. Age-adjusted population trends and cohort studies of brain cancer are of limited power

As a general matter, population trends are of limited immediate value in evaluating a rare disease like brain cancer that is known to have a long latency. The survivors of the atomic bombs that fell at the end of World War II did not exhibit any increased rate of malignant cancer of the brain until four decades later. This established a long latency between exposure and the development of brain cancer and has important implications regarding the evaluation of environmental factors. As an editorial commentary on the release of the Interphone study noted "None of today's established carcinogens, including tobacco, could have been firmly identified as increasing risk in the first ten years or so since first exposure" [3].

Regarding cohort studies of rare events, as many have noted, the only study to approximate a cohort design of brain cancer risk over time in a population—the Danish Cohort Study—does not comport with required methods to do so [4]. In the Danish study, less than half a million registered mobile phone users were followed and the authors concluded that there is no increased risk. In this study, no direct information on cellphone use was available. Further, the rapidly changing nature of exposure to microwave radiation from cellphones, cordless phones and other similar sources of exposure was not

Please cite this article in press as: D.L. Davis, et al., Swedish review strengthens grounds for concluding that radiation from cellular and cordless phones is a probable human carcinogen, Pathophysiology (2013), http://dx.doi.org/10.1016/j.pathophys.2013.03.001

considered. In addition, corporate users, people who would have been the heaviest users, were included in the unexposed group. Corporate users, amounted to almost a quarter of a million people in the 1990s and are known to have used these technologies four times more often than those in this study. Finally, updates to this cohort also lost significant numbers of the original group to follow-up [5,6]. As a result, it is impossible to take the reported study results of no increased risk at face value, especially considering that a cellphone "user," as defined by the Interphone study, was anyone who made one call a week for 6 months.

4. Case–control studies are powerful for studying mobile phone radiation

In general, epidemiologists appreciate that, for the study of rare diseases, such as brain cancer, the case–control design is far more powerful than a cohort study. In fact, all of the few well-designed case–control studies of this issue have found significantly increased risk after a decade of use, with higher risks occurring in those with highest use. Thus, within Interphone Appendix II, those who used phones for ≥1640 h or more had close to a doubled risk of glioma.

As a number of commentators and several of the principal investigators of the Interphone studies have noted, the Interphone study results are limited in many ways [7,8]. The Interphone study did not include information on exposure to cordless phones or other wireless devices, did not include patients who began using these technologies before age 20, and included no cases that occurred after 2005 [9,10].

As a result, the Interphone results likely underestimate current risks from mobile phones, and cannot be relied on to shed light on the risks for those who began using phones as children or teenagers. Adults and children now use cellphones for many hours a day compared to only 2–2.5 h a month at the time the Interphone study was conducted.

Further, any study that categorizes people who used cordless or portable phones (which emit the same microwave radiation as cellphones) as 'unexposed,' increases the chances of finding no effect when a real one may well be present. This is because the study is comparing people who were actually 'exposed' with others who are considered to have been unexposed, but were, in fact, also 'exposed' to radiofrequency fields. Because the Nordic countries were early users of mobile phones, it was possible for the Hardell group to conduct case–control studies on those who began using cellphones and cordless phones before age 20. So far, they are the only group in the world that has investigated an increased risk from long term usage that began in those under age 20. Consistent with the increased sensitivity of the young to toxic agents, the highest risk of tumors occurred for those who began using wireless phones as teenagers, or earlier, with glioma risk increased fourfold (OR 4.3, 95% CI = 1.2–5.5), and acoustic neuroma risk increased almost sevenfold (OR 6.8, 95% CI = 1.4–34) for ipsilateral use.

An especially important result of the latest Hardell analysis is the finding that patient survival is reduced where mobile phone use began at younger ages. "When adjustment was made for age, the cases with glioblastoma who had used wireless phones had an elevated risk of shortened survival compared to unexposed cases in our study." In addition, "a poorer survival among children with acute lymphoblastic leukemia exposed to ELF-EMF has been reported. . ." [1].

Other findings are consistent with an increased risk for cancers of the blood or bone marrow tied with mobile phone use. One study in Thailand found a threefold risk of leukemia from GSM cell phone use (OR 3.0, 95% CI: 1.4–6.8) and more than a fourfold risk for any lymphoid leukemia (OR 4.5, 95% CI: 1.3–15) [11]. Cooke et al. (2010) Q3 also reported increased Acute Lymphocytic Leukemia (ALL) and Acute Myelogenous Lekeumia (AML) risk with ≥15 years since first use of mobile phones, respectively OR = 1.41 (CI = 0.45–4.37) and OR = 2.08 (CI = 0.98–4.39, calculated p-value = 0.051) [12].

5. Exposure misclassification biases toward the null hypothesis

A Swiss personal monitoring study found that mobile phone use currently accounts for one-third of total exposures to wireless and microwave radiation, with routers and base stations accounting for the rest [13]. Misclassification of exposure is well known to bias toward the null hypothesis, or to a finding of "no effect" when, in fact, an effect may well be present. None of the studies carried out on cell phones thus far, including those of Hardell, has taken into account these important other exposures, many of which have changed quite recently and continue to rapidly expand.

Current standards rest on the assumption that permitted levels of microwave radiation from mobile phones do not induce any measureable change in temperature or biological effect. Several independent avenues of research have shown this assumption to be incorrect.

One important study from Sloan Kettering scientist, David Gultekin, and Lothar Moellaer from Cornell [14], found that currently used cellphones can produce hotspots in living brain tissue. Using Positron Emission Tomography (PET), the Director of the National Institute of Drug Abuse, Nora Volkow, reported that 50 min of use of a mobile phone produces significant change in glucose metabolism in the area of the brain that absorbs the most radiation [15]. Reviewing many other relevant studies on EMF impacts on the brain, Corle et al. (2012), concluded:

"*A variety of human, rodent and cell culture experimental studies though inconclusive, do collectively suggest that mammalian brain tissue may be sensitive to cellphone levels of EMF*" [16].

Please cite this article in press as: D.L. Davis, et al., Swedish review strengthens grounds for concluding that radiation from cellular and cordless phones is a probable human carcinogen, Pathophysiology (2013), http://dx.doi.org/10.1016/j.pathophys.2013.03.001

6. Increased susceptibility in young people

The dielectric properties of tissues indicate how easily material can absorb microwave radiation and determine the tissue's response to an electromagnetic current. The measured properties are the conductivity (σ)—which is directly proportional to the SAR, and the permittivity (ε). Empirical data have shown a difference in the dielectric properties of tissues as a function of age. These differences are mostly due to the higher water content in children's tissues, but they also reflect the physiological development of an organism or tissue that involves structural and biochemical changes. The results of studies on age effects showed that, while the dielectric properties of gray matter do not change with age, other tissues such as white matter and spinal cord vary significantly. More significant results were observed in the case of bone, skull and marrow tissues [17–20].

High resolution computerized models based on real human imaging data suggest that the higher conductivity and higher permittivity in children's brain tissues, together with their thinner skulls and smaller heads, will lead to higher SARs in their brains from microwave frequencies when compared to adults. Exposure to other body organs from cellphones carried in the pockets is common. Effects on other body organs are studied as well as in utero effects on the fetus [21–29].

These and many other studies provide important evidence that biological effects from mobile phone radiation occur with contemporary phones and thus strengthen the case for expecting these devices to have impacts on health.

A letter to the U.S. Congress by the American Academy of Pediatrics, dated 12 December 2012 notes:

"*Children are disproportionately affected by environmental exposures, including cell phone radiation. The differences in bone density and the amount of fluid in a child's brain compared to an adult's brain could allow children to absorb greater quantities of RF energy deeper into their brains than adults. It is essential that any new standards for cell phones or other wireless devices be based on protecting the youngest and most vulnerable populations to ensure they are safeguarded through their lifetimes.*"

7. Shortage in oncology services

Projected supply for oncology services in the U.S. is not expected to meet demand in the near future and is already inadequate. In 2007 a study for the American Society of Clinical Oncology (ASCO, 2007) [projected that "supply is projected to only increase 20% between now and 2020, and capacity for oncologist visits is projected to rise even less at 14%. Demand for oncologist services is projected to grow by 48% during that same time" [30]. The projections were based on current cancer rates and delivery patterns applied to the expected U.S. population in 2020. Unless there is a dramatic change in cancer care treatment or delivery between now and 2020, the nation is expected to face an acute shortage of oncologists." Thus, the number of available oncologists is about half those projected to be needed by 2020.

If the elevated risks found in studies of young cellphone users were to occur globally, then rates of glioma could rise significantly from about 3 to 12 per 100,000. In addition to the direct medical costs involved, there will be substantial indirect costs for society, including loss of productivity of those at the peak of their professional lives and incalculable family impacts. This could create a devastating impact on the capacity to deliver neuro-oncology services.

8. Policy implications and research priorities

A new question that these findings raise is profound: could mobile phone radiation not only cause brain cancers, but could its continued use shorten the lives of those who develop these and other diseases? This prospect raised by the analysis of Hardell et al. (2013) should be sufficiently concerning to prompt health authorities around the world to issue advice, especially to their incident cancer patients, to reduce exposures from mobile and cordless phones, while further work continues to explore this matter.

Other important research questions that should be addressed include the following: Could exposures to mobile phone radiation play a role in the unusual rise in autism? Does the increase in deep vein thrombosis as the leading cause of death in pregnancy have any connection with the growing use of mobile phones during pregnancy? Could blood clots such as that developed by Secretary of State Hillary Clinton after a fall be more frequent in those who are also heavy cellphone users? Are tinnitus and other hearing problems associated with longer-term mobile phone use?

About half of the world's mobile phone users are under age 30 today and live in developing countries. If the risks reported by Hardell et al. were to occur in that population, the capacity to provide health care would be overwhelmed. This year, the Central Brain Tumor Registry of the United States (CBTRUS) estimates that in the U.S. about 10,000 people will develop glioma. CBTRUS reports that gliomas constitute 1 of every 3 brain tumors and 4 out of every 5 malignant brain tumors. If current young users of mobile phones face such heavy risks, then several thousand new cases will develop in the U.S. annually. Oncology surgeons, neuro-oncologists, drugs and nurses are already in short supply in many regions of both the developed and developing world. Prognosis for the disease has not changed appreciably, with five-year survival rates being about 5% (CBTRUS, 2012) [31].

Current standards for exposure to radiofrequency fields were set more than fifteen years ago resting on the belief that levels of microwave radiation from mobile phones cannot induce any measureable change in temperature or other biological effect. Recent analyses show that this assumption is no longer tenable. The General Accountability Office (GAO)

Please cite this article in press as: D.L. Davis, et al., Swedish review strengthens grounds for concluding that radiation from cellular and cordless phones is a probable human carcinogen, Pathophysiology (2013), http://dx.doi.org/10.1016/j.pathophys.2013.03.001

recently advised the U.S. Congress that standards for mobile phones should be reassessed (GAO, 2012), noting that no new proposals had been advanced in the past two decades, a period during which both the users and their uses have changed dramatically.

In considering the overall findings on increased risk of brain cancer and mobile phone and other wireless radiation in its 2011 evaluation, IARC Director, Christopher Wild, offered some simple recommendations that have since been widely shared:

"Given the potential consequences for public health of this classification and findings it is important that additional research be conducted into the long-term, heavy use of mobile phones. Pending the availability of such information, it is important to take pragmatic measures to reduce exposure, such as hands-free devices or texting." [32].

9. Liability, simple precautions, and product warnings

Over the past decade, this advice about reducing exposures through simple precautions has been echoed by a growing number of health professionals and regulatory bodies around the world, including the Finnish Radiation and Nuclear Safety Authority, the Health Safety Authority of Britain, the Israeli Health Ministry, the Indian government's Department of Telecom, the Austrian Medical Society, the American Academy of Pediatrics, Environmental Health Trust, Environmental Working Groups, and many others.

With 5.9 billion reported users worldwide, mobile phones constitute a new, ubiquitous and rapidly growing environmental exposure. In 2011, following publication of the Interphone study results, two of the Interphone study researchers including lead author Cardis published an editorial on the potential public health implications of possible brain tumor risk in mobile phone studies [33]. The authors expressed their concern that small increases in risk, especially those found in ipsilateral localized exposure and in long term users are important when considering the huge numbers of people exposed:

"*. . .The findings in several studies of an increased risk for glioma among the highest users on the side of the head where the phone was used and, in Interphone, in the temporal lobe are therefore important. These are the findings that would be expected if there was a risk, as these are the a priori relevant exposure variables.*"

"*Even a small risk at the individual level could eventually result in a considerable number of tumours and become an important public health issue. Simple and low-cost measures, such as the use of text messages, hands-free kits, and/or the loud-speaker mode of the phone could substantially reduce exposure to the brain from mobile phones.*"

Saracci and Samet's commentary (2010), while less unequivocal, supports this view [3]. Since the risk of greatest interest is lifelong use, possibly beginning in childhood—a pattern of exposure that cannot yet be studied, the authors agree that a precautionary approach to the extent and manner of use of mobile phones may find some support in the elevated risks noted in subjects with the highest exposures.

There are a number of experts who contend that the lack of an overall positive trend in gliomas provides evidence that mobile phone use does not cause brain tumors [34–36]. In addition, some assert that there is no exposure–response relationship, either in terms of the amount of mobile phone use or by localization of the brain tumor, and that this argues against a causal association [37]. But, reviews conducted by groups of researchers from different countries, as well as published policy resolutions and advisories from national authorities such as the Finnish Radiation and Nuclear Safety Authority and the Austrian Medical Society, reach much different conclusions and fully support the need for a precautionary approach regarding risk.

The grounds for taking precautionary steps rest on a growing body of evidence.

Abdus-salam et al., 2008: "*the need for caution is emphasized as it may take up to four decades for carcinogenesis to become fully apparent*" [38].

Myung et al., 2009: "*The current study found that there is possible evidence linking mobile phone use to an increased risk of tumors from a meta-analysis of low-biased case–control studies*" [39].

Levis et al., 2011: "*Our analysis of the literature studies and of the results from meta-analyses of the significant data alone shows an almost doubling of the risk of head tumors induced by long-term mobile phone use or latency*" [40].

Committee on the Environment, Agriculture and Local and Regional Affairs of the Council of Europe (2011): "*[For mobile phones] One must respect the precautionary principle and revise the current threshold values; waiting for high levels of scientific and clinical proof can lead to very high health and economic costs, as was the case in the past with asbestos, leaded petrol and tobacco*" [41].

The Russian National Committee On Nonionizing Radiation Protection (RNCNIRP) "*Urgent measures must be taken because of the inability of children to recognize the harm from the mobile phone use and that a mobile phone itself can be considered as an uncontrolled source of harmful exposure*" [42].

As a sign of the times, manufacturers and businesses are developing ways to promote reductions in radiation as well. One of the fastest growing mobile apps is called tawkon—which provides an algorithm indicating the potential danger from signal strength to those using phones. Globally, sales of cases and headsets tested and confirmed to reduce radiation have grown, indicating market demand for such devices.

Please cite this article in press as: D.L. Davis, et al., Swedish review strengthens grounds for concluding that radiation from cellular and cordless phones is a probable human carcinogen, Pathophysiology (2013), http://dx.doi.org/10.1016/j.pathophys.2013.03.001

Phone manufacturers are also issuing advice on reducing exposure, as these notices from Apple and Samsung indicate:

"*To reduce exposure to RF energy, use a hands-free option, such as the built-in speakerphone, the supplied headphones, or other similar accessories. Carry iPhone at least 10 mm away from your body to ensure exposure levels remain at or below the as-tested levels. Cases with metal parts may change the RF performance of the device, including its compliance with RF exposure guidelines, in a manner that has not been testified or certified.*"

What is missing altogether in the above statement is this previously published advice from Apple that these phones, when carried in the pocket, can exceed the FCC exposure guidelines.

Warning: "iPhone's SAR measurement may exceed the FCC exposure guidelines for body-worn operation if positioned less than 15 mm (5/8 inch) from the body (e.g. when carrying iPhone in your pocket)."

Such advice about safer use no longer appears in a printed pamphlet with iPhones, but can be found on the phones by clicking *settings/general/about/legal/RFexposure*.

Other manufacturers also include more safety advice. Samsung is the number one producer of cellphones in the world today. Their new Convoy 2 phone comes with this advice:

"*Your mobile device is not a toy. Do not allow children to play with it because they could hurt themselves and others, damage the device, or make calls that increase your mobile device bill.*"

"*Keep the mobile device and all its parts and accessories out of the reach of small children.*"

The challenge to public health is how to promote sensible policies now. The focus on brain cancer may be the tip of the iceberg in relation to a host of other serious widespread health, behavioral and social effects from such radiation. Downloadable resources that draw upon advisories developed by experts in many nations are available in several languages at www.ehtrust.org.

10. Practical advice for the public

When it comes to using electronic devices, remember: *Distance is your friend.*

- Don't hold a cellphone directly up to your head. Use a headset or speakerphone when using the device, or a non-metal case that has been independently tested to reduce radiation up to 90%.
- Pregnant women should keep cellphones away from their abdomen and men who wish to become fathers should not keep these phones on while in their pocket.
- Don't allow children to play with or use your cellphone. Older children should use a headset or speakerphone when talking on a cellphone.
- Do not text and drive and only use specially adapted antennas when using mobile phones in cars to avoid absorbing maximum power as the phone moves from one cell system to another. When buying a new car, pay attention that the car has a built-in antenna that reduces your direct exposure.
- Turn off your wireless router at night to minimize exposure to radiation.
- Eat green vegetables and get a good night's sleep in a dark room to enhance natural repair of DNA that may have been damaged by radiation.

References

[1] L. Hardell, M. Carlberg, K.H. Mild, Use of mobile phones and cordless phones is associated with increased risk for glioma and acoustic neuroma, Pathophysiology, in press.

[2] IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Volume 102, Non-Ionizing radiation, Part II: Radiofrequency Electromagnetic Fields [Includes Mobile Phones], IARC Press, Lyon, France, 2011.

[3] R. Saracci, J. Samet, Commentary: call me on my mobile phone ... or better not?—a look at the INTERPHONE study results, International Journal of Epidemiology 39 (2010) 695–698.

[4] C. Johansen, J.D. Boice Jr., J. McLaughlin, J. Olsen, Cellular telephones and cancer—a nationwide cohort study in Denmark, Journal of the National Cancer Institute 93 (2001) 203–207.

[5] J. Schüz, R. Jacobsen, J.H. Olsen, J.D. Boice Jr., J.K. McLaughlin, C. Johansen, Cellular telephone use and cancer risk: update of a nationwide Danish cohort, Journal of the National Cancer Institute 98 (2006) 1707–1713.

[6] P. Frei, A. Harbo Poulsen, C. Johansen, J.H. Olsen, M. Steding-Jessen, J. Schüz, Use of mobile phones and risk of brain tumours: update of Danish cohort study, British Medical Journal 343 (2011) d6387.

[7] L.L. Morgan, E. Barris, J. Newton, E. O'Connor, A. Philips, G. Philips, C. Rees, B. Stein, Cellphones and brain tumors: 15 reasons for concern, Science, Spin and the Truth Behind Interphone (2009) 1–44.

[8] M. Kundi, The controversy about a possible relationship between mobile phone use and cancer, Cien Saude Colet 15 (August (5)) (2010) 2415–2430.

[9] Interphone Study Group, Brain tumour risk in relation to mobile telephone use: results of the INTERPHONE international case–control study, International Journal of Epidemiology 39 (2010) 675–694.

[10] E. Cardis, B.K. Armstrong, J.D. Bowman, G.G. Giles, M. Hours, D. Krewski, et al., Risk of brain tumours in relation to estimated RF dose from mobile phones: results from five Interphone countries, Occupational and Environmental Medicine 68 (2011) 631–640.

[11] D.W. Kaufman, T.E. Anderson, S. Issaragrisil, Risk factors for leukemia in Thailand, Annals of Hematology 88 (11) (2009) 1079–1088.

[12] R. Cooke, S. Laing, A.J. Swerdlow, A case–control study of risk of leukaemia in relation to mobile phone use, British Journal of Cancer 103 (2010) 1729–1735.

[13] W. Joseph, P. Frei, M. Roösli, G. Thuróczy, P. Gajsek, T. Trcek, J. Bolte, G. Vermeeren, E. Mohler, P. Juhász, V. Finta, L. Martens, Comparison of personal radio frequency electromagnetic field exposure in different urban areas across Europe, Environmental Research 110 (7) (2010) 658–663.

[14] D.H. Gultekin, L. Moeller, NMR imaging of cell phone radiation absorption in brain tissue. Physical Sciences – Physics – Biological Sciences – Biophysics and Computational Biology: PNAS (2013), Published ahead of print December 17, 2012.

Please cite this article in press as: D.L. Davis, et al., Swedish review strengthens grounds for concluding that radiation from cellular and cordless phones is a probable human carcinogen, Pathophysiology (2013), http://dx.doi.org/10.1016/j.pathophys.2013.03.001

[15] N.D. Volkow, D. Tomasi, G. Wang, et al., Effects of cell phone radiofrequency signal exposure on brain glucose metabolism, JAMA 305 (8) (2011) 808–813.

[16] C. Corle, M. Makale, S. Kesari, Cell phones and glioma risk: a review of the evidence, Journal of Neurooncology 106 (1) (2012) 1–13.

[17] A. Peyman, A.A. Rezazadeh, C. Gabriel, Changes in the dielectric properties of rat tissue as a function of age at microwave frequencies, Physics in Medicine and Biology 46 (6) (2001) 1617–1629.

[18] A. Peyman, S.J. Holden, S. Watts, R. Perrott, C. Gabriel, Dielectric properties of porcine cerebrospinal tissues at microwave frequencies: in vivo, in vitro and systematic variation with age, Physics in Medicine and Biology 52 (8) (2007) 2229–2245.

[19] A. Peyman, C. Gabriel, E.H. Grant, G. Vermeeren, L. Martens, Variation of the dielectric properties of tissues with age: the effect on the values of SAR in children when exposed to walkie-talkie devices, Physics in Medicine and Biology 54 (2) (2009) 227–241.

[20] A. Peyman, C. Gabriel, H.R. Benedickter, J. Fröhlich, Dielectric properties of human placenta, umbilical cord and amniotic fluid. Physics in Medicine and Biology 56 (7) (2011) N93–N98.

[21] O.P. Gandhi, G. Lazzi, C.M. Furse, Electromagnetic absorption in the human head and neck for mobile telephones at 835 and 1900 MHz, IEEE Transactions on Microwave Theory and Techniques 44 (1996) 1884–1897.

[22] O.P. Gandhi, G. Kang, Some present problems and a proposed experimental phantom for SAR compliance testing of cellular telephones at 835 and 1900 MHz, Physics in Medicine and Biology 47 (2002) 1501.

[23] G. Kang, O.P. Gandhi, SARs for pocket-mounted mobile telephones at 835 and 1900 MHz, Physics in Medicine and Biology 47 (23) (2002) 4301–4313.

[24] S. Koulouridis, M. Christopoulou, K.S. Nikita, Comparative assessment of power absorption in heads of adults and children exposed to the radiation of cellular phones at 1800 MHz, The Environmentalist 25 (2005) 223–232.

[25] A.A. de Salles, G. Bulla, C.E. Rodriguez, Electromagnetic absorption in the head of adults and children due to mobile phone operation close to the head. Electromagnetic Biology and Medicine 25 (4) (2006) 349–360.

[26] A. Christ, M.C. Gosselin, M. Christopoulou, S. Kühn, N. Kuster, Age-dependent tissue-specific exposure of cell phone users. Physics in Medicine and Biology 55 (7) (2010) 1767–1783.

[27] S. Akimoto, S. Kikuchi, T. Nagaoka, K. Saito, S. Watanabe, M. Takahashi, K. Ito, Evaluation of specific absorption rate for a fetus by portable radio terminal close to the abdomen of a pregnant woman, IEEE Transactions on Microwave Theory And Techniques 58 (12) (2010).

[28] A. Tomruk, G. Guler, B. Tandogan, E. Ozgur, N.N. Ulusu, N. Seyhan, Effects of intrauterine and extrauterine exposure to 1800 MHz GSM-like radiofrequency radiation on liver regulatory enzymes activities in infant female rabbits, World Academy of Science, Engineering and Technology 44 (2010).

[29] O.P. Gandhi, L.L. Morgan, A.A. de Salles, Y.Y. Han, R.B. Herberman, D.L. Davis, Exposure limits: the underestimation of absorbed cell phone radiation, especially in children, Electromagnetic Biology and Medicine (2011) 1–18.

[30] ASCO, Forecasting the Supply of and Demand for Oncologists: A Report to the American Society of Clinical Oncology (ASCO) from the AAMC Center for Workforce Studies Center for Workforce Studies, 2007.

[31] T.A. Dolecek, J.M. Propp, N.E. Stroup, C. Kutchko, CBTRUS statistical report: primary brain and central nervous system tumors diagnosed in the United States in 2005–2009. Neuro-Oncology 14 (Suppl. 5) (2012) v1–v49.

[32] IARC Classifies Radiofrequency Electromagnetic Fields as Possibly Carcinogenic to Humans. Press Release No. 208, IARC, WHO, 31 May, 2011.

[33] E. Cardis, S. Sadetzki, Indications of possible brain-tumour risk in mobile-phone studies: should we be concerned? Occupational and Environmental Medicine 68 (3) (2011) 169–171.

[34] A.J. Swerdlow, M. Feychting, A.C. Green, L.K. Kheifets, D.A. Savitz, International Commission for Non-Ionizing Radiation Protection Standing Committee on Epidemiology. Mobile phones, brain tumors, and the interphone study: where are we now? Environmental Health Perspectives 119 (11) (2011) 1534–1538.

[35] I. Deltour, A. Auvinen, M. Feychting, C. Johansen, L. Klaeboe, R. Sankila, J. Schüz, Mobile phone use and incidence of glioma in the Nordic countries 1979–2008: consistency check, Epidemiology 23 (2) (2012) 301–307.

[36] F. de Vocht, I. Burstyn, J.W. Cherrie, Time trends (1998–2007) in brain cancer incidence rates in relation to mobile phone use in England, Bioelectromagnetics 32 (5) (2011) 334–339.

[37] D. Aydin, M. Feychting, J. Schüz, T. Tynes, T.V. Andersen, L.S. Schmidt, A.H. Poulsen, C. Johansen, M. Prochazka, B. Lannering, L. Klæboe, T. Eggen, D. Jenni, M. Grotzer, N. Von der Weid, C.E. Kuehni, M. Röösli, Mobile phone use and brain tumors in children and adolescents: a multicenter case–control study. Journal of the National Cancer Institute 103 (16) (2011) 1264–1276.

[38] A. Abdus-salam, T. Elumelu, A. Adenipekun, Mobile phone radiation and the risk of cancer; a review. African Journal of Medicine and Medical Sciences 37 (2) (2008) 107–118.

[39] S.K. Myung, W. Ju, D.D. McDonnell, Y.J. Lee, G. Kazinets, C.T. Cheng, J.M. Moskowitz, Mobile phone use and risk of tumors: a meta-analysis, Journal of Clinical Oncology 27 (33) (2009) 5565.

[40] A.G. Levis, N. Minicuci, P. Ricci, V. Gennaro, S. Garbisa, Mobile phones and head tumours. The discrepancies in cause–effect relationships in the epidemiological studies – how do they arise? Environmental Health 10 (2011) 59.

[41] Committee on the Environment, Agriculture and Local and Regional Affairs, The potential dangers of electromagnetic fields and their effect on the environment. Parliamentary Assembly, Council of Europe. 6 May 2011. http://www.scribd.com/doc/55253905/The-Potential-Dangers-of-Electromagnetic-Fields-and-their-Effect-on-the-Environment

[42] Russian National Committee on Non-Ionizing Radiation Protection, Resolution: electromagnetic fields from mobile phones: health effect on children and teenagers, April 2011.

Please cite this article in press as: D.L. Davis, et al., Swedish review strengthens grounds for concluding that radiation from cellular and cordless phones is a probable human carcinogen, Pathophysiology (2013), http://dx.doi.org/10.1016/j.pathophys.2013.03.001

#8 File #130315, Received in Committee 4/8/13

Milton Marks III, SF college trustee, dies

Carl Nolte
Updated 9:09 pm, Friday, August 10, 2012

Milton Marks III came from a noted political family and was executive director of several nonprofits. Photo: Lea Suzuki, The Chronicle

Milton Marks III, a member of a noted San Francisco political family and a trustee of the City College of San Francisco, died at his San Francisco home Thursday. Mr. Marks was 52 and suffered from glioblastoma, an aggressive form of brain tumor.

Services will be held at the Sinai Memorial Chapel, 1501 Divisadero St., San Francisco, at 11:30 a.m. Sunday.

Mr. Marks suspected that his brain tumor was connected to heavy use of cellular phones, and spoke out often in support of requiring cell phone companies to disclose how much radiation is emitted by the devices.

It was the demands of a political campaign that convinced Mr. Marks to acquire and use a cell phone. He suffered a seizure in December 2010 and strongly suspected - but could never prove - that the tumor he developed was connected to his cell phone.

Mr. Marks was a member of a family active in San Francisco politics for over 40 years. His father was state senator and Judge Milton Marks and his mother Carolene Wachenheimer

Photo Galleries Displaying 1-3 of 40


Celebs at Coachella 2013


Coachella 2013


Athletes who went broke

Most Read | Most Commented

1. 2 explosions at Boston marathon finish line
2. 2 explosions at Boston marathon finish line
3. Boat filled with protected species hits coral reef
4. Berkeley firefighter grazed by bullet
5. Lawyer: Assaulted teen had drawings, name on body
6. Aubrey Plaza asked to leave MTV Movie Awards
7. Two explosions at the finish line of the Boston Marathon result in injuries.

Marks, a longtime member of the San Francisco Commission on the Status of Women, was an influential political figure in her own right.

Mr. Marks had a career as an executive with nonprofit organizations, particularly Friends of the Urban Forest, which planted trees all over the city.

He was also devoted to the region's community colleges and first ran for the San Francisco Community College board in 2000 and was re-elected twice. In his last campaign in 2008, he set a record for the most votes received for the community college board.

He served as president of the City College board, as vice president and as chair of a number of important committees. He attended a trustee meeting as recently as last week and had been working on solutions to the college's problems with accreditation.

"He was dedicated to the needs and priorities of our students, education reform (and) environmental stewardship," said Mayor Ed Lee in a statement.

Lee also called Mr. Marks "a champion for our most vulnerable communities in San Francisco."

Mr. Marks was born in San Francisco and was a graduate of Bowdoin College. He held a master's degree in historical preservation from the University of Pennsylvania.

He served as executive director of several San Francisco organizations, including the Friends of the Urban Forest, the Urban Creeks Council and Congregation Kol Shofar.

He is survived by his wife, Abigail Levinson Marks; by three sons, Nathan, Will and Theo, all of San Francisco; by a brother, David Marks of Mountain View; and a sister, Caro Marks of Sacramento.

Carl Nolte is a San Francisco Chronicle staff writer. E-mail: cnolte@sfchronicle.com

Most Popular Comments

heliosheath 6:32 PM on August 10, 2012

It's difficult to appreciate the contributions of one person, but he seems to own shoes which will be difficult to fill. To his family, condolences.

REPLY (27) (3) POPULARITY: 24 [Report Abuse]

3 replies

rlouie05 6:11 PM on August 10, 2012

RIP Mr. Marks.

American Academy of Pediatrics
DEDICATED TO THE HEALTH OF ALL CHILDREN™

Received in Committee
4/18/13

AAP Headquarters
141 Northwest Point Blvd
Elk Grove Village, IL 60007-1019
Phone: 847/434-4000
Fax: 847/434-8000
E-mail: kidsdocs@aap.org
www.aap.org

Reply to
Department of Federal Affairs
Homer Building, Suite 400 N
601 13th St NW
Washington, DC 20005
Phone: 202/347-8600
Fax: 202/393-6137
E-mail: kids1st@aap.org

December 12, 2012

The Honorable Dennis Kucinich
2445 Rayburn House Office Building
Washington, DC 20515

Dear Representative Kucinich:

On behalf of the American Academy of Pediatrics (AAP), a non-profit professional organization of 60,000 primary care pediatricians, pediatric medical sub-specialists, and pediatric surgical specialists dedicated to the health, safety and well-being of infants, children, adolescents, and young adults, I would like to share our support of H.R. 6358, the *Cell Phone Right to Know Act.*

The AAP strongly supports H.R. 6358's emphasis on examining the effects of radiofrequency (RF) energy on vulnerable populations, including children and pregnant women. In addition, we are pleased that the bill would require the consideration of those effects when developing maximum exposure standards. Children are disproportionately affected by environmental exposures, including cell phone radiation. The differences in bone density and the amount of fluid in a child's brain compared to an adult's brain could allow children to absorb greater quantities of RF energy deeper into their brains than adults. It is essential that any new standards for cell phones or other wireless devices be based on protecting the youngest and most vulnerable populations to ensure they are safeguarded through their lifetimes.

In addition, the AAP supports the product labeling requirements in H.R. 6358. These standards will ensure consumers can make informed choices in selecting mobile phone purchases. They will also enable parents to better understand the potential dangers of RF energy exposure and protect their children.

On July 24, the U.S. Government Accountability Office (GAO) published a report on federal cell phone radiation exposure limits and testing requirements. The GAO noted that the Federal Communications Commission's (FCC) most recent data indicates that the number of estimated mobile phone subscribers has grown from approximately 3.5 million in 1989 to approximately 289 million at the end of 2009. Cell phone use behaviors have also changed during that time. The quantity and duration of cell phone calls has increased, as has the amount of time people use mobile phones, while cell phone and wireless technology has undergone substantial changes. Many more people, especially adolescents and young adults, now use cell phones as their only phone line, and they begin using wireless phones at much younger ages.

Despite these dramatic changes in mobile phone technology and behavior, the FCC has not revisited the standard for cell phone radiation exposure since 1996. The current FCC standard for maximum radiation exposure levels is based on the heat emitted by mobile phones. These guidelines specify exposure limits for hand-held wireless devices in terms of the Specific Absorption Rate (SAR), which measures the rate the body absorbs radiofrequency (RF). The current allowable SAR limit is 1.6 watts per kilogram (W/kg), as averaged over one gram of tissue. Although wireless devices sold in the United States must ensure that they do not exceed the maximum allowable SAR limit when operating at the device's highest possible power level, concerns have been raised that long-term RF energy exposure at this level affects the brain and other tissues and may be connected to types of brain cancer, including glioma and meningioma.

In May 2011, the International Agency for Research on Cancer (IARC), the United Nations' World Health Organization's (WHO) agency promoting international cancer research collaboration, classified RF energy as "possibly carcinogenic to humans." In addition, the National Cancer Institute has stated that although studies have not definitively linked RF energy exposure from cell phones to cancer, more research is required to address rapidly changing cell phone technology and use patterns.

This and other research identified by the GAO demonstrates the need for further research on this issue, and makes clear that exposure standards should be reexamined.

The GAO concluded that the current exposure limits may not reflect the latest research on RF energy, and that current mobile phone testing requirements may not identify maximum RF energy exposure. The GAO proposed that the FCC formally reassess its limit and testing requirements to determine whether they are effective. The AAP commends the activities proposed under H.R. 6358, as they would address this research gap and improve consumer knowledge and safety. Establishing an expanded federal research program as the basis for exposure standards will ensure that consumer protections incorporate the latest research. Currently, the National Institute of Health (NIH), the only federal agency the GAO identified as directly funding research on this topic, provided approximately $35 million from 2001 to 2011. Given this previous funding level, the AAP supports the $50 million per fiscal year for seven years that H.R. 6358 would authorize.

The AAP appreciates your recognition of the need for new research and standards for mobile phone radiation, and is pleased to support H.R. 6358. For further assistance, please do not hesitate to contact Sonya Clay, Assistant Director, Department of Federal Affairs, at 202-347-8600 or sclay@aap.org.

Sincerely,

Thomas K. McInerny, MD, FAAP
President

HARVARD MEDICAL SCHOOL

MASSACHUSETTS GENERAL HOSPITAL

Martha R. Herbert, Ph.D., M.D.
Assistant Professor, Pediatric Neurology
Director, TRANSCEND Research Program
www.transcendresearch.org
transcend@partners.org

TRANSCEND

Martinos Center for Biomedical Imaging
149 13th Street, Room 10.018
Boston, Massachusetts 02129
Phone: (617) 724-5920
Fax: (617) 812-6334
mherbert1@partners.org

Received in Committee 4/18/13

TO: Los Angeles Unified School District
FROM: Martha R Herbert, PhD, MD
RE: Wireless vs. Wired in Classrooms
DATE: February 8, 2013

I am a pediatric neurologist and neuroscientist on the faculty of Harvard Medical School and on staff at the Massachusetts General Hospital. I am Board Certified in Neurology with Special Competency in Child Neurology, and Subspecialty Certification in Neurodevelopmental Disorders.

I have an extensive history of research and clinical practice in neurodevelopmental disorders, particularly autism spectrum disorders. I have published papers in brain imaging research, in physiological abnormalities in autism spectrum disorders, and in environmental influences on ndurodevelopmental disorders such as autism and on brain development and function.

I recently accepted an invitation to review literature pertinent to a potential link between Autism Spectrum Disorders and Electromagnetic Frequencies (EMF) and Radiofrequency Radiation (RFR). I set out to write a paper of modest length, but found much more literature than I had anticipated to review. I ended up producing a 60 page single spaced paper with over 550 citations. It is available at http://www.bioinitiative.org/report/wp-content/uploads/pdfs/sec20_2012_Findings_in_Autism.pdf.

In fact, there are thousands of papers that have accumulated over decades – and are now accumulating at an accelerating pace, as our ability to measure impacts become more sensitive – that document adverse health and neurological impacts of EMF/RFR. Children are more vulnerable than adults, and children with chronic illnesses and/or neurodevelopmental disabilities are even more vulnerable. Elderly or chronically ill adults are more vulnerable than healthy adults.

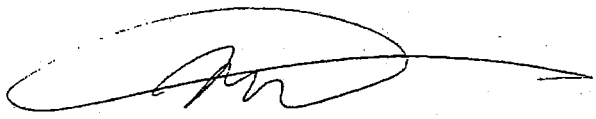
Current te chnologies were designed and promulgated without taking account of biological impacts other than thermal impacts. We now know that there are a large array of impacts that have nothing to do with the heating of tissue. The claim from wifi proponents that the only concern is thermal impacts is now definitively outdated scientifically.

EMF/RFR from wifi and cell towers can exert a disorganizing effect on the ability to learn and remember, and can also be destabilizing to immune and metabolic function. This will make it harder for some children to learn, particularly those who are already having problems in the first place.

Powerful industrial entities have a vested interest in leading the public to believe that EMF/RFR, which we cannot see, taste or touch, is harmless, but this is not true. Please do the right and precautionary thing for our children

I urge you to step back from your intention to go wifi in the LAUSD, and instead opt for wired technologies, particularly for those subpopulations that are most sensitive. It will be easier for you to make a healthier decision now than to undo a misguided decision later.

Thank you.



Martha Herbert, PhD, MD
Pediatric Neurology
Martinos Center for Biomedical Imaging
Massachusetts General Hospital
Harvard Medical School
Boston, Massachusetts
USA

Received in Committee 4/18/13

San Francisco's Cell Phone Fact Sheet is Factual

Joel M. Moskowitz, Ph.D.
UC Berkeley Center for Family and Community Health
September 12, 2012

Contrary to the recent opinion issued by the 9th U.S. Circuit Court of Appeals, the revised fact sheet adopted by San Francisco to implement its cell phone "right to know" ordinance is "factual and uncontroversial." (1)

This ordinance is the first in the U.S to require cell phone retailers to distribute a fact sheet that informs customers that cell phone use may increase their risk of cancer. Furthermore, it provides important information about how to use cell phones safely to reduce potential health risks.

All but one of the assertions in the fact sheet appear on the FCC and FDA web sites. A statement about children's greater exposure to cell phone radiation has been documented in the peer-reviewed, scientific literature by Professor Om Gandhi and his colleagues. (2)

The FCC and FDA make similar recommendations on their web sites for consumers who are concerned about their exposure to cell phone radiation so the San Francisco fact sheet is no more controversial than the Federal government's advice to consumers who wish to reduce potential risks.

The revised fact sheet incorporates the concerns raised by the CTIA, the wireless industry lobbying group, about the original fact sheet developed by the City. The revised fact sheet was approved by U.S. District Judge William Alsup who heard the lawsuit filed by the CTIA against San Francisco. According to the judge, the CTIA chose not to contest the revised fact sheet but now claims it did not have the opportunity to do so.

Since the original hearing on this case, the U.S. Government Accountability Office issued a report that challenges the FCC's certification of cell phone safety and called on the FCC to revamp its cell phone testing procedures because cell phone users generally keep their phones closer to their body than the test allows. Thus, cell phone users may be exposed to more radiation than the FCC considers to be safe. (3) Also, a bill was introduced in the Congress that would require cell phone warning labels and make the Environmental Protection Agency the lead Federal agency for protecting the public from cell phone radiation health risks. (4)

The revised fact sheet appears below. Following this is an annotated version of the fact sheet that includes citations from the FCC and FDA web sites which support the assertions made in the fact sheet.

References

(1) Egelko, B. Court blocks S.F. warning on cell phones. *San Francisco Chronicle*. Sep 10, 2012. http://www.sfgate.com/bayarea/article/Court-blocks-S-F-warning-on-cell-phones-3854826.php

(2) "When electrical properties are considered, a child's head's absorption can be over two times greater, and absorption of the skull's bone marrow can be ten times greater than adults." (Gandhi, Morgan, de Salles, Han, Herberman, Davis. Exposure Limits: The underestimation of absorbed cell phone radiation, especially in children. Electromagn Biol Med 2012; 31(1):34-51. http://www.ncbi.nlm.nih.gov/pubmed/21999884)

(3) "Exposure and Testing Requirements for Mobile Phones Should Be Reassessed." GAO-12-771, Jul 24, 2012. http://www.gao.gov/products/GAO-12-771

(4) Tsukayama H. GAO criticizes FCC's standards for cellphone radiation. Washington Post, Aug 7, 2012. http://www.washingtonpost.com/business/economy/gao-criticizes-fccs-standards-for-cellphone-radiation/2012/08/07/08c1e91e-e0c9-11e1-8fc5-a7dcf1fc161d_story.html

http://www.prlog.org/11973342

You can limit exposure to Radio-frequency (RF) Energy from your cell phone.

Although all cell phones sold in the United States must comply with RF safety limits set by the Federal Communications Commission (FCC), no safety study has ever ruled out the possibility of human harm from RF exposure.

This material was prepared solely by the City and County of San Francisco and must be provided to consumers under local law.

11/11

RF Energy has been classified by the World Health Organization as a possible carcinogen (rather than as a known carcinogen or a probable carcinogen) and studies continue to assess the potential health effects of cell phones. **If you are concerned about potential health effects from cell phone RF Energy, the City of San Francisco recommends:**

- **Limiting cell phone use by children**
  Average RF energy deposition for children is two times higher in the brain and up to ten times higher in the bone marrow of the skull compared with cell phone use by adults.
- **Using a headset, speakerphone or text instead**
  Exposure decreases rapidly with increasing distance from the phone.
- **Using belt clips and purses to keep distance between your phone and body**
  Do not carry on your body to at least meet the distance specified in your phone's user manual.
- **Avoiding cell phones in areas with weak signals (elevators, on transit, etc.)**
  Using a cell phone in areas of good reception decreases exposure by allowing the phone to transmit at reduced power.
- **Reducing the number and length of calls**
  Turn off your cell phone when not in use.

Learn More: **SF Department of the Environment** @ SFEnvironment.org/cellphoneradiation • (415) 355-3700
Federal Communications Commission @ FCC.gov/cgb/consumerfacts/mobilephone.html
World Health Organization @ WHO.int/mediacentre/factsheets/fs193/en/

This material was prepared solely by the City and County of San Francisco and must be provided to consumers under local law.

11/11

Annotated version of
San Francisco's revised (11/11) cell phone fact sheet

Received in Committee 4/18/16

SF: "You can limit exposure to Radio-frequency (RF) Energy from your cell phone."

[FCC1: "if you are concerned about avoiding even potential risks, you can take a few simple steps to minimize your exposure to radiofrequency energy (RF)."]

SF: "Although all cell phones sold in the United States must comply with RF Safety limits set by the Federal Communications Commission (FCC), no safety study has ever ruled out the possibility of human harm from RF exposure."

[FCC2: "there is no federally developed national standard for safe levels of exposure to radiofrequency (RF) energy ... Federal, state and local government agencies and other organizations have generally relied on RF exposure standards developed by expert non-government organizations such as the Institute of Electrical and Electronics Engineers (IEEE) and the National Council on Radiation Protection and Measurements (NCRP). Since 1996, the FCC has required that all wireless communications devices sold in the United States meet its minimum guidelines for safe human exposure to radiofrequency (RF) energy. The FCC's guidelines and rules regarding RF exposure are based upon standards developed by IEEE and NCRP and input from other federal agencies, such as those listed above ... to date, the weight of scientific evidence has not effectively linked exposure to radio frequency energy from mobile devices with any known health problems."]

[FCC3: "The FDA, which has primary jurisdiction for investigating mobile phone safety, has stated that it cannot rule out the possibility of risk, but if such a risk exists, 'it is probably small'."]

SF: "RF energy has been classified by the World Health Organization as a possible carcinogen (rather than as a known carcinogen or a probable carcinogen) and studies continue to assess the potential health effects of cell phones."

[FCC2: "Recently, some health and safety interest groups have interpreted certain reports to suggest that wireless device use may be linked to cancer and other illnesses, posing potentially greater risks for children than adults. While these assertions have gained increased public attention, currently no scientific evidence establishes a causal link between wireless device use and cancer or other illnesses... The FCC closely monitors all of these study results. However, at this time, there is no basis on which to establish a different safety threshold than our current requirements."]

[FCC4: "IARC Classification: On May 31, 2011, the World Health Organization's International Agency for Research on Cancer (IARC) classified radiofrequency fields as 'possibly carcinogenic to humans.'"]

[FDA1: "The World Health Organization's International Agency for Research on Cancer Classified Radiofrequency Fields as Possibly Carcinogenic to Humans on May 31, 2011.

The International Agency for Research on Cancer (IARC), through the *Monographs* program, seeks to identify environmental factors that can increase the risk of cancer in humans. IARC uses the following categories to classify environmental agents:

Group 1	Carcinogenic to humans.
Group 2A	Probably carcinogenic to humans.
Group 2B	Possibly carcinogenic to humans.
Group 3	Not classifiable as to its carcinogenicity to humans.
Group 4	Probably not carcinogenic to humans.

IARC has classified radiofrequency fields in Group 2B, possibly carcinogenic to humans.

IARC interprets the 2B classification as meaning there is limited evidence showing radiofrequency carcinogenicity in humans and less than sufficient evidence of carcinogenicity in experimental animals."]

SF: "If you are concerned about potential health effects from cell phone energy, the City of San Francisco recommends:"

[FCC2: some parties recommend taking measures to further reduce exposure to RF energy. **The FCC does not endorse the need for these practices**, but provides information on some simple steps that you can take to reduce your exposure to RF energy from cell phones. **For example**, wireless devices only emit RF energy when you are using them and, the closer the device is to you, the more energy you will absorb.]

[FCC3: "Further, it [the FDA] has stated that, while there is no proof that cellular telephones can be harmful, concerned individuals can take various precautionary actions ..." SF: Some measures to reduce your RF exposure include:"]

- **SF: "Limiting cell phone use by children"**
  Average RF energy deposition for children is two time higher in the brain and up to ten times higher in the bone marrow of the skull compared with cell phone use by adults."

[Gandhi et al (2012).]

[FDA2: "The scientific evidence does not show a danger to any users of cell phones from RF exposure, including children and teenagers. The steps adults can take to reduce RF exposure apply to children and teenagers as well.
- Reduce the amount of time spent on the cell phone"]

[FDA1: "there is consensus that additional research is warranted to address gaps in knowledge, such as the effects of cell phone use over the long-term and on pediatric populations."]

- **SF: "Using a headset, speakerphone or text instead**
  Exposure decreases rapidly with increasing distance from the phone."

[FCC2: "Use a speakerphone, earpiece or headset to reduce proximity to the head (and thus exposure). While wired earpieces may conduct some energy to the head and wireless earpieces also emit a small amount of RF energy, both wired and wireless earpieces remove the greatest source of RF energy (the cell phone) from proximity to the head and thus can greatly reduce total exposure to the head.]

[FCC2: "Consider texting rather than talking - but don't text while you are driving."]

[FCC2: "Increase the distance between wireless devices and your body."]

[FCC3: [FDA recommendation):"making greater use of telephones with hands-free kits where there is a greater separation distance between the user and the radiating antenna."]

- **SF: "Using belt clips and purses to keep distance between your body and the phone Do not carry on your body to at least meet the distance specified in your phone's user manual."**

[FCC1: "If you must conduct extended conversations by wireless phone every day, you could place more distance between your body and the source of the RF, since the exposure level drops off dramatically with distance. For example, you could use a headset and carry the wireless phone away from your body or use a wireless phone connected to a remote antenna."]

- **SF: "Avoiding cell phones in areas with weak signals (elevators, on transit, etc.) Using a cell phone in areas of good reception decreases exposure by allowing the phone to transmit at reduced power."**

[FCC1: If you must conduct extended conversations by wireless phone every day ... you could ... use a wireless phone connected to a remote antenna.]

- **SF: "Reducing the number and length of calls Turn off your cell phone when not in use."**

[FCC1: Since time is a key factor in how much exposure a person receives, reducing the amount of time spent using a wireless phone will reduce RF exposure.]

[FCC3: [FDA recommendation):"including limiting conversations on hand-held cellular telephones"]

[FDA2: "if you are concerned about avoiding even potential risks, you can take a few simple steps to minimize your RF exposure.

- Reduce the amount of time spent using your cell phone"]

References

SF: Revised San Francisco cell phone "right to know" fact sheet (11/11)

FCC1: http://www.fcc.gov/encyclopedia/faqs-wireless-phones

FCC2: http://www.fcc.gov/guides/wireless-devices-and-health-concerns

FCC3: http://transition.fcc.gov/oet/rfsafety/rf-faqs.html

FCC4: http://transition.fcc.gov/oet/rfsafety/

FDA1: http://www.fda.gov/Radiation-EmittingProducts/RadiationEmittingProductsandProcedures/HomeBusinessandEntertainment/Cellphones/ucm116335.htm

FDA2: http://www.fda.gov/Radiation-EmittingProducts/RadiationEmittingProductsandProcedures/HomeBusinessandEntertainment/CellPhones/ucm116331.htm

FDA3: http://www.fda.gov/Radiation-EmittingProducts/RadiationEmittingProductsandProcedures/HomeBusinessandEntertainment/CellPhones/ucm116293.htm

American Academy of Pediatrics
DEDICATED TO THE HEALTH OF ALL CHILDREN™

Received in Committee 7/18/12

AAP Headquarters
141 Northwest Point Blvd
Elk Grove Village, IL 60007-1019
Phone 847/434-4000
Fax. 847/434-8000
E-mail. kidsdocs@aap.org
www.aap.org

Reply to
Department of Federal Affairs
Homer Building, Suite 400 N
601 13th St NW
Washington, DC 20005
Phone 202/347-8600
Fax. 202/393-6137
E-mail. kids1st@aap.org

July 12, 2012

The Honorable Julius Genachowski
Commissioner
Federal Communications Commission
445 12th Street SW
Washington, DC 20554

Dear Chairman Genachowski:

The American Academy of Pediatrics (AAP), a non-profit professional organization of 60,000 primary care pediatricians, pediatric medical sub-specialists, and pediatric surgical specialists dedicated to the health, safety and well-being of infants, children, adolescents, and young adults strongly supports the proposal for a formal inquiry into radiation standards for cell phones and other wireless products. The Academy encourages the Federal Communications Commission (FCC) to vote to move forward with this inquiry in an expeditious manner.

The FCC has not assessed the standard for cell phone radiation since 1996. According to industry groups, approximately 44 million people had mobile phones when the standard was set; today, there are more than 300 million mobile phones in use in the United States. While the prevalence of wireless phones and other devices has sky-rocketed, the behaviors around cell phone uses have changed as well. The number of mobile phone calls per day, the length of each cell phone call, and the amount of time people use mobile phones has increased, while cell phone and wireless technology has undergone substantial changes. Many more people, especially adolescents and young adults, now use cell phones as their only phone line and they begin using wireless phones at much younger ages.

The FCC standard for maximum radiation-exposure levels are based on the heat emitted by mobile phones. These guidelines specify exposure limits for hand-held wireless devices in terms of the Specific Absorption Rate (SAR), which measures the rate the body absorbs radiofrequency (RF). The current allowable SAR limit is 1.6 watts per kilogram (W/kg), as averaged over one gram of tissue. Although wireless devices sold in the United States must ensure that they do not exceed the maximum allowable SAR limit when operating at the device's highest possible power level, concerns have been raised that long-term RF exposure at this level affects the brain and other tissues and may be connected to types of brain cancer, including glioma and meningioma.

In the past few years, a number of American and international health and scientific bodies have contributed to the debate over cell phone radiation and its possible link to cancer. The International Agency for Research on Cancer (IARC), part of the

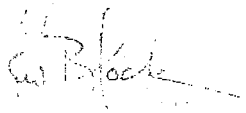
United Nations' World Health Organization, said in June 2011 that a family of frequencies that includes mobile-phone emissions is "possibly carcinogenic to humans." The National Cancer Institute has stated that although studies have not demonstrated that RF energy from cell phones definitively causes cancer, more research is needed because cell phone technology and cell phone use are changing rapidly. While a definitive link between cell phone radiation and brain cancer has not been established, these studies and others clearly demonstrate the need for further research into this area and highlight the importance of reassessing the current SAR to determine if it is protective of human health.

The AAP believes the inquiry to reassess the radiation standard presents an opportunity to review its impacts on children's health and well-being. In the past, such standards have generally been based on the impact of exposure on an adult male. Children, however, are not little adults and are disproportionately impacted by all environmental exposures, including cell phone radiation. In fact, according to IARC, when used by children, the average RF energy deposition is two times higher in the brain and 10 times higher in the bone marrow of the skull, compared with mobile phone use by adults. While the Academy appreciates that the FCC is considering investigating whether the emission standards should be different for devices primarily used by children, it is essential that any new standard for cell phones or other wireless devices be based on protecting the youngest and most vulnerable populations to ensure they are safeguarded throughout their lifetimes.

Finally, in reviewing the SAR standard, the FCC has the opportunity to highlight the importance of limiting media use among children. The Academy has found potentially negative effects and no known positive effects of media use by children under the age of two, including television, computers, cell phones, and other handheld wireless devices. In addition, studies consistently show that older children and adolescents utilize media at incredibly high rates, which potentially contributes to obesity and other health and developmental risks. In reviewing the SAR limit, the FCC has the opportunity to improve the health of our nation by highlighting the importance of limiting screen time and media use for children and adolescents.

The AAP supports the proposal for a formal inquiry into radiation standards for cell phones and other wireless products and the Academy encourages the FCC to vote in favor of moving forward with this investigation. If you have questions or concerns, please contact Kristen Mizzi in the AAP's Washington Office at 202/347-8600.

Sincerely,



Robert W. Block, MD FAAP
President

RWB/km

CC: Commissioner Robert M. McDowell
Commissioner Mignon Clyburn
Commissioner Jessica Rosenworcel
Commissioner Ajit Pai

American Academy of Pediatrics
DEDICATED TO THE HEALTH OF ALL CHILDREN™

Received in Committee 4/18/13

AAP Headquarters
141 Northwest Point Blvd
Elk Grove Village, IL 60007-1019
Phone. 847/434-4000
Fax. 847/434-8000
E-mail. kidsdocs@aap.org
www.aap.org

Reply to
Department of Federal Affairs
Homer Building, Suite 400 N
601 13th St NW
Washington, DC 20005
Phone. 202/347-8600
Fax. 202/393-6137
E-mail. kids1st@aap.org

December 12, 2012

The Honorable Dennis Kucinich
2445 Rayburn House Office Building
Washington, DC 20515

Dear Representative Kucinich:

On behalf of the American Academy of Pediatrics (AAP), a non-profit professional organization of 60,000 primary care pediatricians, pediatric medical sub-specialists, and pediatric surgical specialists dedicated to the health, safety and well-being of infants, children, adolescents, and young adults, I would like to share our support of H.R. 6358, the *Cell Phone Right to Know Act*.

The AAP strongly supports H.R. 6358's emphasis on examining the effects of radiofrequency (RF) energy on vulnerable populations, including children and pregnant women. In addition, we are pleased that the bill would require the consideration of those effects when developing maximum exposure standards. Children are disproportionately affected by environmental exposures, including cell phone radiation. The differences in bone density and the amount of fluid in a child's brain compared to an adult's brain could allow children to absorb greater quantities of RF energy deeper into their brains than adults. It is essential that any new standards for cell phones or other wireless devices be based on protecting the youngest and most vulnerable populations to ensure they are safeguarded through their lifetimes.

In addition, the AAP supports the product labeling requirements in H.R. 6358. These standards will ensure consumers can make informed choices in selecting mobile phone purchases. They will also enable parents to better understand the potential dangers of RF energy exposure and protect their children.

On July 24, the U.S. Government Accountability Office (GAO) published a report on federal cell phone radiation exposure limits and testing requirements. The GAO noted that the Federal Communications Commission's (FCC) most recent data indicates that the number of estimated mobile phone subscribers has grown from approximately 3.5 million in 1989 to approximately 289 million at the end of 2009. Cell phone use behaviors have also changed during that time. The quantity and duration of cell phone calls has increased, as has the amount of time people use mobile phones, while cell phone and wireless technology has undergone substantial changes. Many more people, especially adolescents and young adults, now use cell phones as their only phone line, and they begin using wireless phones at much younger ages.

Despite these dramatic changes in mobile phone technology and behavior, the FCC has not revisited the standard for cell phone radiation exposure since 1996. The current FCC standard for maximum radiation exposure levels is based on the heat emitted by mobile phones. These guidelines specify exposure limits for hand-held wireless devices in terms of the Specific Absorption Rate (SAR), which measures the rate the body absorbs radiofrequency (RF). The current allowable SAR limit is 1.6 watts per kilogram (W/kg), as averaged over one gram of tissue. Although wireless devices sold in the United States must ensure that they do not exceed the maximum allowable SAR limit when operating at the device's highest possible power level, concerns have been raised that long-term RF energy exposure at this level affects the brain and other tissues and may be connected to types of brain cancer, including glioma and meningioma.

In May 2011, the International Agency for Research on Cancer (IARC), the United Nations' World Health Organization's (WHO) agency promoting international cancer research collaboration, classified RF energy as "possibly carcinogenic to humans." In addition, the National Cancer Institute has stated that although studies have not definitively linked RF energy exposure from cell phones to cancer, more research is required to address rapidly changing cell phone technology and use patterns.

This and other research identified by the GAO demonstrates the need for further research on this issue, and makes clear that exposure standards should be reexamined.

The GAO concluded that the current exposure limits may not reflect the latest research on RF energy, and that current mobile phone testing requirements may not identify maximum RF energy exposure. The GAO proposed that the FCC formally reassess its limit and testing requirements to determine whether they are effective. The AAP commends the activities proposed under H.R. 6358, as they would address this research gap and improve consumer knowledge and safety. Establishing an expanded federal research program as the basis for exposure standards will ensure that consumer protections incorporate the latest research. Currently, the National Institute of Health (NIH), the only federal agency the GAO identified as directly funding research on this topic, provided approximately $35 million from 2001 to 2011. Given this previous funding level, the AAP supports the $50 million per fiscal year for seven years that H.R. 6358 would authorize.

The AAP appreciates your recognition of the need for new research and standards for mobile phone radiation, and is pleased to support H.R. 6358. For further assistance, please do not hesitate to contact Sonya Clay, Assistant Director, Department of Federal Affairs, at 202-347-8600 or sclay@aap.org.

Sincerely,

Thomas McInerny MD

Thomas K. McInerny, MD, FAAP
President

Received in Committee 4/18/13

HARVARD MEDICAL SCHOOL

MASSACHUSETTS GENERAL HOSPITAL

Martha R. Herbert, Ph.D., M.D.
Assistant Professor, Pediatric Neurology
Director, TRANSCEND Research Program
www.transcendresearch.org
transcend@partners.org

TRANSCEND

Martinos Center for Biomedical Imaging
149 13th Street, Room 10.018
Boston, Massachusetts 02129
Phone: (617) 724-5920
Fax: (617) 812-6334
mherbert1@partners.org

TO: Los Angeles Unified School District
FROM: Martha R Herbert, PhD, MD
RE: Wireless vs. Wired in Classrooms
DATE: February 8, 2013

I am a pediatric neurologist and neuroscientist on the faculty of Harvard Medical School and on staff at the Massachusetts General Hospital. I am Board Certified in Neurology with Special Competency in Child Neurology, and Subspecialty Certification in Neurodevelopmental Disorders.

I have an extensive history of research and clinical practice in neurodevelopmental disorders, particularly autism spectrum disorders. I have published papers in brain imaging research, in physiological abnormalities in autism spectrum disorders, and in environmental influences on ndurodevelopmental disorders such as autism and on brain development and function.

I recently accepted an invitation to review literature pertinent to a potential link between Autism Spectrum Disorders and Electromagnetic Frequencies (EMF) and Radiofrequency Radiation (RFR). I set out to write a paper of modest length, but found much more literature than I had anticipated to review. I ended up producing a 60 page single spaced paper with over 550 citations. It is available at http://www.bioinitiative.org/report/wp-content/uploads/pdfs/sec20_2012_Findings_in_Autism.pdf.

In fact, there are thousands of papers that have accumulated over decades – and are now accumulating at an accelerating pace, as our ability to measure impacts become more sensitive – that document adverse health and neurological impacts of EMF/RFR. Children are more vulnerable than adults, and children with chronic illnesses and/or neurodevelopmental disabilities are even more vulnerable. Elderly or chronically ill adults are more vulnerable than healthy adults.

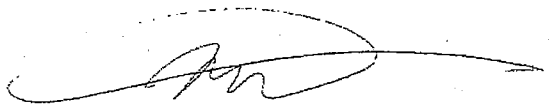
Current te chnologies were designed and promulgated without taking account of biological impacts other than thermal impacts. We now know that there are a large array of impacts that have nothing to do with the heating of tissue. The claim from wifi proponents that the only concern is thermal impacts is now definitively outdated scientifically.

EMF/RFR from wifi and cell towers can exert a disorganizing effect on the ability to learn and remember, and can also be destabilizing to immune and metabolic function. This will make it harder for some children to learn, particularly those who are already having problems in the first place.

Powerful industrial entities have a vested interest in leading the public to believe that EMF/RFR, which we cannot see, taste or touch, is harmless, but this is not true. Please do the right and precautionary thing for our children

I urge you to step back from your intention to go wifi in the LAUSD, and instead opt for wired technologies, particularly for those subpopulations that are most sensitive. It will be easier for you to make a healthier decision now than to undo a misguided decision later.

Thank you.



Martha Herbert, PhD, MD
Pediatric Neurology
Martinos Center for Biomedical Imaging
Massachusetts General Hospital
Harvard Medical School
Boston, Massachusetts
USA

Received late
in Comments
4/18/13

SECTION 20

Findings in Autism (ASD) Consistent with Electromagnetic Fields (EMF) and Radiofrequency Radiation (RFR)

Martha Herbert, PhD, MD
Pediatric Neurology
TRANSCEND Research Program
Massachusetts General Hospital
Harvard Medical School

Cindy Sage, MA
Sage Associates
Santa Barbara, CA USA

For the BioInitiative Working Group

December 2012

CONTENTS

I. INTRODUCTION

The premise of this review is that although scant attention has been paid to possible links between electromagnetic fields and radiofrequency exposures (EMF/RFR) and Autism Spectrum Disorders (ASDs), such links probably exist. The rationale for this premise is that the physiological impacts of EMF/RFR and a host of increasingly well-documented pathophysiological phenomena in ASDs have remarkable similarities. Additional support may be found in the parallels between the rise in reported cases of ASDs and the remarkable increases in EMF/RFR exposures over the past few decades. Reviewing these similarities does not prove that these parallels imply causality – that kind of research has not been done. Moreover, the physiological processes affected by EMF/RFR are also impacted by other environmental factors. Yet EMF/RFR does not need to be a unique contributor to ASDs to add significantly to system overload ('allostatic load') and dysfunction. Even so these pathophysiological overlaps do suggest that the potential for an EMF/RFR-ASD connection should be taken seriously, and that their vulnerable biological features may make many with ASDs more likely to experience adverse EMF/RFR impacts. This is a sufficient basis to recommend that precautionary measures should be implemented and respected, that further research should be prioritized, and that policy level interventions based on existing and emerging data should be designed and pursued. Moreover, pursuing this link could help us understand ASDs better and find more ways to improve the lives of people with ASDs and of so many others.

A. How are Biology and Behavior Related?

Considering a potential link between ASDs and EMF/RFR (or indeed of any potential contributor to incidence or pathogenesis) requires taking account of the evolution that has been occurring in our understanding of the relationship between ASD's behavioral and biological features. ASDs were first labeled as 'autism' in 1943 by Leo Kanner, a child psychiatrist who extracted several key behavioral features, related to communication and social interaction challenges and a tendency toward restricted interests and repetitive behaviors, characteristic of all 11 of the children in his first case series (Kanner 1943). Although in the seven decades since this condition was first constructed as a category there has been some modification of the way these behavioral features have been characterized, ASDs are still defined behaviorally, although sensory issues such as hypo- or hyper-reactivity have recently been included in the diagnostic criteria (Diagnostic and Statistical Manual of Mental Disorders or DSM-V) (American Psychiatric Association 2000, 2013, May).

1. Transduction is fundamental but poorly understood

Yet in considering how an environmental factor such as EMF/RFR could lead to autism and/or influence its severity or incidence, we need to think about how underlying biology is transduced into changes in nervous system electrical activity, and how these in turn generate the set of behaviors we have categorized as 'autism.' (Herbert 2005) This means not taking behaviors as given, or as purely determined by genetics, but exploring the full range of biology that generates these features and challenges.

2. More than brain

Although 'autism' has long been considered to be a psychiatric or neurological brain-based disorder (Rapin and Katzman 1998; Polleux and Lauder 2004), it has become undeniable that people diagnosed with ASDs often also have a multitude of biological features – including systemic pathophysiological disturbances (such as oxidative stress, mitochondrial dysfunction and metabolic and immune abnormalities) (Ming et al. 2012; Tsaluchidu et al. 2008; Pieczenik and Neustadt 2007; Gonzalez et al. 2011) as well as symptomatic medical comorbidities (such as gastrointestinal distress, recurrent infections, epilepsy, autonomic dysregulation and sleep disruption) (Nikolov et al. 2009; Kotagal and Broomall 2012; Kaartinen et al. 2012; Daluwatte et al. 2012; Tuchman and Cuccaro 2011; Canitano 2007; Malow 2004; Kang and Barnes 2013; Jyonouchi et al. 2011) – in addition to the core defining behaviors – and many of these occur commonly (Kohane et al. 2012). The problem has been that no one such biological feature has turned out to be present in every single person carrying an ASD diagnosis – and they are not specific to ASDs, either. Moreover there has been much variability in many of the features of autism – not only between individuals but in many cases within individuals at different points in time or under different circumstances. Because of this variability, the relevance of many of these biological features has been dismissed as secondary and not intrinsically related to the 'autism.' Instead, many have considered the behavioral features as fundamental not only to how autism manifests and is definedbut also to the core intrinsic nature of ASDs, even though the biological basis of these behaviors has by no means been established.

3. Heterogeneity: More genetic and environmental than physiological

It is not as if this variability is unique to the 'environmental side.' At the present time over 800 genes have been associated with ASDs, and over 100 different rare genetic syndromes are frequently accompanied by ASD, with no clear specific unifying mechanism uniting this remarkable heterogeneity (Trikalinos et al. 2006; Ring et al. 2008; Pelphrey et al. 2011; Mandell 2011; Hall et al. 2012; Bill and Geschwind 2009). Similarly a large number of potential environmental contributors are under investigation

ranging from toxicants and Vitamin D deficiency or failure to take prenatal vitamins to air pollution and stress or infection in pregnancy (Whitehouse et al. 2012; Kocovska et al. 2012; Schmidt et al. 2011; Landrigan 2010; Roberts et al. 2007; Shelton, Hertz-Picciotto, and Pessah 2012; Becerra et al. 2012; Volk et al. 2011). Yet at the physiological level a smaller set of disturbances are showing up as common across substantial numbers of people with ASDs – and in fact not uniquely to ASDs but also in myriad other chronic conditions whose prevalence also appears to be increasing (Bilbo Jones, and Parker 2012; Knox 2010). Prominent among these are immune disturbances including inflammation, mitochondrial dysfunction, and oxidative stress, as well as toxic body burden. Vulnerability to all of these can be increased mildly or substantially by a variety of often common genetic mutations, but may remain latent without the overlay of environmental triggers. Conversely, with substantial enough environmental input, genetic vulnerability may not be necessary.

4. Mechanism is more than correlation

Just HOW biological features might be related to the behavioral features that have up until now defined ASDs has not been clarified; until recently the main research effort regarding pathophysiology in ASDs has been to establish the presence of these phenomena in the first place. Even so, some correlations between biological and behavioral features have been identified – e.g. a higher level of immune abnormalities correlates with more aberrant behaviors (Wei et al. 2012; Careaga and Ashwood 2012; Jyonouchi et al. 2011; Ashwood et al. 2011; Heuer et al. 2008; Zerrate et al. 2007; Curran et al. 2007). Still, such correlations in themselves do not explain the *mechanisms* by which the *transduction of pathophysiology into behavior* might actually occur. In order to do that, an important component would be to study the relationship between systemic pathophysiology and nervous system electrophysiology.

5. EMF/RFR research may help us understand how ASDs 'work'

Assessing the potential contribution of EMF/RFR to ASDs puts this question of the nature of the pathophysiology-behavior transduction into an interesting and provocative light since the brain is simultaneously a tissue-based physical organ that can be compromised by cellular pathophysiology as well as altered developmental processes, and an information processing system that operates through networks of synchronized electrical oscillations (brain waves) – and EMF/RFR impacts may occur directly at both of these levels. To date the emphasis in ASD research has largely been on 'structure-function' relationships that have been anatomy-centered. This research has generated correlations between brain structures and behaviors, and has found some genetic correlates as well, but it has made assumptions that these phenomena are rooted in genetics and genetically perturbed molecular structures and substances. This leads to targeting the molecular level with pharmaceuticals, but not to the broader agenda of

understanding environmental or physiological contributions or dynamic features of brain and behavior. Thus, exploring how EMF/RFR impacts ASDs may help to force the question of how these pathophysiological and electrophysiological/information processing levels actually interact, and how anatomy may in many ways be a product rather than a cause of physiology.

B. Time Courses of Mechanisms

For the most part, researchers have looked for causes of autism in mechanisms that occur early and create permanent change or damage. This approach is logical if one assumes that genetic influences are overwhelmingly predominant, and 'autism' is a fixed lifelong trait. However evidence is emerging that ASDs may in many respects be more state-like and variable than trait-like and fixed.

1. Plasticity

One of the remarkable shifts in conceptual thinking about ASDs is an appreciation of its brain plasticity (Helt et al. 2008). Growing numbers of reports of improvement and loss of diagnosis, reversal of neurological symptoms in a growing number of mouse models of genetic syndromes that in humans prominently feature autism (Cobb, Guy and Bird 2010; Ehninger et al. 2008; Goebel-Goody et al. 2012; Henderson et al. 2012; Kaphzan et al. 2012; Liu, huang, and Smith 2012; Mehta, Gandal, and Siegel 2011; Paylor et al. 2008; Rotschafer et al. 2012; Sato et al. 2012; Suvrathan et al. 2010), short-term pharmaceutically induced improvement in brain connectivity (Narayanan et al. 2010), and transient reversal or abeyance of symptomatology under various circumstances (including fever, fluid-only diet, and certain antibiotic treatments (Sandler et al. 2000; Curran et al. 2007)) – all of these throw into question the long-standing assumption that we are simply dealing with a 'broken brain.' Indeed, how could a 'broken brain' produce markedly improved function with such a short turnaround time? (Herbert 2009) Such a time frame cannot possibly be accounted for by remodeling of the brain's anatomical substrate. 'Brain waves' and their synchronization, on the other hand, could easily vary over short time periods. Looking into physiological and environmental modulators not only of brain development but also of everyday brain function becomes increasingly imperative.

In addition, documentation of average to superior intelligence in most people with autism (Edelson 2006; Dawson et al. 2007), as well as of domains of perceptual superiority (Soulieres, Zeffiro, et al. 2011; Soulieres, Dawson et al. 2011; Samson et al. 2011; Soulieres et al. 2010; Soulieres et al. 2009; Mottron et al. 2006; Mottron 2004; Bertone et al. 2005; Perreault et al. 2011), call into question the long-standing assumption that ASDs are intrinsically or for the most part associated with cognitive deficits – another strike against the outdated 'deficit' or 'broken brain' model.

2. Mechanisms that operate actively throughout the lifecourse

One particularly valuable lesson about ASDs that can be learned from looking at how EMF/RFR affects underlying biology is that these impacts are by no means confined to early development. We already have clinical reports of 'intermittent autism' – for example, some children with mitochondrial disease who have ups and downs of their bioenergetics status 'have autism' on their bad days but don't display autistic features on their good days (Korson 2007). These children with their vulnerable, barely compensated mitochondria seem to be teetering right at the brink of the interface of metabolic and electrophysiological dysfunction, tipping back and forth on this knife edge. It makes one wonder what everyday exposures – allergens, infection, pesticide on the school playground, even perchance EMF/RFR – might contribute to the bad days (with their loss of electrophysiological optimization, probably on account of insufficient energy to drive fully integrated brain function), and conversely how many choices exist in everyday life that could tilt things in the direction of more good days (by helping to stabilize more optimal nervous system performance) (Herbert and Weintraub 2012).

The short time course needed for biologically effective EMF/RFR 'doses' to lead to observable impacts reflects that these exposures can affect cells without obstruction (unlike many chemical agents), and create impacts within minutes. This type of mechanism may also give us fresh and important ways of understanding the short-term variability – the good days and the bad days – that are so common in ASD even in those who do not have a formal diagnosis of mitochondrial disease.

3. Pathophysiology and allostatic load

Based on these considerations, the strategy to be pursued in this examination of a potential EMF/RFR - ASD link is to review the many parallels between underlying biology, or pathophysiology, in ASDs and the impacts of EMF/RFR on living organisms. EMF/RFR exposures have demonstrated impacts at just about every level at which biology and physiology have been shown to be disrupted in ASDs. EMF/RFR has been shown to potentiate the impact of various toxicants when both exposures occur together (Juutilainen, Kumlin, and Naarala 2006); this may be additive or more than additive. This suggests that EMF/RFR may synergize with other contributors and make things worse. With many different environmental factors piling on to a much smaller number of environmentally vulnerable physiological mechanisms (Herbert 2010), one must consider that the model of 'allostatic load' – the sum total of stressors and burdens – may be central to understanding how the many risk factors interact to create autism – and to create a spectrum of levels of severity across so many of ASD's associated features. A cascade of exposures interacting with vulnerabilities can potentially lead to a tipping point for an individual, such as the phenomenon of autistic regression experienced by a substantial subset of people with ASDs. When exposures increase at the population

level, we are likely to see trends of increase in the number of people passing that tipping point and getting diagnosed. EMF/RFR exposures have increased several thousand-fold or more in the past two decades from wireless technology innovations that have unplanned side effects from pulsed RFR, a newly classified human carcinogen (Baan et al, 2011). Nearly six billion people globally own wireless phones, for example. Many hundreds of thousands more are exposed to wireless whole-body transmissions from wireless antenna facilities (Sage and Carpenter, BioInitiative 2012 Report, Section 24). For this as well as for physiological reasons allostatic loading as a viable concept for the study of ASDs should reasonably address EMF/RFR as one of the collection of exposures of relevance to the overall stress load, since it is now a chronic and unremitting exposure in daily life at environmentally relevant levels shown to cause bioeffects from preconception and pregnancy through infancy, childhood and the whole lifecourse.

In an article entitled "Unrelenting Stress is Toxic,: The New Scientist (28 July 2012) describes stress in an eloquent way:

> *"Unrelenting stress is toxic because it can turn the body's defense system against itself. Neuroendocrinologist Bruce McEwen at Rockefeller University in New York says the stress response that evolved to protect us from harm can be hijacked and actually cause harm when the stress level never abates. In a normal situation, the introduction of stress causes the body to deliver a boost of energy – by sending a surge of glucose to the muscles – and to increase heart rate, blood pressure and breathing to get oxygen to the muscles in hurry. At the same time, blood vessels constrict and clotting factors increase – ready to slow bleeding in case you are wounded. These responses are a part of a fight-or-flight survival kit, and once the stress has passed, these should subside. But for people under unrelenting stress, this response never quite switches off – leaving sugar levels unregulated, high blood pressure, increate risk of blood clots, depressed sex drive and an immune system buckling under the strain. Prolonged exposure to stress hormones can have other effects as well, including affecting the brain by altering the structure of the neurons and their connections, which in turn can influence behaviour and hormonal processes."*

This passage refers to effects on the hypothalamo-pituitary-adrenal axis (Aldad, 2012), but as will be discussed in the Part II, equally important is cellular stress from stress proteins (heat shock protein HSP) and from oxidative stress generated at very low-intensity EMF and RFR levels as detailed in the BioInitiative 2012 Update, Section 7 by Martin Blank, PhD; Blank, 2012). Both are significant kinds of stress that can add body-burdens via allostatic loading.

II. PARALLELS IN PATHOPHYSIOLOGY

This section will review parallels in pathophysiology between ASDs and impacts of EMF/RFR. It will begin with a review of mechanisms of direct impact at the level of molecules, cells, tissues and genes. It will then move on to consider how these levels of damage lead to degradation of the integrity of functional systems including mitochondrial bioenergetics, melatonin, immune function and nervous system physiology. The review of parallels will conclude with a discussion of electromagnetic signaling and synchronized oscillation from membranes to nervous system, treating 'aberrant' neural systems and somatic function and behaviors as consequences or 'outputs' of disturbed underlying physiology to which EMF/RFR is a plausible contributor.

A. Damage: Means and Domains

ASDs have been conceptualized as 'neurodevelopmental' which has focused attention on how genes and environment could alter brain development. This leads to the unstated presumption that virtually everything important about the brain in ASDs has to do with differences in the way it was formed. In genetics this has led to a hunt for neurodevelopmental genes. There is no question that environmental impacts can alter brain development, and impact brain function across the lifespan. This chapter begins the work to systematically rectify the omission of EMF/RFR as one environmental contributor in ASDs.

However the influence of the environment on neurodevelopmental conditions such as ASDs does not stop there. Evidence is accumulating showing that increased expression of genes associated with physiological dysregulation, as well as single-nucleotide polymorphisms (SNPs) associated with these issues, may be if anything more prominent than alterations of 'neurodevelopmental' genes (Lintas, Sacco, and Persico 2012). In a study of gene expression in ASDs, Down syndrome and Rett syndrome, these authors state, *"Our results surprisingly converge upon immune, and not neurodevelopmental genes, as the most consistently shared abnormality in genome-wide expression patterns. A dysregulated immune response, accompanied by enhanced oxidative stress and abnormal mitochondrial metabolism seemingly represents the common molecular underpinning of these neurodevelopmental disorders."* Others have also found pathophysiology-related genes as figuring most prominently in alterations of gene expression in ASD (Kong et al. 2012; Jung, Kohane, and Wall 2011; Voineagu et al. 2011; Waly et al. 2012). SNPs associated with methylation abnormalities, impaired

glutathione synthesis and mitochondrial dysfunction also have been identified as significant risk factors.

Genetics may create risk, but the actual nervous system and health consequences probably come from dysfunction at the physiological level. Evidence for pathophysiological dysfunction in ASDs increasingly abounds. In particular, a growing body of literature documents immune aberrations, low total and reduced glutathione levels, lower activity of the anti-oxidative stress system and mitochondrial dysfunction. These phenomena may be both genetically and environmentally modulated. As will be discussed further below, they are certainly pertinent to the neurodevelopment of the brain, which has been by far the dominant focus autism research, but it does not stop there as they can significantly modulate brain function in real time, as well as shape the function of the entire organism, including the autonomic system, the cardiovascular, endocrine, immune, gastrointestinal and reproductive systems and more.

1. Cellular Stress

Oxidative Stress

Autism (ASD) research indicates that oxidative stress may be a common attribute amongst many individuals with autism. In the past decade the literature on this has moved from a trickle to a flood. Studies document reduced antioxidant capacity, increased indicators of oxidative stress and free radical damage, alterations in nutritional status consistent with oxidative stress, altered lipid profiles, and pertinent changes not only in blood but also in brain tissue. Associations of ASDs with environmental exposures such as air pollution and pesticides are indirectly supportive as well, since such exposures are linked in other literature to oxidative stress (Kanthasamy et al. 2012; Roberts et al. 2010; Knox 2010; Rose, Melnyk, Trusty, et al. 2012; Rose, Melnyk, Pavliv, et al. 2012; Ghanizadeh et al. 2012; Frustaci et al. 2012; Rossignol and Frye 2011; Adams et al. 2011, 2011; Mostafa et al. 2010; Zecavati and Spence 2009; Yao et al. 2006; Naviaux 2012; Chauhan and Chauhan 2006; Chauhan, Chauhan, and Brown 2009).

Reactive oxygen species are produced as a normal consequence of mitochondrial oxidative metabolism as well as other reactions, but when their number exceeds the cell's antioxidant capacity a situation of oxidative stress develops. It is certainly the case that oxidative stress can be a consequence of exposures to chemical toxicants, or of the interactive impacts of toxicants, nutritional insufficiencies and genetic vulnerabilities. This set of risk factors has received considerable attention for the potential roles each component and various possible combinations could play in causing or exacerbating autism.

Less often mentioned in the ASD pathophysiology literature is that it is also well established that EMF/RFR exposures can be associated with oxidative damage.

Published scientific papers that demonstrate the depth of EMF and RFR evidence reporting oxidative damage in human and animal models are profiled in Section 6 (Genotoxicity) of this BioInitiative 2012 Report and in the BioInitiative Report (2007), both by Henry Lai, PhD (Lai, 2012; Lai, 2007). These cellular effects can occur at low-intensity, legal levels of exposure that are now 'common environmental levels' for pregnant women, the fetus, the infant, the very young child, and the growing child as well as for adults. Electromagnetic fields (EMF) can enhance free radical activity in cells (Lai and Singh 2004; De Iuliis et al. 2009) particularly via the Fenton reaction, and prolonging the effect causes a larger increase, indicating a cumulative effect. The Fenton reaction is a catalytic process of iron to convert hydrogen peroxides, a product of oxidative respiration in the mitochondria, into hydroxyl free radical, which is a very potent and toxic free radical (Lai, in the BioInitiative Report 2007; Lai, 2007). Free radicals damage and kill organelles and cells by damaging macromolecules, such as DNA, protein and membrane components.

Further indications of a link to oxidative stress are findings that EMF and RFR at very low intensities can modulate glutamate, glutathione and GABA, and affect mitochondrial metabolism. Alterations in all these substances and processes have been documented in ASDs (Bristot Silvestrin et al. 2012; Brown et al. 2012; Choudhury, Lahiri, and Rajamma 2012; Essa et al. 2012; Oberman 2012; Yang and Pan 2012; Chauhan, Audhya, and Chauhan 2012; Frustaci et al. 2012; Main et al. 2012; Pecorelli et al. 2012; Rose, Melnyk, Pavliv, et al. 2012; Rose, Melnyk, Trusty et al. 2012; Waly et al. 2012; Banerjee et al. 2012; Coghlan et al. 2012; Enticott et al. 2012; Kang and Barnes 2013; Mendez et al. 2012; Piton et al. 2012; Anitha, Nakamura, Thanseem, Matsuzaki, et al. 2012; Anitha, Naamura, Thanseem, Yamada, et al. 2012; Gargus 2008; Giulivi et al. 2010; Hadjixenofontos et al. 2013; Napolioni et al. 2011; Rossignol and Frye 2011). Campisi et al (2010) report that increased glutamate levels from 900 MHz cell phone frequency radiation on primary rat neocortical astroglial cell cultures induced a significant increase in ROS levels and DNA fragmentation after only 20 min with pulsed RFR at non-thermal levels (Campisi et al. 2010).

Fragopoulou et al (2012) conducted proteomics analysis of proteins involved in brain regulation in mice as a consequence of prolonged exposure to EMF (Fragopoulou et al. 2012). They identified altered expression of 143 proteins, ranging from as low as 0.003 fold downregulation up to 114 fold overexpression with affected proteins including neural function-related proteins including Glial Fibrillary Acidic Protein (GFAP), alpha-synuclein, Glia Maturation Factor beta (GMF), apolipoprotein E (apoE)), heat shock proteins, and cytoskeletal proteins (i.e., neurofilaments and tropomodulin), as well as proteins of brain metabolism such as aspartate aminotransferase and glutamate dehydrogenase. The authors pointed out that oxidative stress was consistent with some of these changes.

Aberrations in glutathione metabolism and deficiencies in reserves of reduced glutathione are increasingly associated with ASDs, both systemically and in the brain. The parallel with EMF/RFR impacts here is strong, since glutathione reduction associated with EMF/RFR is reported in at least twenty three relevant research studies in both human and animal studies since 1998, including the following citations (Shapiro et al. 2012; Ozgur, Guler, and Seyhan et al. 2010; Ozguner et al. 2005; Moustafa et al. 2001; Kesari, Kumar, and Behari 2011; Jelodar, Akbari, and Nazifi 2012; Hoyto et al. 2008; Guney et al. 2007; Esmekaya et al. 2011; Atasoy et al. 2012)Al-Demegh, 2012; Kumar, 2010; Meral, 2007; Oktem et al. 2005; Ozguner et al. 2006). It is increasingly appreciated that glutathione is a final common pathway, a critical piece of environmentally vulnerable physiology, as glutathione reserves are compromised by an enormous number of environmental stressors, so that the cumulative impact upon glutathione may be far greater than could be predicted by the magnitude of any specific exposure (Lee, Jacobs, and Porta 2009), which supports an allostatic loading model.

Also of note are studies showing that the effects of EMF/RFR can be reduced by supplementation with antioxidants and radical scavengers. As an example, Vitamins E and C reduced adverse impacts on rat endometrium from 900MHz EMR exposure (Guney et al. 2007). Gingko biloba has also prevented mobile phone-induced increases in malondialdehyde and nitric oxide levels in brain tissue as well as decreases in brain superoxide dismutase and glutathione peroxidase activities and increases in brain xanthin oxidase and adenosine deaminase activities, and treated rats were spared the histopathological cell injury found in the untreated rats (Ilhan et al. 2004). Substantial further literature on antioxidants and radical scavengers is reviewed in Section 15 in Belyaev's contribution to the Bioinitiative 2012 Report (Belyaev 2012).

Stress protein (heat shock protein) responses

Another well-documented effect of exposure to low- intensity ELF and RFR is the creation of stress proteins (heat shock proteins) that signal a cell is being placed under physiological stress) (Weisbrot et al. 2003; Velizarov, Raskmark, and Kwee 1999; Leszczynski et al. 2004; Leszczynski et al. 2002; de Pomerai et al. 2000; Daniells et al. 1998; Blank and Goodman 2004). Heat shock proteins are in a family of inducible proteins that are initiated when any increased need for protection from stray electrons occurs (Padmini 2010; Bottoni, Giardina, and Scatena 2009). The HSP response is generally associated with heat shock, exposure to toxic chemicals and heavy metals, and other environmental insults. HSP is a signal of cells in distress. Plants, animals and bacteria all produce stress proteins to survive environmental stressors like high temperatures, lack of oxygen, heavy metal poisoning, and oxidative stress. It should also be noted that the generation of HSP stress proteins can have constructive medical applications, such as protection from reperfusion of the heart following ischemic injury (George et al. 2008). Another concomitant impact of cellular stress can be protein

misfolding, which has been documented in association with exposure to EMF/RFR. (Bohr and Bohr 2000; Mancinelli et al. 2004)

Although a number of papers have demonstrated increases in HSPs in people with ASDs (El-Ansary and Al-Ayadhi 2012; Evers, Cunningham-Rundles, and Hollander 2002; El-Ansary, Ben Bacha, and Kotb 2012; Walker, Segal, and Aschner 2006; Vojdani et al. 2004), it has been investigated far less often than oxidative stress. Part of the research needed to study possible influences of EMF/RFR on ASDs would be to study this more carefully.

2. Membranes and channels

Cell membranes and lipid peroxidation

Cell and organelle membranes play roles in partitioning cells from the extracellular milieu as well as in sustaining boundaries and regulating flow of materials between cellular compartments needing different metabolic parameters for their activities. They also play critical roles in maintaining electrical differences and the flow of electricity.

Adey (2002) summarized studies that report cell membranes as the site of initial field transductive coupling.

> *"Collective evidence points to cell membrane receptors as the probable site of first tissue interactions with both ELF and microwave fields for many neurotransmitters (Mironova et al. 1994), hormones (Liburdy 1995; Ishido, Nitta, and Kabuto 2001), growth- regulating enzyme expression (Byus, Pieper, and Adey 1987; Chen et al. 2000; Litovitz et al. 1993) (Penafiel et al. 1997), and cancer-promoting chemicals (Cain, Thomas, and Adey 1993; Mevissen, Haussler, and Loscher 1999). In none of these studies does tissue heating appear involved causally in the responses. Physicists and engineers have continued to offer microthermal, rather than athermal, models for these phenomena (Barnes 1996; Astumian, Weaver, and Adair 1995), with views that exclude consideration of cooperative organization and coherent charge states, but it is difficult to reconcile experimental evidence for factors such as modulation frequency-dependence and required duration of an amplitude-modulated signal to elicit a response (coherence time) (Litovitz et al. 1993) with models based on the equilibrium dynamics of tissue heating."* (Adey 2002)

Membranes are well-known targets of oxidative stress. Membrane damage is a major route through which free radical damage proliferates through the cellular system. Lipid peroxidation of membranes most often affects polyunsaturated fatty acids such as EPA and DHA which are the most abundant and vulnerable lipids in the brain where the damage they sustain can have serious impacts – DHA is 40% of brain tissue. Lipid

peroxidation of membranes has been identified as an effect of EMF/RFR in multiple studies (Desai, Kesari, and Agarwal 2009; Phelan et al. 1992). A variety of other mechanisms for membrane alteration related to EMF/RFR have been intimated in the literature. Physicochemical properties of membranes such as phase transition of phosphatidylcholine can be shifted by nonthermal effects of microwave radiation (Beneduci et al. 2012). Membrane potential and currents may also be impacted by pulsed radiofrequency fields (Linz et al. 1999). This has been observed graphically in altered cellular movement in Paramecium caudatum, with these cells becoming broader, with a broader-appearing cytopharynx, with their pulse vesicles having difficult in expelling their content outside the cell, and with less efficient movement of cilia (Cammaerts et al. (2011) which the authors suggested might be due to targeting of the cellular membrane. The impacts on this unicellular organism may help us imagine what the impact of EMF/RFR might be on cells with some structural similarities, such as columnar epithelial cells and ciliated cells in mucosal surfaces in the respiratory system, digestive tract, uterus and fallopian tubes and central spinal cord.

Indications of lipid peroxidation of membranes has been documented in ASDs, including malonaldehyde and isoprostanes, as well as alteration of membrane phospholipids and prostaglandins (Pecorelli et al. 2012; El-Ansary et al. 2010; El-Ansary, Ben Bacha, and Kotb 2012; Zhang, Sun, et al. 2012; Yao et al. 2006; Al-Gadani et al. 2009; Chauhan and Chauhan 2006; Ming, Stein, et al. 2005; Zoroglu et al. 2004) In one study the iosoprostane levels showed a biomodal distribution with the majority of ASD subjects showing moderate increase but a smaller group showing dramatic increases (Ming, Stein, et al. 2005). Thromboxane, reflecting platelet activation, was also elevated in one study (Yao et al. 2006). Given that this phenomenon has been identified in many people with ASDs, it is plausible that such individuals will likely be more vulnerable to having such cellular injuries caused, worsened or both by EMF/RFR exposures.

Calcium channels

Of particular prominence in the EMF/RFR physiological impact literature is the impact on calcium channels and signaling. Calcium signaling is ubiquitous in biological systems ranging from single-celled organisms to the most sophisticated functioning of our nervous and immune systems. This signaling takes place through a myriad of mechanisms within and between cells. The exquisite tuning of organisms is influenced by the precision of functioning of these systems, with even subtle disturbances having the potential to ramify in a nonlinear fashion through a system causing larger-scale disturbances elsewhere. EMF/RFR exposures have been shown to create disturbances in calcium signaling through a variety of mechanisms, including membrane leakage (Nesin et al. 2012), alteration of calcium-binding proteins and GFAP reactivity (Maskey et al. 2012; Maskey et al. 2010), and altered ultrastructural distribution of calcium and calcium-activated ATPases after exposure (Kittel et al. 1996). Adey (2002) provided an

overview of key studies on calcium efflux and the importance of calcium in cell signalling. *"Early studies described calcium efflux from brain tissue in response to ELF exposures (Bawin and Adey 1976; Blackman et al. 1985), and to ELF-modulated RF fields (Bawin and Adey 1976) (Blackman 1979) (Blackman et al. 1985; Dutta, Ghosh, and Blackman 1989). Calcium efflux from isolated brain subcellular particles (synaptosomes) with dimensions under 1.0 μm also exhibit an ELF modulation frequency-dependence in calcium efflux, responding to 16 Hz sinusoidal modulation, but not to 50 Hz modulation, nor to an unmodulated RF carrier (Lin-Liu and Adey 1982). In the same and different cell culture lines, the growth regulating and stress responsive enzyme ornithine decarboxylase (ODC) responds to ELF fields (Byus et al. 1988; Litovitz et al. 1993) and to ELF-modulated RF fields (Byus, Pieper, and Adey 1987) (Litovitz et al. 1993) (Penafiel et al. 1997)."* (Adey 1994)

Dutta et al (1992) reported:

> *"Radio-frequency electromagnetic radiation (RFR) at 915 and 147 MHz, when sinusoidally amplitude modulated (AM) at 16 Hz, has been shown to enhance release of calcium ions from neuroblastoma cells in culture. The dose-response relation is unusual, consisting of two power-density "windows" in which enhanced efflux occurs, separated by power-density regions in which no effect is observed. To explore the physiological importance of these findings, we have examined the impact of RFR exposure on a membrane-bound enzyme, acetylcholinesterase (AChE), which is intimately involved with the acetylcholine (ACh) neurotransmitter system. Neuroblastoma cells (NG108), exposed for 30 min to 147-MHz radiation, AM at 16 Hz, demonstrated enhanced AChE activity, as assayed by a procedure using 14C-labeled ACh. Enhanced activity was observed within a time window between 7.0 and 7.5 h after the cells were plated and only when the exposure occurred at power densities identified in a previous report as being effective for altering the release of calcium ions. Thus RFR affects both calcium-ion release and AChE activity in nervous system-derived cells in culture in a common dose-dependent manner."* (Dutta et al. 1992)

The prominence of these calcium signaling impacts of EMF/RFR are striking when considered in relation to ASD pathophysiology, where such alterations have been proposed as of central importance. Calcium channels play an important role in regulating neuronal excitability, whose disturbance during development has been thought by many to be potentially contributory to the development of ASDs, as well as to the often associated vulnerability to seizures. Gene alterations have been identified associated with a number of voltage-gated calcium channels in ASDs (Smith, 2012; Krey and Dolmetsch 2007; Pasca et al. 2011; Gargus 2009; Lu et al. 2012). However, based on an examination of patient laboratory and phenotype data it has been argued that aberrant calcium signaling could be downstream: Palmieri and Persico (2010) suggest that *"an*

abnormal neuroimmune response as a relevant player in elevating intracellular Ca2+ levels, deranging neurodevelopment, driving oxidative stress, and ultimately affecting synaptic function and neural connectivity especially in long-range neuronal pathways physiologically responsible for integrated information processing." (Palmieri and Persico 2010) Peng and Jou (2010) have in turn shown how increased intracellular calcium can cause oxidative stress, and a vicious circle: *"...mitochondrial ROS [reactive oxygen species]rise can modulate Ca2+ dynamics and augment Ca2+ surge. The reciprocal interactions between Ca2+ induced ROS increase and ROS modulated Ca2+ upsurge may cause a feedforward, self-amplified loop creating cellular damage far beyond direct Ca2+ induced damage."* (Peng and Jou 2010)

Environmental as well as genetic routes to calcium signaling dysfunction have been identified (Pessah and Lein 2008) including chemicals such as the polyaromatic hydrocarbons. PCB-95 in particular modulates the calcium-dependent signaling pathway responsible for activity-dependent dendritic growth (Wayman, 2012; Wayman, 2012). In fact, once a genetic mutation has been associated with altering a critical signaling pathway and conferring risk for autism, chemicals or other environmental agents can be identified that target the same pathways and also confer ASD risk. Stamou et al. (2012) have reviewed this strategy of identifying multiple mechanisms converging on common signaling pathways regarding Ca(2+)-dependent mechanisms as well as extracellular signal-regulated kinases (ERK)/phosphatidylinositol-3-kinases (PI3K) and neuroligin-neurexin-SHANK (Stamou et al. 2012). From this point of view, there may be no particular reason to privilege genetic mutations in their contribution to a disturbance of calcium signaling, since whether this function becomes derailed due to a genetic mutation, from a chemical toxin or from EMF/RFR perturbation of calcium signaling, the functional effect is comparable. Moreover if a person is subject to multiple triggers all of which have calcium signaling impacts, the gene-environment interactions may lead to impacts that could be less, the same as or more than any one contributor alone might create.

3. Junctions and barriers

The damage discussed so far has been at the molecular and subcellular level. However impacts from this level reverberate up to larger scales in the system. Where membranes create boundaries between cells and subcellular compartments, barriers do this at a larger scale. Cells become capable of forming barriers between each other through tight junctions which block substances and cells from 'slipping through the cracks,' so to speak, between the cells. Conversely, gap junctions are subcellular structures providing openings that allow physical passage of materials between cells otherwise separated by membranes.

It appears that such connections between cells can also be altered by electromagnetic fields and radiofrequency exposures, at least under certain circumstances. High frequency magnetic fields have been observed to be associated with a sharp decrease in intercellular gap junction-like structures, in spite of increased gene expression for pertinent proteins (Cervellati, 2009). Changes in tight junctions have been observed upon exposure to microwave and x-ray irradiation {Palfia, 2001).

A number of papers in the ASD research field document problems pertinent to junctions. Connexin abnormalities have been documented in neuropathological studies (Fatemi et al. 2008). and MacFabe and colleagues identified lipid alterations associated with oxidative stress, membrane fluidity and the modulation of gap junction coupling (Thomas et al. 2012). Decrease in platelet endothelial cell adhesion molecule-1 were reduced and this reduction correlated with repetitive behavior and abnormal brain growth; achesion molecules modulate permeability and signaling at the blood-brain barrier as well as leukocyte infiltration into the central nervous system (Onore et al. 2012).

EMF and RFR might also compromise biologically important barrier structures that separate blood flow from organs like the brain (Salford et al, BioInitiative Report 2012, Section 10) (Salford, 2012). This raises important questions regarding whether other 'barriers' that keep blood flow separate from the gut (gut-blood barrier), or the placenta (blood-placenta barrier) or the eye (ocular-blood barrier) may also be rendered pathologically leaky, and allow albumin, toxins, pro-inflammatory cytokines and infectious agents to cross this barrier into the intestines (invoking immune responses) and impacting the developing fetus (Somosy, 1993). While there are a fair number of negative studies, there are also many studies showing and association between EMF/RFR and pathological leakage of the blood-brain barrier (BBB), as well as evidence in animal studies of damage to brain cells and damage to or death of neurons. Such leakage has been shown to be potentiated by physiological factors such as diabetes and insulin (Gulturk et al 2010) and has also potentiated viral lethality in a dose-dependent fashion (Lange et al, 1991). Many of the positive findings were associated with non-thermal exposures comparable to normal cell phone radiation exposure (Salford, 1994; Salford, 2003; Salford, 2007; Salford, 1992; Eberhardt, 2008; Nittby, 2009; Nittby, 2008). There are scattered reports of increased permeability across other membranes and barriers, such as the blood-testicle barrier in mice (Wang, 2008; Wang et al., 2010 and the rat liver canalicular membrane (Lange, 1993). A 1992 study by Kues et al. reported that *"studies in our laboratory have established that pulsed microwaves at 2.45 GHz and 10 mW/cm2 are associated with production of corneal endothelial lesions and with disruption of the blood-aqueous barrier in the non-human primate eye."* (Kues et al. 1992) A recent study showing impact of high-frequency electromagnetic fields on trophoblastic connexins (Cervellati et al. 2009) may indicate the vulnerability of the placenta and placental barrier function to electromagnetic fields. A thorough review and

methodological discussion of literature regarding EMF/RFR impacts on the BBB is provided by Salford in Section 10 of the BioIniative 2012 Report (Salford, 2012).

According to a review by Zlokovic, *"BBB breakdown, due to disruption of the tight junctions, altered transport of molecules between blood and brain and brain and blood, aberrant angiogenesis, vessel regression, brain hypoperfusion, and inflammatory responses, may initiate and/or contribute to a "vicious circle" of the disease process, resulting in progressive synaptic and neuronal dysfunction and loss in disorders such as Alzheimer's disease, Parkinson's disease, amyotrophic lateral sclerosis, multiple sclerosis, and others."* (Zlokovic 2008). The integrity of the BBB can be compromised by oxidative stress which can lead to increased permeability (Parathath, Parathath, and Tsirka 2006). The resultant extravasation of albumin into brain parenchyma can be excitotoxic and neurotoxic (Hassel, Iversen, and Fonnum 1994; Eimerl and Schramm 1991).

The evidence suggesting possible existence of barrier function compromise in people with ASDs is largely indirect. The existence of brain neuroinflammation in ASDs has been documented in a growing number of studies (Boso et al. 2006; El-Ansary and Al-Ayadhi 2012; Young et al. 2011), and this is known to be associated with BBB permeability (Erickson, Dohi, and Banks 2012; Janigro 2012; Takeshita and Ransohoff 2012). In a review of clinical MRI findings in ASDs 19/59 showed white matter signal abnormalities (Boddaert et al. 2009), which in other settings have been associated with cerebral hypoperfusion, though not necessarily in the same locations as the hyperintensities (Vardi et al. 2011; Brickman, 2009). Blood flow abnormalities, predominantly hypoperfusion, documented in a few dozen PET and SPECT studies, could also be caused by and/or associated with physiological phenomena associated with vascular permeability as will be revisited below. Increased intestinal permeability has been documented (although its absence has also been documented) (de Magistris et al. 2010; Lucarelli et al. 1995; D'Eufemia et al. 1996; Horvath and Perman 2002; White 2003; Robertson et al. 2008; Souza et al. 2012) and discussed in the context of food exposures, particularly gluten (Silva et al. 2012; Sapone et al. 2011; Visser et al. 2009; Simpson et al. 2009; Fasano 2009; Lammers et al. 2008; De Angelis et al. 2006). The reactivity to large numbers of different foods clinically observed in many children with autism has been framed by some as a manifestation of indiscriminate exposure of the immune system and the brain to food proteins on account of intestinal permeability as well as BBB permeability (Theoharides and Doyle 2008). This reactivity could in turn feed in to aberrant immune responsivity which in turn could further amplify barrier vulnerability (Fasano, 2009).

A number of studies have made an association between an increased risk of having a child with autism and maternal infection during pregnancy. This phenomenon looks like it is a result of the maternal immune system response rather than being due to an impact

deriving from a specific infectious agent; but the potential for an accompanying compromise of the placental barrier is also conceivable in this setting. Under these circumstances the fetal risk of exposure to maternal blood toxins, cytokines and stress proteins in-utero could potentially be increased if placenta barrier (BPB) function were impaired. The integrity, or compromise thereto, of the maternal-fetal interface via the placenta is an important modulator of brain development (Hsiao and Patterson 2012).

4. Genetic alterations and reproductive impacts

Because of the high heritability of autism that was calculated from the concordance rates of monozygotic (identical) vs. dizygotic (fraternal) twins found in by a series of small twin studies performed some decades ago, the overwhelming emphasis in recent decades in autism research has been on genetics, and on finding linkages between genes, brain and behavior. As mentioned earlier, this point of view also promotes more of a structural/anatomical orientation than a bioelectric/physiological orientation. Along with this emphasis it has seemed obvious to people just looking at the stubborn persistence of symptoms in affected individuals that ASDs are inborn, lifelong brain defects. From this vantage point there would be no reason to think about the transduction of pathophysiology – whether acquired or genetic or some combination – to brain and hence behavior (or, more broadly, neurocognitive function). Thus the research agenda of looking for gene-brain-behavior correlations has seemed both self-evident and sufficient.

In recent years the genetic premises of this seemingly obvious framing of autism as overwhelmingly genetic have been undermined at several levels. (The undermining of the brain premises will be discussed beyond what was covered in Part I in later sections.) First the number of reported cases is increasing, making it more difficult to maintain that ASDs are purely genetic because these increases can only be partly explained away by greater awareness or other data artifacts (King and Bearman 2009; Hertz-Picciotto and Delwiche 2009). Second, the complexity of the ways we understand how genes might relate to autism has grown, from an expectation a decade ago that a small number of genes (even less than a dozen) would explain everything to an identification of close to a thousand genes associated with autism, as well as 'de novo' mutations present in ASD children but not their parents and even 'boutique' mutations not shared beyond an individual family. Out of over a hundred genetic syndromes in which autism commonly occurs, it is unclear what the pertinent genetic mutations and rearrangements have in common to account for the shared association with ASDs (Anney et al. 2010; Betancur 2011). Moreover, a recent twin study that was much larger than any of the prior such studies identified a modest genetic role but a substantial environmental role (Hallmayer et al. 2011). Also of interest, a Swedish study of identical twins and schizophrenia grouped into monochorionic (shared placenta) and dichorionic (each had its own placenta) showed 60% concordance for schizophrenia diagnosis for monochorionic twins but only 10.7%

concordance for dichorionic twins (Davis, Phelps, and Bracha 1995); though this work has not yet been replicated in ASD twins, in principle it opens the door to non-genetic interpretations of any concordance figures that have generally been assumed to be indicators of heritable genetics. The authors of this study interpreted their findings as consistent with data on viral infection as a contributor to schizophrenia risk (a possibility also entertained in ASDs (Patterson 2012; Teixeira and Barichello 2012; Atladottir et al. 2012, 2012; Hornig et al. 1999), but one could also consider the possibility of differences in the dichorionic cases in the integrity of the placental barrier.

All of this calls into question the idea that genetics can be presumed to be the 'cause' of autism simply based upon heritability calculations, and upgrades the importance of looking not only at the environment and environmentally vulnerable physiology, but also at acquired mutations. There is certainly progress being made through genetic research to the identification of networks of genes and mechanisms on which genes converge (Voineagu et al. 2011), but environmental mechanisms converge on these mechanisms too (Stamou et al. 2012), and the mechanisms are what drive the impacts.

Genotoxicity

One route through which environmental impacts may influence an organism's status is by changing genes through mutation – that is, by genotoxicity. This has been proposed as a mechanism for the generation of 'de novo' mutations (found in children but not their parents) being found in ASDs (Kinney et al. 2010) and increasingly in other settings as well, making mutations something that needs to be accounted for rather than simply assuming tey are associated with normal, stable variation. Reviews and published scientific papers on genotoxicity and EMF report that both ELF-EMF and RFR exposures can be considered genotoxic – i.e., damaging to DNA – under certain conditions of exposure, including under conditions of intermittent and/or chronic ELF and RFR exposure that are of low-intensity and below current world safety standards (Ruediger 2009; Ivancsits et al. 2005; Diem et al. 2005; Blank and Goodman 2011; Phillips, Singh, and Lai 2009; REFLEX 31 May 2004; Sage and Carpenter 2009; Lai and Singh 2004). Types of genetic damage reported have included DNA fragmentation and single- and double-strand DNA breaks, micronucleation and chromosome aberrations, all of which indicate genetic instability. Genotoxic impacts of EMF/RFR are further reviewed in the BioInitiative Working Group 2007 contribution by Lai as well as in Section 6 of the present Bioinitiative Report {Lai, 2007; Lai, 2012).

The European research program REFLEX (Risk Evaluation of Potential Environmental Hazards From Low-Energy Electromagnetic Field Exposure Using Sensitive in vitro Methods – a 5FP EU project) documented many changes in normal biological functioning in tests on DNA at exposure levels below existing public safety standards(REFLEX 31 May 2004). Some of the key findings included:

- Gene mutations, cell proliferation and apoptosis which are caused by or result in altered gene and protein expression profiles. The convergence of these events is required for the development of all chronic diseases.
- Genotoxic effects and a modified expression of numerous genes and proteins after EMF exposure could be demonstrated with great certainty.
- Genotoxic effects produced by RF-EMF in fibroblasts, HL- 60 cells, granulosa cells of rats and neural progenitor cells derived from mouse embryonic stem cells.
- Response of cells to RF exposure between SAR levels of 0.3 and 2 W/Kg with a significant increase in single- and double-strand DNA breaks and in micronuclei frequency.
- A clear demonstration of increase in intracellular generation of free radicals in HL-60 cells accompanying RF-EMF exposure.
- The observation that the induced DNA damage was not based on thermal effects, which raises concerns about the thermal-based environmental safety limits for ELF-EMF exposure.

These impacts could be contributors to a role for genetics in ASDs that does not derive from only inheritance but also from environmental and epigenetic influences. Moreover, in the light of the great heterogeneity of genetic findings in ASD alongside the documented impacts of EMF/RFR upon many other levels of pathophysiology than simply genetics, it becomes worth reflecting whether genetics might not be the primary problem but instead, in many cases at least, just one of many levels of collateral damage from environmental impacts. Whatever genetic variants a person carries may bias their system toward specific vulnerability, or may contribute more generically by increasing entropy and molecular disorder; in either capacity they may aggravate the situation but may not be part of the main cause.

Contributors to Genotoxicity

Oxidative stress and free radical damage to DNA

Oxidative stress and excessive free radical production are very well known to be potentially genotoxic. They can be a consequence of myriad environmental factors, including but by no means limited to EMF/RFR. The DNA damage that can result could very well be one cause of 'de novo' mutations. Although there is not a consensus at this time about the rates or causes of *de novo* mutations in ASDs, and using present methods of detection are only found in a small percentage of individuals with ASDs, given the potential contribution of environmentally triggered oxidative stress and free radical damage that we know is present in at least large numbers of people with ASDs, a serious investigation of the potential contribution of EMF and RFR to de novo mutations in ASD seems warranted, given the large increase in exposure to these phenomena accompanying the massively increased non-ionizing radiation exposures in daily life due to

electrification and the global saturation of RFR from wireless technologies (BioInitiative 2012 Report, Section 24, Public Health Implications, Sage and Carpenter, 2012).

Challenge to DNA repair mechanisms

Reduced DNA repair may contribute to increased risk of cancers, but it may also contribute to a variety of other diseases and disturbances of growth and development. When the rate of damage to DNA exceeds the rate at which DNA can be repaired, there is the possibility of retaining mutations and initiating pathology. Failure to trigger DNA damage repair mechanisms, or incomplete or failed repair, may be a consequence of a variety of commonplace stressors, including EMF/RFR exposure. A decrease in DNA repair efficiency has been reported to result from exposure to low-intensity RFR in human stem cells, and other cells. Mobile phone frequency GSM exposure at the frequency of 915 MHz consistently inhibited DNA repair foci in lymphocytes (Markova et al. 2005; Belyaev et al. 2005; Belyaev, Markova, and Malmgren 2009). Belyaev, Markova and colleagues (2005) and Markova et al. (2009) reported that very low-intensity microwave radiation from mobile phones inhibits DNA repair processes in human stem cells. A significant reduction in 53BP1 ((tumor suppressor p53 binding protein 1) foci was found in cells exposed to microwave radiofrequency radiation within one hour of exposure. Fibroblast cells were impacted in this fashion but adapted over time, whereas stem cells were similarly affected (inhibited 53BP1 foci) but did not adapt to microwave radiation during chronic exposure (Markova et al. 2005; Belyaev et al. 2005). Additional challenges to DNA repair mechanisms include not only toxicants and other damaging inputs but also nutritional insufficiencies of substances important to the proper functioning of DNA repair mechanisms, including Vitamin D, essential fatty acids, and minerals such as selenium and molybdenum (Christophersen and Haug 2011). The high possibility that various such contributors may combine supports an 'allostatic load' model of environmental injury and genotoxicity. Also note the overlap between nutritional risk factors for oxidative stress and for impaired DNA repair mechanisms. This supports a vicious circle model where the more oxidative damage to the genome, the less the cells will be prepared to deal with it successfully. It can also work the other way around – nutrients can attenuate the degree of damage; instances of this will be discussed in the Melatonin section below.

Chromatin condensation

Chromatin condensation is another hallmark of damage from EMF and RFR. Orderly chromatin condensation is a normal part of cell division, but it can also be provoked pathologically. The work of Markova, Belyaev and others has repeatedly shown that RFR exposure can cause chromatin condensation. Belyaev (1997) reported that super-low intensity RFR resulted in changes in genes, and chromatin condensation of DNA at intensities comparable to exposures from cell towers (typically at RFR levels of 0.1 to 1.0 uW/cm2) (Belyaev, Alipov, and Harms-Ringdahl 1997). Significant microwave-induced

changes in chromatin conformation were observed when rat thymocytes were analyzed in-between 30-60 min after exposure to MW (Belyaev and Kravchenko 1994). This effect nearly disappeared if the cells were incubated more than 80 min between exposure and analysis.

In recent studies, human lymphocytes from peripheral blood of healthy and hypersensitive to EMF persons were exposed to non-thermal microwave radiation NT MW) from the GSM mobile phones (Belyaev et al. 2005; Markova et al. 2005). NT MW induced changes in chromatin conformation similar to those induced by heat shock, which remained up to 24 h after exposure. The same group has reported that contrary to human fibroblast cells, which were able to adapt during chronic exposure to GSM/UMTS low intensity RFR exposure, human stem cells did not adapt (Belyaev, Markova, and Malmgren 2009).

Researchers have recently identified large numbers of "spontaneous genetic glitches," or de novo mutations, more likely to be transmitted by fathers than by mothers to their children (Neale et al. 2012; O'Roak et al. 2012; Sanders et al. 2012). These glitches are widely distributed across the genome, with their location rather than their size conferring risk. The Eichler team at the University of Washington found that 39% of the 126 most severe or disruptive mutations map to a network associated with chromatin remodeling that has already been ranked as significant amongst autism candidate genes (O'Roak et al. 2012). Whether the prominence of chromatin-related gene mutations can be related in any meaningful way to the impacts of EMF/RFR on chromatin condensation is not possible to say at this point in time and this apparent parallel between ASDs and EMF/RFR may be a pure coincidence, though an intriguing one worth looking into further, including regarding how these mutations and the chromatin-remodeling impacts of EMF/RFR exposure may interact.

Gonadal and germline impacts

De novo mutations have been shown to be more of a problem related to paternal age (O'Roak et al. 2012; Paul, Nagano, and Robaire 2011; Iossifov et al. 2012; Cantor et al. 2007; Alter et al. 2011), and this may be related to the impact of environmental factors such as EMF/RFR on the stem cell genome, particularly in sperm which have no DNA repair capacity. Vulnerability of testes and ova, and of sperm and egg cells, relates to the tissue milieu in which damage to the germline can take place, as well as on the greater vulnerability of stem cells. Several international laboratories have replicated studies showing adverse effects on sperm quality, motility and pathology in men who use and particularly those who wear a cell phone, PDA or pager on their belt or in a pocket (Agarwal et al. 2008; Agarwal et al. 2009; Wdowiak, Wdowiak, and Wiktor 2007; De Iuliis et al. 2009; Fejes et al. 2005; Aitken et al. 2005) Kumar, 2012). Other studies conclude that usage of cell phones, exposure to cell phone radiation, or storage of a

mobile phone close to the testes of human males affect sperm counts, motility, viability and structure (Aitken et al. 2004; Agarwal et al. 2007; Erogul et al. 2006). Animal studies have demonstrated oxidative and DNA damage, pathological changes in the testes of animals, decreased sperm mobility and viability, and other measures of deleterious damage to the male germ line (Dasdag et al. 1999; Yan et al. 2007; Otitoloju et al. 2010; Salama et al. 2009) Behari et al. 2006; Kumar et al. 2012). Of note, altered fatty acids consistent with oxidative stress have been found in sperm cells in male infertility (Zalata et al. 1998; Zalata, Hafez, and Comhaire 1995).

There are fewer animal studies that have studied effects of cell phone radiation on female fertility parameters. Panagopoulous et al. 2012 report decreased ovarian development and size of ovaries, and premature cell death of ovarian follicles and nurse cells in *Drosophila melanogaster* (Panagopoulos 2012). Gul et al (2009) report rats exposed to stand-by level RFR (phones on but not transmitting calls) caused decrease in the number of ovarian follicles in pups born to these exposed dams (Gul, Celebi, and Ugras 2009). Magras and Xenos (1997) reported irreversible infertility in mice after five (5) generations of exposure to RFR at cell phone tower exposure levels of less than one microwatt per centimeter squared (μW/cm2) (Magras and Xenos 1997).

Implications of genotoxicity

The issue of genotoxicity puts the contribution of genetic variation into a different light – as something that needs to be accounted for, not necessarily assumed as the starting point. In this regard it has been speculated that the apparent higher rates of autism in Silicon Valley, discussed in the past as related to 'geek genes' (Silberman 2001), might be conditioned by higher levels of exposure to EMF/RFR. The relationship between the greater vulnerability of male sperm than of female eggs to adverse effects of EMF/RFR exposure and the marked (4:1) predominance of paternal origin of de novo point mutations (4:1 bias), also deserves further careful attention (O'Roak et al. 2012).

5. Implications of Damage

We have reviewed parallels between ASD and EMF/RFR in molecular, cellular and tissue damage, including cellular stress (oxidative stress, the heat shock response and protein misfolding), injury of membranes, aberrant calcium signaling, and compromise of junctions and barriers. The genotoxicity of EMF/RFR was reviewed in relation to issues of environmental contributions to autism and of the phenomenon of de novo mutations. The compromise of the tissue substrate appears to have many commonalities in ASDs and in EMF/RFR exposures. Also notable was the possibility of attenuating some of the damage through increasing antioxidant status.

These commonalities come to mind in considering the implications of a recent study documenting arrest of symptomatology in a mouse model of Rett syndrome through a

bone marrow transplant of wild-type microglia (Derecki et al. 2012; Derecki, Cronk, and Kipnis 2012). The introduction of these competent microglia cells did not directly target the neuronal defect associated with the MECP2 gene mutation; instead the benefits of the transplant were diminished through inhibition of phagocytosis. Phagocytosis involves removing debris. This suggests that while research has focused on how specific molecular defects, particularly in the synapse, may contribute to Rett pathophysiology, there may also be an important contribution from cellular debris, misfolded proteins and other disordered cellular structure and function. Such disorder could be accumulating in cells under the conditions of pathophysiological disarray reviewed above. This has potentially broad implications for other genetic disorders, as well as for conditions like ASDs which are for the most part idiopathic. Based on this study as well as on the levels of damage just reviewed, problems in cells that are pertinent to ASDs most likely go beyond any specific defect introduced by a mutation. Additionally it is conceivable that many of the mutations may be not part of normal background variation but instead collateral damage from the same environmental factors that are also driving the damage to the pathophysiology. It is also encouraging that at least some of the damage and dysfunction was reversible by a generic cellular mechanism (phagocytosis), and this could have broad significance for idiopathic ASDs as well, along with other conditions involving related pathophysiological challenges.

B. Degradation of System Integrity

In the setting of molecular, cellular and tissue damage, one would predict that the organization and efficiency of a variety of organelles, organs and systems would also be degraded. EMF/RFR exposures yield a stressful situation of chronically interrupted homeostasis. Here we will review disturbances from EMF/RFR in systems (including include oxidative and bioenergetics metabolism, immune function and electrophysiological oscillations) that include molecular and cellular components subject to the kinds of damage discussed in the previous section. We will review disturbances that have been associated with EMF/RFR, and consider the parallel disturbances that have been documented in ASDs.

1. Mitochondrial dysfunction

Mitochondria are broadly vulnerable, in part because the integrity of their membranes is vital to their optimal functioning – including channels and electrical gradients, and their membranes can be damaged by free radicals which can be generated in myriad ways. Moreover, just about every step in their metabolic pathway can be targeted by environmental agents, including toxicants and drugs, as well as mutations (Wallace and Starkov 2000). This supports an allostatic load model for conditions in which mitochondrial dysfunction is an issue, which includes ASDs as well as myriad other chronic conditions.

Mitochondria are commonly discussed in terms of the biochemical pathways and cascades of events by which they metabolize glucose and generate energy. But in parallel with this level of function there also appears to be a dimension of electromagnetic radiation that is part of the activity of these organelles. For example, electromagnetic radiation can be propagated through the mitochondrial reticulum, which along with the mitochondria has a higher refractive index than the surrounding cell and can serve to propagate electromagnetic radiation within the network (Thar and Kuhl 2004). It is also the case that *"The physiological domain is characterized by small-amplitude oscillations in mitochondrial membrane potential (delta psi(m)) showing correlated behavior over a wide range of frequencies.... Under metabolic stress, when the balance between ROS [reactive oxygen species, or free radicals] generation and ROS scavenging [as by antioxidants] is perturbed, the mitochondrial network throughout the cell locks to one main low-frequency, high-amplitude oscillatory mode. This behavior has major pathological implications because the energy dissipation and cellular redox changes that occur during delta psi(m) depolarization result in suppression of electrical excitability and Ca2+ handling..."* (Aon, Cortassa, and O'Rourke 2008). These electromagnetic aspects of mitochondrial physiology and pathophysiology could very well be impacted by EMF/RFR.

There are also a variety of types of mitochondrial damage that have been documented in at least some of the studies that have examined the impacts of EMF/RFR upon mitochondria. These include reduced or absent mitochondrial cristae (Khaki et al. 2006; Lahijani, Tehrani, and Sabouri 2009; Esmekaya et al. 2011), mitochondrial DNA damage (Xu et al. 2010), swelling and crystallization (Lahijani, Tehrani, and Sabouri 2009), alterations and decreases in various lipids suggesting an increase in their use in cellular energetics (Chernysheva 1987), damage to mitochondrial DNA (Xu et al. 2010), and altered mobility and lipid peroxidation after exposures (Wang et al. 2002). Also noted has been enhancement of brain mitochondrial function in Alzheimer's transgenic mice and normal mice (Dragicevic et al. 2011). The existent of positive as well as negative effects gives an indication of the high context dependence of exposure impacts, including physical factors such as frequency, duration, and tissue characteristics; these are

intensively reviewed in Belyaev's contribution to BioInitiative 2012 in Section 15 (Belyaev 2012).

The idea that mitochondrial dysfunction might be common in ASDs met with a fair bit of consternation, and many professionals have preferred to limit their consideration to mitochondrial disorders with proven genetic mutations. However the concept of mitochondrial dysfunction is better established in other areas of medicine, with thousands of papers and hundreds of reviews carrying "mitochondrial dysfunction" in their titles. By now there is a large amount of evidence for biochemical and other abnormalities in a large portion of children with autism that are consistent with mitochondrial dysfunction (Giulivi et al. 2010; Palmieri et al. 2010; Pastural et al. 2009). Recently published postmortem brain tissue studies that have added a new dimension of evidence for mitochondrial abnormalities in ASDs will be reviewed in the section on alteration of brain cells below.

Some have called the mitochondrial issues most commonly seen in ASDs 'secondary mitochondrial dysfunction' (Zecavati and Spence 2009; Rossignol and Frye 2011) to indicate that it results from environment insults and/or other pathophysiological dysfunction rather than directly from genetics (Hadjixenofontos et al. 2012); the already discussed potential for EMF/RFR to damage channels, membranes and mitochondria themselves could contribute in a number of ways to degrading mitochondrial function without a basis in genetic mutation, as could toxicant exposures and immune challenges. In a meta-analysis of studies of children with ASD and mitochondrial disorder, the spectrum of severity varied, and 79% of the cases were identified by laboratory not associated with genetic abnormalities (Rossignol and Frye 2011). "*Substantial percentages of autistic patients display peripheral markers of mitochondrial energy metabolism dysfunction, such as (a) elevated lactate, pyruvate, and alanine levels in blood, urine and/or cerebrospinal fluid, (b) serum carnitine deficiency, and/or (c) enhanced oxidative stress.....In some patients, these abnormalities have been successfully explained by the presence of specific mutations or rearrangements in their mitochondrial or nuclear DNA. However, in the majority of cases, abnormal energy metabolism cannot be immediately linked to specific genetic or genomic defects.*" (Palmieri and Persico 2010)

2. Melatonin dysregulation

Melatonin, mitochondria, glutathione, oxidative stress

Melatonin is well-known for its role in regulation of circadian rhythms, but it also plays important metabolic and regulatory roles in relation to cellular protection, mitochondrial malfunction and glutathione synthesis. (Leon et al. 2005; Luchetti et al. 2010; Limon-Pacheco and Gonsebatt 2010) *"It is known that melatonin scavenges oxygen and*

nitrogen-based reactants generated in mitochondria. This limits the loss of the intramitochondrial glutathione and lowers mitochondrial protein damage, improving electron transport chain (ETC) activity and reducing mtDNA damage. Melatonin also increases the activity of the complex I and complex IV of the ETC, thereby improving mitochondrial respiration and increasing ATP synthesis under normal and stressful conditions." (Leon et al. 2005) It also helps prevent the breakdown of the mitochondrial membrane potential, decrease electron leakage, and thereby reduce the formation of superoxide anions. (Hardeland 2005) Pharmacological doses of melatonin not only scavenge reactive oxygen and nitrogen species, but enhance levels of glutathione and the expression and activities of some glutathione-related enzymes. (Limon-Pacheco and Gonsebatt 2010; Gupta, Gupta, and Kohli 2003)

Melatonin can attenuate or prevent some EMF/RFR effects

Melatonin may have a protective effect in the setting of some EMF/RFR exposures, apparently in relation to these functions just described. EMF/RFR can impact melatonin; one example is exposure to 900-MHz microwave radiation promoted oxidation, which reduced levels of melatonin and increased creatine kinase and caspase-3 in exposed as compared to sham exposed rats (Kesari, Kumar, and Behari 2011).

Further types of adverse impacts can be seen in the next set of examples, but what is interesting is that melatonin can attenuate or prevent them. In an experiment exposing rats to MW from a GSM900 mobile phone with and without melatonin treatment to study renal impacts (Oktem et al. 2005), the untreated exposed rats showed increases of lipid peroxidation markers as reduction of the activities of superoxide dismutase, catalase and glutathione peroxidase indicating decrement in antioxidant status. However these negative effects were inhibited in the exposed rats treated with melatonin. Melatonin also inhibited the emergence of preneoplastic liver lesions in rats exposed to EMFs (Imaida et al. 2000). The development of DNA strand breaks was observed in RFR exposed rats; this DNA damage was blocked by melatonin (Lai and Singh 1997). Exposure of cultured cortical neurons to EMF led to an increase in 8-hydroxyguanine in neuronal mitochondria, a common biomarker of DNA oxidative damage, along with a reduction in the copy number of mitochondrial DNA and the levels of mitochondrial RNA transcripts; but these effects could all be prevented by pretreatment with melatonin (Xu et al. 2010). In a study of skin lesion induced by exposure to cell phone radiation, the skin changes in the irradiated group (which included thicker stratum corneum, epidermal atrophy, papillamatosis, basil cell proliferation, increased epidermal granular cell layer and capillary proliferation, impaired collagen tissue distribution and separation of collagen bundles in dermis) were prevented (except for hypergranulosis) by melatonin treatment (Ozguner et al. 2004). Melatonin as well as caffeic acid phenyethyl ester (an antioxidant) both protected against retinal oxidative stress in rates exposed long-term to mobile phone irradiation (Ozguner, Bardak, and Comlekci 2006). Nitric oxide (NO) was increased in

nasal and sinus mucosa in rats after EMF exposure, with this NO possibly acting as a defense mechanism suggesting tissue damage; but this was prevented by pretreatment with melatonin (Yariktas et al. 2005). Melatonin treatment significantly prevented the increase in the MDA (malondyaldehyde, a marker of lipid peroxidation) content and XO (xanthine oxidase) activity in rat brain tissue after 40 days of exposure, but it was unable to prevent the decrease of CAT activity and increase of carbonyl group contents (Sokolovic et al. 2008).

Of note, the melatonin production of infants in isolettes in neonatal intensive care units appears to be impacted by the high ELF-EMF environment, in that when infants were removed from those exposures they showed an increase in melatonin levels (Bellieni, Tei, et al. 2012). There is an increased prevalence of ASDs in children who were born prematurely (Indredavik et al. 2010; Indredavik et al. 2008; Johnson et al. 2011; Johnson et al. 2010; Johnson and Marlow 2011; Lampi et al. 2012; Limperopoulos 2009, 2010; Limperopoulos et al. 2008; Matson, Matson, and Beighley 2011; Pinto-Martin et al. 2011). There are many potential prematurity-associated factors that could contribute to increased risk for ASDs, but electromagnetic exposure might be one of them worthy of further consideration, as it could be modified; conversely, such exposures in vulnerable infants are likely to have much broader impacts beyond reducing melatonin synthesis.

Melatonin and autism

Based on the commonality of both sleep disorders and low melatonin levels, Bourgeron (2007) proposed that synaptic and clock genes are important in ASDs, and that future studies should investigate the circadian modulation of synaptic function (Bourgeron 2007). A number of melatonin-related genetic variants have been identified as associated with ASDs. Polymorphisms, deletions and polymorphisms in the ASMT gene, which encodes the last enzyme of melatonin synthesis, have been found (Pagan et al. 2011; Jonsson et al. 2010; Melke et al. 2008), and variations have been found as well for melatonin receptor genes (Chaste et al. 2010; Pagan et al. 2011; Jonsson et al. 2010). CYP1A2 polymorphisms have been found in slow melatonin metabolisers, in whom melatonin levels are aberrant and initial response to melatonin for sleep disappeared in a few weeks (Braam et al. 2012).

Regarding melatonin status in people with ASDs, a recent meta-analysis summarized the current findings as indicating that *"1) Physiological levels of melatonin and/or melatonin derivatives are commonly below average in ASD and correlate with autistic behavior, 2) Abnormalities in melatonin-related genes may be a cause of low melatonin levels in ASD, and 3) ... treatment with melatonin significantly improves sleep duration and sleep onset latency in ASD."* (Rossignol and Frye 2011) The meta-analysis also showed that polymorphisms in melatonin-related genes in ASD could contribute to lower melatonin

concentrations or an altered response to melatonin, but only in a small percentage of individuals, since pertinent genes were found in only a small minority of those screened.

Autism AND Melatonin AND Glutathione

Whereas PubMed searches for "autism AND melatonin" and "autism AND glutathione" each coincidentally yielded 72 citations, and "melatonin AND glutathione" yielded 803 citations, the search for "autism AND melatonin AND glutathione" yielded zero citations. This is interesting given the strong connection of melatonin and glutathione metabolically, as discussed above, alongside of the strongly established interest in both glutathione and melatonin in ASD research and increasingly in clinical practice. Hopefully one contribution of an investigation of EMF/RFR links to ASDs will be to help bring attention to this relationship, which may help identify potential environmental and physiological causes for low melatonin in those without pertinent mutations. Of pertinence, tryptophan hydroxylase (TPH2) – the rate limiting enzyme in the synthesis of serotonin, from which melatonin is derived – is extremely vulnerable to oxidation, and tends to misfold when its cysteine residues are oxidized, with the enzyme being converted to a redox-cycling quinoprotein (Kuhn and Arthur 1999; Kuhn and Geddes 1999; Kuhn et al. 2011; Kuhn and Arthur 1997).

3. Disturbed immune function

There is by now a broad appreciation of the presence of immune disturbances in ASDs, to the point where there is an emerging discussion of ASDs as neuroimmune disorders (Bilbo, Jones, and Parker 2012; Persico, Van de Water, and Pardo 2012). Research identifying immune features in ASDs spans from genetics where risk genes have been identified to epigenetics where altered expression of immune genes is being reported as prominent in ASD epigenetics (Kong et al. 2012; Waly et al. 2012; Lintas, Sacco, and Persico 2012), and also includes prenatal infectious and immune disturbances as risk factors for autism as well as other neurodevelopmental and neuropsychiatric diseases as well as other conditions such as asthma (Patterson 2011; Smith et al. 2007; Fox, Amaral, and Van de Water 2012). Immune disturbances in infants and children with ASD are heterogeneous, with some but not all manifesting autoimmunity (Soumiya, Fukumitsu, and Furukawa 2011; Martin et al. 2008). Anecdotally, recurrent infection is common while on the other hand some get sick less often than their peers. It is common for people with autism to have family members with immune or autoimmune diseases (Croen et al. 2005). The immune system is turning out to have an important role in brain development (Bilbo and Schwarz 2012; Schwarz and Bilbo 2012; Boksa 2010). As mentioned, glial activation associated with brain immune response has been identified in a growing number of studies. Whether or not EMF/RFR contributes to these features of ASDs causally, based on the evidence below regarding immune impacts of EMF/RFR exposure (which is also reviewed much more thoroughly by Johansson in Section 8 of the present

Bioinitiative Report) (Blank 2012), it is certainly plausible that such exposures could serve as aggravating factors.

Low-intensity exposures

It is clear that the body's immune defense system responds to very low-intensity exposures. Chronic exposure to factors that increase allergic and inflammatory responses on a continuing basis is likely to be harmful to health, since the resultant chronic inflammatory responses can lead to cellular, tissue and organ damage over time. We are increasingly appreciating the extent to which many chronic diseases are related to chronic immune system dysfunction. Disturbance of the immune system by very low-intensity electromagnetic field exposure is discussed as a potential underlying cause for cellular damage and impaired healing (tissue repair), which could lead to disease and physiological impairment (Johansson 2009; Johannson 2007).

Both human and animal studies report that exposures to EMF and RFR at environmental levels associated with new technologies can be associated with large immunohistological changes in mast cells as well as other measures of immune dysfunction and dysregulation. Mast cells not only can degranulate and release irritating chemicals leading to allergic symptoms; they are also widely distributed in the body, including in the brain and the heart, which might relate to some of the symptoms commonly reported in relation to EMF/RFR exposure (such as headache, painful light sensitivity, and cardiac rhythm and palpitation problems).

Consequences of immune challenges during pregnancy

As mentioned, infection in pregnancy can also increase the risk of autism and other neurodevelopmental and neuropsychiatric disorders via maternal immune activation (MIA). Viral, bacterial and parasitic infections during pregnancy are thought to contribute to at least 30% of cases of schizophrenia (Brown and Derkits 2010). The connection of maternal infection to autism is supported epidemiologically, including in a Kaiser study where risk was associated with psoriasis and with asthma and allergy in the second trimester (Croen et al. 2005), and in a large study of autism cases in the Danish Medical registry (Atladottir et al. 2010) with infection at any point in pregnancy yielding an adjusted hazard ration of 1.14 (CI: 0.96-1.34) and when infection occurred during second trimester the odds ratio was 2.98 (CI: 1.29-7.15). In animal models, while there is much variation in study design, mediators of the immune impact appear to include oxidative stress, interleukin-6 and increased placental cytokines (Smith et al. 2007; Patterson 2009; Boksa 2010). Garbett et al. (2012) commented on several mouse models of the effects of MIA on the fetal brain that *"The overall gene expression changes suggest that the response to MIA is a neuroprotective attempt by the developing brain to counteract environmental stress, but at a cost of disrupting typical neuronal differentiation and axonal growth."* (Garbett et al. 2012). Maternal fetal brain-reactive

autoantibodies have also been identified in some cases (Braunschweig et al. 2012; Braunschweig and Van de Water 2012; Fox, Amaral, and Van de Water 2012; Goines et al. 2011; Wills et al. 2009; Wills et al. 2011; Zimmerman et al. 2007).

Although we have evidence of immune impacts of EMF/RFR, the impact of repeated or chronic exposure to EMF and RFR during pregnancy is poorly studied; could this trigger similar immune responses (cytokine production) and stress protein responses, which in turn would have effects on the fetus? Although this has been poorly studied, we do have data that very low cell phone radiation exposures during both human and mouse pregnancies have resulted in altered fetal brain development leading to memory, learning, and attention problems and behavioral problems (Aldad et al. 2012).

Potential immune contributions to reactivity and variability in ASDs

Immune changes in ASDs appear to be associated with behavioral change (Shi et al. 2003; Ashwood et al. 2008; Ashwood et al. 2011; Breece et al. 2012; Heuer et al. 2008), but the mechanisms are complex and to date poorly understood (Careaga and Ashwood 2012) and likely will need to be elucidated through systems biology methods that capture multisystem influences on the interactions across behavior, brain and immune regulation (Broderick and Craddock 2012), including electrophysiology.

Two of the particularly difficult parts of ASDs are the intense reactivity and the variability in assorted symptoms such as tantrums and other difficult behaviors. Children with ASDs who also have gastrointestinal symptoms and marked fluctuation of behavioral symptoms have been shown to exhibit distinct innate immune abnormalities and transcriptional profiles of peripheral blood monocytes (Jyonouchi et al. 2011). It is worth considering EMF/RFR exposures could be operating through related mechanisms so as to add to allostatic loading in ways that exacerbate behavior. In Johansson 2006 and 2007 a foundation is provided for understanding how chronic EMF/RFR exposure can compromise immune function and sensitize a person to even small exposures in the future (Johannson 2007; Johansson et al. 2006). Johansson discusses alterations of immune function at environmental levels resulting in loss of memory and concentration, skin redness and inflammation, eczema, headache, and fatigue. Mast cells that degranulate under EMF and RFR exposures and substances secreted by them (histamine, heparin and serotonin) may contribute to features of this sensitivity to electromagnetic fields (Johansson et al. 2006). Theoharides and colleagues have argued that environmental and stress related triggers might activate mast cells, causing inflammatory compromise and leading to gut-blood-brain barrier compromise, seizures and other ASD symptoms (Theoharides et al. 2012, 2010), and that this cascade of immune response and its consequences might also be triggered in the absence of infection by mitochondrial fragments that can be released from cells in response to stimulation by IgE/anti-IgE or by the proinflammatory peptide substance P (Zhang, Asadi, et al. 2012).

Seitz et al. (2005) reviewed an extensive literature on electromagnetic hypersensitivity conditions reported to include sleep quality, dizziness, headache, skin rashes, memory and concentration impairments related to EMF and RFR (Seitz, 2005). Some of these symptoms are common in ASDs, whether or not they are due to EMF/RFR exposure, and the experience of discomfort may be hard to document due to difficulties with self-reporting in many people with ASDs.

Johansson (2007, 2009) also reports that benchmark indicators of immune system allergic and inflammatory reactions occur under exposure conditions of low-intensity non-ionizing radiation (immune cell alterations, mast cell degranulation histamine-positive mast cells in biopsies and immunoreactive dendritic immune cells) (Johannson 2007; Johansson 2009). In facial skin samples of electro- hypersensitive persons, the most common finding is a profound increase in mast cells as monitored by various mast cell markers, such as histamine, chymase and tryptase (Johansson et al. 2001). In ASDs, infant and childhood rashes, eczema and psoriasis are common, and they are common in family members as well (Bakkaloglu et al. 2008).

4. Alteration of and damage to cells in the brain

Brain cells have a variety of ways of reacting to environmental stressors, such as shape changes, metabolic alterations, upregulation or downregulation of neurotransmitters and receptors, other altered functionality, structural damage, production of un-metabolizable misfolded proteins and other cellular debris, and apoptosis; these range along a spectrum from adaptation to damage and cell death. These types of alterations can be looked at in animals under controlled conditions, but in human beings direct cellular examination can only be done on surgical biopsy tissue – which is hardly ever available in people with ASDs – or after death, at which point there has been a whole lifetime of exposures that are generally impossible to tease apart if there were even motivation to do so. This complicates the comparison of brain cell and tissue-related pathophysiology between what is seen in ASDs and what is associated with EMF/RFR exposures.

Brain cells

Impact of EMF/RFR on cells in the brain has been documented by some of the studies that have examined brain tissue after exposure, although the interpretation of inconsistencies across studies is complicated by sometimes major differences in impact attributable to differences in frequencies and duration of exposure, as well as to differences in resonance properties of tissues and other poorly understood constraints on cellular response. These studies and methodological considerations have been reviewed in depth in Belyaev, 2012 in section 15 of the 2012 BioInitiatve Report (Belyaev 2012), as well as by Salford et al. (2012) in Section 10 (Salford, Nittby, and Persson 2012). A few examples of observations after exposure have included dark neurons (an indicator of neuronal damage), as well as alteration of neuronal firing rate (Bolshakov and Alekseev

1992), and upregulation of genes related to cell death pathways in both neurons and astrocytes (Zhao, Zou, and Knapp 2007). Astrocytic changes included increased GFAP and increased glial reactivity (Chan et al. 1999; Ammari et al. 2008; Ammari et al. 2010; Brillaud, Piotrowski, and de Seze 2007), as well as astrocyte-pertinent protein expression changes detected by Fragopoulou et al, 2012 as mentioned above. Also observed has been a marked protein downregulation of the nerve growth factor glial maturation factor beta (GMF) which is considered as an intracellular signal transduction regulator in astrocytes, which could have significant impact on neuronal-glial interactions as well as brain cell differentiation and tumor development. Diminution of Purkinje cell number and density has also been observed, (Ragbetli et al. 2010) including in two studies of the impacts of perinatal exposure (Albert, 1981; Albert, 1981). Promotion of pro-inflammatory responses in EMF-stimulated microglial cells has also been documented (Yang et al. 2010).

Neuropathology findings in ASDs have been varied and have been interpreted according to various frameworks ranging from a regionalized approach oriented to identifying potential brain relationships to ASD's behavioral features (Amaral, Schumann, and Nordahl 2008) to identifying receptor, neurotransmitter and interneuron abnormalities that could account for an increased excitation/inhibition ratio (Levitt 2009; Geschwind 2007; Anney 2010; Casanova 2006; Rubenstein 2003). Studies have documented a range of abnormalities in neurons, including altered cellular packing in the limbic system, reduced dendritic arborization, and reductions in limbic GABAergic systems. Over the past decade a shift has occurred from presuming that all pertinent brain changes occurred prior to birth, to an acknowledgement that ongoing cellular processes appear to be occurring not only after birth but well into adulthood (Bauman and Kemper 2005). One of the reasons for this shift was the observation that head size (as well as brain weight and size) was on average larger in children with autism, and the head sizes of children who became diagnosed with autism increased in percentile after birth (Herbert 2005).

Neuroinflammation, glial activation and excitotoxicity

Although much attention has been paid in ASD brain literature to specific regions manifesting differences in size and activity in comparison to those without ASDs, there are other observations that are not strictly regional in nature, such as more widely distributed scaling differences (e.g. larger brains, wider brains, increased white matter volume, along with altered functional connectivity and coherence to be discussed below). Recently more studies have appeared identifying pathophysiological abnormalities such as neuroinflammation, mitochondrial dysfunction and glutathione depletion in brain tissue. Neuroinflammation was first identified in a study of postmortem samples from eleven individuals aged 5-44 who had died carrying an ASD diagnosis, in which activated astrocytes and microglial cells as well as abnormal cytokines and chemokines were found. Other research has identified further astrocyte abnormalities include, altered

expression of astrocyte markers GFAP abnormalities including elevation, antibodies, and altered signaling (Laurence 2005; Singh 1997; Fatemi et al. 2008). Increased microglia activation and density as well as increased myeloid dendritic cell frequencies have also been documented. (Vargas et al. 2005; Breece et al. 2012; Tetreault et al. 2012), as has abnormal microglial-neuronal interactions (Morgan et al. 2012). Recently through use of the PET ligand PK11105 microglial activation was found to be significantly higher in multiple brain regions in young adults with ASDs (Suzuki et al. 2013). Genes associated with glial activation have been documented as upregulated. Garbett et al measured increased transcript levels of many immune genes, as well as changes in transcripts related to cell communication, differentiation, cell cycle regulation and chaperone systems (Garbett et al. 2008). Voineaugu and colleagues performed transcriptomic analysis of autistic brain and found a neuronal module of co-expressed genes which was enriched with genetically associated variants, and an immune-glial module showing no such enrichment for autism GWAS signals (Voineagu et al. 2011).

Neuroinflammation also does not appear to be strictly localized in a function-specific fashion, and it may contribute both to more broadly distributed and more focal features for tissue-based reasons. It may be that brain regions with particular prominence in ASDs may have distinctive cellular characteristics – e.g. the amygdala (Baron-Cohen et al. 2000; Dziobek et al. 2010; Hall et al. 2010; Mercadante et al. 2008; Nordahl et al. 2012; Otsuka et al. 1999; Schulkin 2007; Schumann and Amaral 2006; Schumann et al. 2009; Truitt et al. 2007; Zirlinger and Anderson 2003), which may have a larger or more reactive population of astrocytes (Johnson, Breedlove, and Jordan 2010) or the basal ganglia which may have greater sensitivity to even subtle hypoxia or perfusion abnormalities. In this case it may be the histology of these areas that makes them vulnerable to environmental irritants, and this may contribute to how environmental factors such as EMF/RFR might trigger or aggravate some of ASD's features. More widely distributed brain tissue pathology be part of what leads to differences in ASDs in brain connectivity. However these types of tissue-function relationships have been poorly investigated. The contribution of tissue differences is one of the physical considerations covered by Belyaev (2012) in Section 15 of the 2012 BioInitiative Report (Belyaev, 2012).

Various signs of mitochondrial dysfunction and oxidative stress have also been identified in the brain. Findings include downregulation of expression of mitochondrial electron transport genes (Anitha, Nakamura, Thanseem, Matsuzaki, et al. 2012) or deficit of mitochondrial electron transport chain complexes (Chauhan et al. 2011), brain region specific glutathione redox imbalance (Chauhan, Audhya, and Chauhan 2012), and evidence of oxidative damage and inflammation associated with low glutathione redox status (Rose, Melnyk, Pavliv, et al. 2012). Oxidative stress markers were measured as increased in cerebellum (Sajdel-Sulkowska, Xu, and Koibuchi 2009).

Additional support for the presence of tissue pathophysiology-based changes in brains of people with ASDs comes from the various studies documenting reduction in Purkinje cell numbers (Whitney et al. 2009; Whitney et al. 2008; Bauman and Kemper 2005; Shi et al. 2009; Blatt and Fatemi 2011; Fatemi et al. 2002; Fatemi et al. 2012), possibly due to oxidative stress and an increased excitation/inhibition ratio that could potentially be acquired (Fatemi et al. 2012). Also of note are changes in the glutamatergic and GABAergic systems, which when imbalanced can disturb the excitation/inhibition ratio and contribute to seizure disorders; reductions in GABA receptors as well as in GAD 65 and 67 proteins that catalyse the conversion of glutamate into GABA have been measured. (Yip, Soghomonian, and Blatt 2007, 2008, 2009) A consensus statement on the cerebellum in ASDs stated that, *"Points of consensus include presence of abnormal cerebellar anatomy, abnormal neurotransmitter systems, oxidative stress, cerebellar motor and cognitive deficits, and neuroinflammation in subjects with autism."* (Fatemi et al. 2012)

Some indirect corroboration for these findings has come from neuroimaging, where the initial hypothesis regarding the tissue basis of the larger size of brains in so many people with autism – that it was due to a higher density of neurons and more tightly packed axons – came under question with the emergence of contradictory findings, well reviewed a few years ago by Dager and colleagues (Dager et al. 2008). These include reduced rather than increased density of NAA (n-acetylaspartate, a marker of neuronal integrity and density that is produced in the mitochondria), reduced rather than increased fractional anisotropy suggesting less tightly packed axonal bundles (Bode et al. 2011; Cascio et al. 2012; Mak-Fan et al. 2012; Travers et al. 2012; Walker et al. 2012; Wolff et al. 2012); Sundaram, 2008) and greater rather than lower diffusivity, all of which may be more consistent with lower density of tissue and tissue metabolites and more fluid, which could be consistent with neuroinflammation and/or oxidative stress. The early postnatal development of such lower fractional anisotropy and increased diffusivity was measured in the process of occurring recently, in the first large prospective longitudinal imaging study of infants, who trended from 6 months to 2 years in the direction of these findings becoming more pronounced – but still with substantial overlap with those infants who did not develop autism (Wolff et al. 2012). This trend was consistent with prior studies showing increase in head size after birth, and added some information about what was happening in the brain to drive this size increase, although due to its methods it could only indirectly address the possibilty that emergence during the first few years of life of tissue pathophysiology disturbances such as neuroinflammation might be contributing to these trends (Herbert 2012).

There is also substantial variability across many different types of brain findings. Of interest is that a number of functional brain imaging and electrophysiology studies have identified greater heterogeneity in response to stimuli between individuals in the ASD

group than individuals in the neurotypical control group (Muller et al. 2003; Dinstein et al. 2012). This may make more sense from the point of view of non-linear response – i.e. a disproportionality between output and input (as well as state and context sensitivity), in a pathophysiologically perturbed brain system. Nonlinearity has also been a significant methodological issue in EMF/RFR research because linear methods of study design and data analysis have often been insensitive to effects, whereas nonlinear methods have been argued to show greater sensitivity (Carrubba and Marino 2008; Marino, Wolcott, Chervenak, Jourd'heuil, Nilsen, Frilot, et al. 2001; Marino and Frilot 2003; Carrubba et al. 2006; Carrubba et al. 2012; Marino, Nilsen, and Frilot 2003; Marino, Wolcott, et al. 2001, 2001; Carrubba et al. 2007; Marino et al. 2000; Bachmann, 2005).

The presence of various types of tissue pathophysiology both in findings in postmortem tissue from individuals with ASDs and in documented impacts of EMF/RFR exposure are intriguing and suggest overlap in processes involved. But it is not really possible to infer any specific agent of injury from cellular responses since for the most part these are not specific but rather are stress or repair responses generic to a variety of triggers. It is important to entertain how environmental agents could contribute to brain changes in ASDs, and how these changes may develop over progress over time after the earliest periods in brain development. EMF/RFR exposures could be preconceptional, prenatal or postnatal – or all of the above; it is conceivable that this could be the case in ASDs as well.

Altered development

There is some evidence for altered brain and organism development in relation to EMF/RFR exposure. Aldad et al. 2012 exposed mice in utero to cellular telephone radiation, with resultant aberrant miniature excitatory postsynaptic currents, dose-responsive impaired glutamatergic synaptic transmission onto layer V pyramidal neurons of the prefrontal cortex (Aldad et al. 2012). Lahijani exposed preincubated chicken embryos to 50 Hz EMFs, and made the following morphological observations: *"exencephalic embryos, embryos with asymmetrical faces, crossed beak, shorter upper beak, deformed hind limbs, gastroschesis, anophthalmia, and microphthalmia. H&E and reticulin stainings, TEMS, and SEMs studies indicated EMFs would create hepatocytes with fibrotic bands, severe steatohepatitis, vacuolizations, swollen and extremely electron-dense mitochondria, reduced invisible cristae, crystalized mitochondria with degenerated cristae, myelin-like figures, macrophages engulfing adjacent cells, dentated nuclei, nuclei with irregular envelopes, degenerated hepatocytes, abnormal lipid accumulations, lipid droplets pushing hepatocytes' nuclei to the corner of the cells, abundant cellular infiltrations cellular infiltrations inside sinusoid and around central veins, disrupted reticulin plexus, and release of chromatin into cytosol,, with partially regular water layers,"* and attributed cell damage to elevated free radical induced cell membrane disruptions (Lahijani, Tehrani, and Sabouri 2009).

Although it is of great interest to characterize the changes in development associated with ASDs, it is also difficult to do in human beings because at present diagnosis is not possible until at least 2-3 years after birth. By now there have been a lot of prospective studies of infants at high risk for autism, but the in vivo brain imaging and electrophysiology data from these studies is only starting to be published, and so the for now the main sources of information are still inference backwards from post-mortem or imaging data, and animal models, both of which have clear limitations. Thus it is impossible to seek precise parallels here between what we know about the development of ASDs compared with the impacts of EMF/RFR exposures.

Nevertheless it is of real concern that such exposures have elicited some of the brain tissue changes that have been documented, both in early development and subsequently. Already noted above is the question of whether high exposures of neonates to monitoring equipment may affect the melatonin levels of neonates (Bellieni, Tei, et al. 2012); these exposures also impact heartrate variability . There are no studies yet on infants exposed to baby surveillance monitors or DECT wireless phones. However there are good laboratory testing studies yielding actual measurements of these devices that conclude: *"Maximum incident field exposures at 1m can significantly exceed those of base stations (typically 0.1 - 1 V/m). At very close distances the derived or reference exposure limits are violated" for baby surveillance monitors and DECT phones.* Further, the authors conclude that, based on very strictly controlled laboratory testing of everyday devices like baby monitors and some cordless phones *"(W)orse case peak spatial SAR values are close to the limit for the public or uncontrolled environments, e.g., IEEE802.11b and Bluetooth Class I".*(Kuhn et al. 2012) Even exposure of the fetus to laptop computer wireless emissions through the pregnant mother's use of them may on her lap involve induction of strong intracorporeal electric current densities from the power supply possibly even more than the device itself (Bellieni, Pinto, et al. 2012).

Brain blood flow and metabolism

Cerebral perfusion and metabolism abnormalities have been identified in close to 2 dozen papers studying autistic cohorts. Cerebral perfusion refers to the quantity of blood flow in the brain. Abnormal regulation of cerebral perfusion is found in a range of severe medical conditions including tumors, vascular disease and epilepsy. Cerebral hypoperfusion has also been found in a range of psychiatric disorders (Theberge 2008). Neurocognitive hypotheses and conclusions, as well as localization of perfusion changes, have been heterogeneous across these papers. Hypoperfusion or diminished metabolism has been identified in frontal regions (George, 1992; Gupta, 2009; Degirmenci, 2008; Wilcox, 2002; Galuska, 2002; Ohnishi, 2000; temporal lobes (Boddaert, 2002 ; Burroni, 2008 ; Degirmenci, 2008, Galuska, 2002, George, 1992 ; Hashimoto, 2000, Ohnishi, 2000, Ryu, 1999, Starkstein, 2000, Zilbovicius, 2000), as well as a variety of subcortical regions including basal ganglia (Degirmenci, 2008; Ryu, 1999; Starkstein, 2000),

cerebellum (Ryu, 1999), limbic structures (Ito, 2005, Ohnishi, 2000) and thalamus (Ito, 2005, Ryu, 1999, Starkstein, 2000) – i.e., in a widely distributed set of brain regions. It is interesting to note that even with this regional variation in localization, most of these publications showed that cerebral perfusion was *reduced*; in the only one of those studies reporting some areas of localized hyperfusion, these areas were found in the middle of areas in the frontal pole and temporal lobe that were hypoperfused (McKelvey 1995), Only one study showed no difference in perfusion between autistic and control subjects (Herold 1988). Possibly because virtually all of these studies were oriented toward testing neuropsychological rather than pathophysiological hypotheses, there were no probes or tests reported to unearth the tissue level alterations that might be underlying these reductions in blood flow in these brains.

While a large number of animal studies have documented BBB abnormalities from EMF/RFR exposures, only a few PET studies have been performed evaluating EMF exposure effects upon brain glucose metabolism. Volkow et al. performed PET scans both with and without EMF exposure (50 min of GSM-900 with maximum SAR of 0.901 W/kg), and the participants were blinded to the exposure situation (Volkow et al. 2011). A 7% increase in metabolism in the exposure situation compared to controls was identified regionally on the same side of the head as where the mobile phone was placed, in the right orbitofrontal cortex and in the lower part of the right superior temporal gyrus . The strength of the E-field from the phones correlated positively with the brain activation, which the authors hypothesized was from an increase in brain neuron excitability. . A subsequent smaller study by Kwon et al. demonstrated not increased but decreased brain ^{18}FDG uptake after GSM-900 exposure, this time in the temporoparietal junction (Kwon et al. 2011).

Many possible mechanisms could be involved in the metabolic and perfusion abnormalities identified, ranging from altered neuronal activity that was hypothesized in the Volkow et al. (2011) ^{8}FDG PET study to narrowing of vascular lumen in the setting of reduced perfusion. Underlying tissue pathophysiology-based phenomena could influence the measurable metabolism and perfusion abnormalities, via mechanisms such as excitotoxicity, cell stress response, constriction of capillary lumen by activated astrocytes, volume effects of vascular extravasation, subtle alterations in blood viscosity due to immune or oxidative stress-associated blood chemical changes, with other possibilities as well. Given the types of damage at the cellular level covered in this pathophysiology section so far – including oxidative stress, membrane and barrier function damage and poorly functioning channels, which occur both in ASDs as a consequence of EMF/RFR exposure, and given the heterogeneity of localization of abnormalities in the autism perfusion papers as well as considerations of nonlinearity, it may not be so surprising that the results in the two PET studies of human impacts of EMF exposure were not consistent.

6. Electrophysiology perturbations

At this stage the argument we hit a key pivot point, where we look at how the alterations in molecular, cellular and systems physiological function, which occur in the brain as well as in the body, impact the transduction into the electrical signaling activities of the brain and nervous system. Certainly the cells and tissues whose physiological challenges we have already discussed provide the material substrate for the electrical activity. Although ASD behaviors are influenced by many factors, they must in principle be mediated through nervous system electrophysiology.

If the cells responsible for generating synapses and oscillatory signaling are laboring under cellular and oxidative stress, lipid peroxidation, impaired calcium and other signaling system abnormalities, then mitochondrial metabolism will fall short, all the more so because of the challenges from the immune system which in turn be triggered to a major extent by environment. How well will synapses be generated? How well will immune-activated and thereby distracted glial cells be able to modulate synaptic and network activity? (Tasker et al. 2012; Eroglu and Barres 2010; Bilbo and Schwarz 2009; Fields 2006)

At present we are in the early stages of being able to formulate these questions well enough to address them. We do know that microglial activation can impact excitatory neurotransmission mediated by astrocytes (Pascual et al. 2012). We do know that the cortical innate immune response increases local neuronal excitability and can lead to seizures (Rodgers et al. 2009; Gardoni et al. 2011). We do know that inflammation can play an important role in epilepsy (Vezzani et al. 2011). We know less about lower levels of chronic or acute pathophysiological dysfunction and how they may modulate and alter the brain's electrophysiology.

Seizures and Epilepsy

EEG signals in ASDs are abnormal on a variety of levels. At the most severe level, EEGs show seizure activity. In addition to the association of some severe epilepsy syndromes (e.g. Landau Kleffner, tuberous sclerosis) with autism, the risk of epilepsy is substantially higher in people with ASDs than in the general population, with a large subset of these individuals experiencing seizure onset around puberty, likely in relation to aberrations in the dramatic and brain-impactful hormonal shifts of that phase of life. Although less than 50% of people clearly have seizures or epilepsy, a much larger number have indications of epileptiform activity, and an even larger percent have subclinical features that can be noted by a clinical epileptologist though not necessarily flagged as of clinical concern.

Epileptic seizures can be both caused by and cause oxidative stress and mitochondrial dysfunction. Seizures can cause extravasation of plasma into brain parenchyma (Mihaly

and Bozoky 1984; Librizzi et al. 2012; Marchi et al. 2010; van Vliet et al. 2007; Yan et al. 2005) which can trigger a vicious circle of tissue damage from albumin and greater irritability, as discussed above. Evidence suggests that if a BBB is already disrupted, there will be greater sensitivity to EMF/RFR exposure than if the BBB were intact (Tore et al. 2002; Tore et al. 2001), suggesting that such exposures can further exacerbate vicious circles already underway.

The combination of pathophysiological and electrophysiological vulnerabilities has been explored in relation to the impact of EMF/RFR on people with epilepsy – which, as discussed above, is a lot more common in ASDs than in the general population.. EMF/RFR exposures from mobile phone emissions have been shown to modulate brain excitability and to increase interhemispheric functional coupling (Vecchio et al. 2012; Tombini et al. 2012). In a rat model the combination of picrotoxin and microwave exposure at mobile phone-like intensities led to a progressive increase in neuronal activation and glial reactivity, with regional variability in the fall-off of these responses three days after picrotoxin treatment (Carballo-Quintas et al. 2011), suggesting a potential for interaction between a hyperexcitable brain and EMF/RFR exposure.

One critical issue here is nonlinearity and context and parameter sensitivity of impact. In one study, rat brain slices exposed to EMF/RFR showed reduced synaptic activity and diminution of amplitude of evoked potentials, while whole body exposure to rats led to synaptic facilitation and increased seizure susceptibility in the subsequent analysis of neocortical slices (Varro et al. 2009). Another study unexpectedly identified enhanced rat pup post-seizure mortality after perinatal exposure to a specific frequency and intensity of exposure, and concluded that apparently innocuous exposures during early development might lead to vulnerability to stimuli presented later in development (St-Pierre et al. 2007)

Sleep

Sleep involves a profound change in brain electrophysiological activity, and EEG abnormalities including disrupted sleep architecture figure in sleep challenges in ASD. Sleep symptoms include bedtime resistance, sleep onset delay, sleep duration and night wakings, and sleep architecture can involve significantly less efficient sleep, less total sleep time, prolonged sleep latency, and prolonged REM latency (Buckley et al. 2010; Giannotti et al. 2011), with these sleep problems being worse in children with ASDs who regressed than in those who did not regress into their autism (Giannotti, 2011). EEG abnormalities have also been associated with EMF/RFR exposure, including disrupted sleep architecture as well as changes in sleep spindles and in the coherence and correlation across sleep stages and power bands during sleep (Borbely, 1999; Huber, 2003).

Sleep disturbance symptoms are also common in both situations. Insomnia is commonly reported in people who are chronically exposed to low-level wireless antenna emissions. Mann (1996) reported an 18% reduction in REM sleep, which is key to memory and learning functions in humans. In ASDs sleep difficulties are highly pervasive and disruptive not only to the affected individual but also to their whole family due to the associated problems such as noise and the need for vigilance.

The multileveled interconnections involved in the modulation of sleep exemplify the interconnectedness of the many levels of pathophysiology reviewed here: *"Extracellular ATP associated with neuro- and glio-transmission, acting via purine type 2 receptors, e.g., the P2X7 receptor, has a role in glia release of IL1 and TNF. These substances in turn act on neurons to change their intrinsic membrane properties and sensitivities to neurotransmitters and neuromodulators such as adenosine, glutamate and GABA. These actions change the network input-output properties, i.e., a state shift for the network."* (Clinton et al. 2011) With disturbance simultaneously at so many of these levels, it is not surprising that sleep dysregulation is nearly universal in ASDs, and common in the setting of EMF/RFR exposures.

Quantitative electrophysiology

While clinical reading of EEG studies is done visually, a growing number of studies are examining EEG and MEG data using digital signal processing analysis, and often using data collected in controlled research settings with high density array equipment and carefully designed stimuli paradigms. In these settings a variety of abnormalities have been identified other than epileptic. These include abnormalities in the power spectrum, i.e. the distribution of power over the different frequencies present, with some studies showing impaired or reduced gamma-and activity (Sun et al. 2012; Rojas et al. 2008; Rippon, 2007) and others 8) showing reduction of spectral power across all bands (Tierney et al. 2012) while still others showed increased high-frequency oscillations. (Orekhova et al. 2007) Abnormalities in coherence and synchronization between various parts of the brain have been found (Muller 2008; Muller et al. 2011; Wass 2011), comparable to abnormal functional connectivity measured by fMRI (Just et al. 2004) but measurable using EEG or MEG with higher temporal resolution (Duffy, 2012; Isler, 2010; Murias, 2007; Murias, 2007; Coben, 2008). Several studies have identified reduced complexity and increased randomness in EEGs of people with autism (Lai et al. 2010; Catarino et al. 2011), as well as an increase in power but a reduction in coherence (Isler et al. 2010; Mathewson et al. 2012). Some electrophysiological metrics are emerging as potential discriminators between brain signal from individuals with ASDs and those who are neurotypical, such as a wavelet-chaos-neural network methodology applied to EEG signal (Ahmadlou, Adeli, and Adeli 2010).

EMF/RFR also has impacts at levels of brain function measurable by these techniques. At various frequencies and durations of exposure it has been noted to impact alpha and beta rhythms (Hinrikus et al. 2008), to increase randomness (Marino, Nilsen, and Frilot 2003; Marino and Carrubba 2009), to alter power, to modulate interhemispheric synchronization (Vecchio et al. 2007), to alter electrical activity in brain slices (Tattersall et al. 2001) and to alter the patterns of coordination (spectral power coherence) across the major power bands (Hountala et al. 2008). Bachman et al. (2006) showed statistically significant changes in EEG rhythms and dymanics occurred in between 12% and 20% of healthy volunteers (Bachmann, 2006). In children, exposures to cell phone radiation have resulted in changes in brain oscillatory activity during some memory tasks.

Sensory processing

At the symptomatic level issues with sensory processing are highly prevalent in ASDs. Phenomenology can include hypersensitivity to external stimuli, hyposensitivity to internal sensations and difficulty localizing sensation including pain, and difficulty processing more than one sensory channel at one time. (Robledo, Donnellan, and Strandt-Conroy 2012; Perry et al. 2007; Sacco et al. 2010) There is now electrophysiological evidence of abnormalities at early (brainstem) stages of sensory processing, as well as in later stages of processing that occur in the cortex. Some studies have shown lower and some longer latencies of response to an auditory stimulus. Domains of perception where the performance of people with ASDs is superior to that of neurotypical individuals have been identified. (Marco et al. 2011) *"It is obvious...that sensory processing abnormalities in ASD are distributed rather than localized; sensory abnormalities in ASD obviously span multiple dimensions of latency, adaptation, magnitude and behavior abnormalities, with both enhanced and impaired behavior associated with aberrant cortical responses. Given this diversity in findings, the heterogeneity of ASD, and broad variability seen over and over again in the ASD groups almost irrespective of the study, it is hard to imagine that one single theory could account for all of these observations.... It is therefore probable that several mechanisms and neuronal abnormalities, most likely at multiple levels (from single neurons through to inter-area connections), all contribute to varying degrees to the abnormal sensory processing observed in ASD. It is also likely that no single mechanism is unique to one sensory modality, which is why we see such a widely distributed range of abnormalities across modalities."* (Kenet 2011)

It is also possible that the mechanisms may not simply be neural – they may also be modulated by glial, metabolic, immune, perfusional and other physiological processes and physical properties as well. Yet although there is some consideration of the pathophysiology-sensory function interaction (Kern et al. 2010), it has basically not been fleshed out in studies of ASDs with experimental designs integrating pathophysiological and electrophysiology.

Kenet et al. (2010) demonstrated environmental vulnerability of sensory processing in the brain by the exposure of rat dams to noncoplanar polychlorinated biphenyls (PCBs), during gestation and for three subsequent weeks of nursing (Kenet, 2011). *"Although the hearing sensitivity and brainstem auditory responses of pups were normal, exposure resulted in the abnormal development of the primary auditory cortex (A1). A1 was irregularly shaped and marked by internal nonresponsive zones, its topographic organization was grossly abnormal or reversed in about half of the exposed pups, the balance of neuronal inhibition to excitation for A1 neurons was disturbed, and the critical period plasticity that underlies normal postnatal auditory system development was significantly altered. These findings demonstrate that developmental exposure to this class of environmental contaminant alters cortical development."* (Kenet et al. 2007). This study may be particularly relevant for EMF/RFR exposures, as the noncoplanar PCBs were discussed above as targeting calcium signaling as do EMF/RFR exposures – i.e. they both converge upon a common cellular mechanism (Pessah and Lein 2008; Stamou et al. 2012), justifying exploring the hypothesis that the outcomes one might expect from EMF/RFR could be similar.

Autonomic dysregulation

Although there are a fair number of negative studies regarding the impact of EMF/RFR exposure on the autonomic nervous system, increased HRV and autonomic disturbances have been documented (Andrzejak et al. 2008; Szmigielski et al. 1998; Bortkiewicz et al. 2006; Graham et al. 2000; Saunders and Jefferys 2007). Buchner and Eger (2010), in a study in rural Germany of the health impacts of exposures from a new base station yielding novel exposure to EMF/RFR, saw a significant elevation of the stress hormones adrenaline and noradrenaline during the first six months with a concomitant drop in dopamine, with a failure to restore the prior levels after a year and a half. These impacts were felt by the young, the old and the chronically ill, but not by healthy adults (Buchner and Eger 2011).

Effects on the neonate are also evident. Bellieni et al (2008) found that heart rate variability is adversely affected in infants hospitalized in isolettes or incubators where ELF-EMF levels are in the 0.8 to 0.9 μT range (8 to 9 mG). Infants suffer adverse changes in heart rate variability, similar to adults (Bellieni et al. 2008). This electromagnetic stress may have lifelong developmental impacts, based on a study showing that in utero beta 2 agonist exposure can potentially induce a permanent shift in the balance of sympathetic-to-parasympathetic tone (Witter et al. 2009).

Meanwhile clinical observation and a growing body of literature support a major role for stress in ASDs (Anderson and Colombo 2009; Anderson, Colombo, and Unruh 2012; Daluwatte et al. 2012; Ming et al. 2011), with variability amongst individuals in the severity of the stress response but a tendency to have high tonic sympathetic arousal at

baseline (Hirstein, Iversen, and Ramachandran 2001; Toichi and Kamio 2003; Ming, Julu, et al. 2005; Mathewson et al. 2011; Cheshire 2012; Chang et al. 2012).

The impact of EMF/RFR exposure can also be greatly influenced by the stress system status of the individual being exposed. Tore et al sympathecotomized some of his rats before exposure to GSM, to simulate cell phone exposure (Tore et al. 2002; Tore et al. 2001). Salford et al. (2012) reviewed the results:

> *"Comparing the animals, which had been subjected to ganglionectomy, to the other animals, Töre et al. made an interesting observation: as expected, albumin extravasation was more prominent in the sympathectomised sham-exposed rats as compared to normal exposed rats. This was due to the fact that the sympathectomised rats were in a chronic inflammation-prone state with hyper-development of pro-inflammatory structures, such as the parasympathetic and sensory inputs as well as mast cells, and changes in the structure of the blood vessels. Such an inflammation-prone state has a well-known effect on the BBB leakage. However, when comparing sham-exposed sympathectomised rats to GSM-exposed sympathectomised rats, a remarkable increase in albumin leakage was present in the GSM exposed sympathectomised rats compared to the sham rats.* ***In the GSM-exposed sympathectomised rats, both brain areas and the dura mater showed levels of albumin leakage resembling those observed in positive controls after osmotic shock****.[emphasis added] Indeed, more attention should be paid to this finding, since it implicates that the sensitivity to EMF-induced BBB permeability depends not only on power densities and exposure modulations, but also on the initial state of health of the exposed subject."* (Salford, Nittby, and Persson 2012)

This dramatically greater impact on an autonomically and immunologically vulnerable set of animals raises concerns since the vulnerabilities of these animals bear some resemblance to the pathophysiological challenges of individuals with ASDs.

The interconnection between stress and brain connectivity (or coherence) in ASDs is brought out by Narayanan et al. (2010) n a pilot study testing the impact of the beta blocker propranolol on brain functional connectivity measured using functional MRI (Narayanan et al. 2010). A fairly immediate increase in functional connectivity was noted from propranolol – but not from nadolol which has the same vascular effects but does not cross the BBB. Propranolol decreases the burden of norepinephrine, thereby reducing the impact of stress systems on brain processing, and the authors interpreted these effects as creating an improvement of the brain's signal-to-noise ratio (Hasselmo, 1997), allowing it to utilize and coordinate more remote parts of its networks. This suggests that stressors such as EMF/RFR, by adding non-biologically meaningful noise to the system, might have the opposite effects, degrading coherent integration.

C. De-tuning of the Brain and Organism

1. Electromagnetic signaling, oscillation and synchrony are fundamental, and vulnerable

While electrophysiological activity is an intrinsic property of the nervous system, electromagnetic signaling are vital parts of every cell and of molecular structure.

> *"All life on earth has evolved in a sea of natural low-frequency electromagnetic (EM) fields. They originate in terrestrial and extraterrestrial sources. The ever-growing use of electric power over the last century has sharply modified this natural environment in urban environments. Exposure to power-frequency fields far stronger than the natural environment is now universal in civilized society."* (Adey 1994)

Adey published some of the earliest scientific studies on the "cooperativity" actions of cells in communication. Studies showing us that the flux of calcium in brain tissue and immune cells is sensitive to ELF-modulated radiofrequency fields is actually telling us that some of the most fundamental properties of cells and thus of our existence can be modulated by EMF/RFR.

> *"...in first detection of environmental EM fields in tissues, there appears to be a general consensus that the site of field action is at cell membranes. Strands of protein are strategically located on the surface of cells in tissue, where they act as detectors of electrical and chemical messages arriving at cell surfaces, transducing them and transmitting them to the cell interior. The structural basis for this transductive coupling by these protein strands is well known. Through them, cell membranes perform a triple role, in* ***signal detection, signal amplification, and signal transduction to the cell interior.***" (Adey 1994)

Communication between cells through gap junctions, which is a means of "metabolic cooperation," is also vulnerable to disruption, as discussed earlier.

Oscillation is also a universal phenomenon, and biological systems of the heart, brain and gut are dependent on the cooperative actions of cells that function according to principles of non-linear, coupled biological oscillations for their synchrony, and are dependent on exquisitely timed cues from the environment at vanishingly small levels (Buzsaki 2006; Strogatz 2003). The key to synchronization is the joint actions of cells that co-operate electrically - linking populations of biological oscillators that couple together in large arrays and synchronize spontaneously according to the mathematics described for Josephson junctions (Brian Josephson, the 1993 Nobel prize winner for this concept). This concept has been professionally presented in journal articles and also popularized in a book by Prof. Steven Strogatz, a mathematician at Cornell University who has written

about 'sync' as a fundamental organizing principle for biological systems (Strogatz 2001) (Strogatz 2003).

> *"Organisms are biochemically dynamic. They are continuously subjected to time-varying conditions in the form of both extrinsic driving from the environment and intrinsic rhythms generated by specialized cellular clocks within the organism itself. Relevant examples of the latter are the cardiac pacemaker located at the sinoatrial node in mammalian hearts and the circadian clock residing at the suprachiasmatic nuclei in mammalian brains. These rhythm generators are composed of thousands of clock cells that are intrinsically diverse but nevertheless manage to function in a coherent oscillatory state. This is the case, for instance, of the circadian oscillations exhibited by the suprachiasmatic nuclei, the period of which is known to be determined by the mean period of the individual neurons making up the circadian clock. The mechanisms by which this collective behavior arises remain to be understood."* (Strogatz 2003)

The brain contains a population of oscillators with distributed natural frequencies, which pull one another into synchrony (the circadian pacemaker cells). Strogatz has addressed the unifying mathematics of biological cycles and external factors disrupt these cycles. This also applies to mitochondria:

> *"Organisation of mitochondrial metabolism is a quintessential example of a complex dissipative system which can display dynamic instabilities. Several findings have indicated that the conditions inducing instabilities are within the physiological range and that mild perturbations could elicit oscillations. Different mathematical models have been put forth in order to explain the genesis of oscillations in energy metabolism. One model considers mitochondria as an organised network of oscillators and indicates that communication between mitochondria involves mitochondrial reactive oxygen species (ROS) production acting as synchronisers of the energy status of the whole population of mitochondria. An alternative model proposes that extramitochondrial pH variations could lead to mitochondrial oscillations."* (Iotti, Borsari, and Bendahan 2010)

The field of bioelectromagnetics has studied exposure to very low levels of electromagnetic frequencies.

These exposures can alter critical properties of chemical reactions. *"In a chemical reaction, the bond breaks and each partner reclaims its electron from the bond, moving away to encounter a new partner. It is now an unattached, highly reactive free radical. Reforming a bond requires a meeting between two radicals with opposite electron spins, the union producing a singlet pair. The lifetime of free radicals is typically short, in the*

range of microseconds to nanoseconds. It is in this brief period that imposed magnetic fields may alter the rate and amount of product of a chemical reaction. Since the effect is only on the kinetics of chemical reactions, they are known as magnetokinetic effects (Steiner and Ulrich, 1989). They occur only in nonthermal states of biomolecular systems, defined as an insensitivity to random thermal interactions during the brief period of their existence (Walleczek, 1994). They are a consequence of a coherent quantum-mechanical step which accompanies free radical formation." (Adey 1994)

Not just chemical reactions but synchronous biological oscillations in cells (pacemaker cells) can be disturbed and disrupted by artificial, exogenous environmental signals, which can lead to desynchronization of neural activity that regulates critical functions (including metabolism) in the brain, gut and heart and circadian rhythms governing sleep and hormone cycles (Strogatz, 1987). Buzsaki in his book *Rhythms of the Brain* (2006) says "*rhythms can be altered by a wide variety of agents and that these perturbations must seriously alter brain performance.*" (Buzsaki 2006)

Disturbance can get increasingly disruptive as more damage occurs and more systems are thrown out of kilter and out of cooperativity. One can think of the kindling model in which repeated induction of seizures leads to longer and more sever seizures and greater behavioral involvement. The combination of disruptive and stimulatory effects of biologically inappropriate EMF/RFR exposures could contribute to disruption of synchronized oscillation and cooperativity at a myriad of levels but particularly in the brain, and this may contribute to the loss of coherence and complexity in the brain in autism, as well as dysregulation of multiple other bodily systems. Strogatz points out that there are many more ways of being desynchronized than being synchronized (Strogatz, 2003). It has even been suggested that autism itself could be due to brain desynchronization (Welsh, 2005).

2. Behavior as an "emergent property"

Although from a pathophysiological point of view one might hypothesize that a brain with greater indications of oxidative stress along with immune activation and mitochondrial dysfunction might generate different oscillatory activity than a brain in which those pathophysiological features were absent, to date almost no attention has been paid to testing this hypothesis in ASD or neurodevelopmental and neuropsychiatric conditions more generally. From this vantage point it would make sense to propose that the compromised whole body health status of at least many with ASDs would make it harder for them to maintain the resilience of their brain cells and brain activities in the face of potentially disruptive exposures. Yet the investigation of how this might occur remains a largely unexplored frontier. But from the point of view of making sense of the

brain impact of environmental challenges – including but not limited to EMF-RFR – this investigation is crucial.

The pathophysiological perspective that guides this review would suggest a move away from considering the behavioral manifestations of ASDs as core 'traits,' *Instead behaviors may be better understood as 'outputs' or emergent properties – what the brain and body produce – when their physiological attributes are altered* in these fashions for whatever reasons – be they genetic, environmental or many combinations of both (Anderson 2009, 2008; Sieb 2004; Smith and Thelen 2003; Custodio et al. 2007; Herbert 2012). Sleep and consciousness have also been considered 'emergent properties' (Krueger et al. 2008; Krueger and Obal 2003). Brain oscillatory activity is critical for organizing behavior, and it arises from cells and subcellular features that are shaped by the environment and can act differently based on their functional status as well as on account of external sensory or psychosocial stimuli.

In particular, a) brain oscillatory activity is intimately connected with underlying cellular, metabolic and immune status, b) EMF/RFR is capable of perpetrating changes at each of these levels, and c) problems at each of these levels can make other problems worse. And as mentioned earlier, EMF/RFR and various toxicants can co-potentiate damage (Juutilainen and Kumlin 2006; Juutilainen, Kumlin, and Naarala 2006; Verschaeve et al. 2006; Ahlbom et al. 2008; Hoyto et al. 2008; Juutilainen 2008; Luukkonen et al. 2009; Markkanen, Juutilainen, and Naarala 2008), amplifying allostatic load.

Put together, all of this implies that the combination of these EMF/RFR impacts may quite plausibly significantly contribute both to how ASDs happen in individuals and to why there are more reported cases of ASDs than ever before (with studies showing that not all of this increase can be written off as artifact (King and Bearman 2009; Hertz-Picciotto and Delwiche 2009).

The hopeful side of this framing of the problem comes from moving beyond the increasingly anachronistic idea that autism is determined overwhelmingly by genetic code about which we can do little or nothing. An emerging model that explains much more of what we now know frames ASDs as the dynamic, active outcomes of perturbed physiological processes – again, more like a chronic but changeable 'state' than a 'trait.' In the latter model, one is empowered to strongly reduce exposures and to make aggressive constructive environmental changes – particularly in diet and nutrition, given their protective potency discussed above (Herbert and Weintraub 2012). In this way allostatic load can be reduced, physiological damage can be repaired, homeostasis can be restored and resilience and optimal function can be promoted.

III. IMPLICATIONS

A. Summary

In the above review, the case has been made that ASDs involve physiological challenges at multiple levels, and that these challenges are paralleled in the physiological impacts of EMF/RFR exposure. Evidence has also been presented to suggest that the many levels of damage and degradation of physiological and functional integrity are profoundly related to each other. Although autism spectrum disorders (ASDs) are defined by problems with behavior, communication, social interaction and sensory processing, under the surface they also involve a range of disturbances of underlying biology that find striking parallels in the physiological impacts of electromagnetic frequency and radiofrequency exposures (EMF/RFR). At the cellular and molecular level many studies of people with ASDs have identified oxidative stress and evidence of free radical damage, evidence of cellular stress proteins, as well as deficiencies of antioxidants such as glutathione. Elevated intracellular calcium in ASDs can be associated with genetic mutations but more often may be downstream of inflammation or chemical exposures. Cell membrane lipids may be peroxidized, mitochondria may function poorly, and immune system disturbances of various kinds are common. Brain oxidative stress and inflammation as well as measures consistent with blood-brain barrier and brain perfusion compromise have been documented. Changes in brain and autonomic nervous system electrophysiology can be measured and seizures are far more common than in the population at large. Sleep disruption and high levels of stress are close to universal. In parallel, all of these phenomena have also been documented to result from or be modulated by EMF/RFR exposure. Moreover, some people with ASDs have de novo mutations (that their parents do not have), and EMF/RFR exposures could contribute to this due to their potential genotoxicity. EMF/RFR exposure during pregnancy may send spurious signals to developing brain cells during pregnancy, altering brain development during critical periods, and may increase oxidative stress and immune reactivity that can increase risk for later developmental impairments, with further disruption later in development increasing risk, physiological dysregulation and severity of outcome.

All of this does not prove that EMF/RFR exposures cause autism, but it does raise concerns that they could contribute by increasing risk, and by making challenging biological problems and symptoms worse in these vulnerable individuals. Placed alongside the dramatic rise in reported cases of ASDs, that parallels the dramatic rise in deployment of wireless technologies, a strong case can be made for aggressively investigating links between ASDs and EMR/RFR, and minimizing exposures for people with autism as well as families preconceptionally, during pregnancy, and around infants and children at home, at school, and in health care centers and hospitals.

These arguments have implications for how we understand what ASDs 'are' and how they work. These implications call upon us to take the environmental contribution very seriously, which involves on the one hand a sobering appreciation of the vast array of exposures that can contribute to risk via perturbed development and physiological degradation, and on the other hand a sense that there are powerful things we can do to improve the situation.

B. Exposures and their Implications

Several thousand scientific studies over four decades point to serious biological effects and health harm from EMF and RFR as are intensively reviewed in the many detailed sections of this BioInitiative Report. These studies report genotoxicity, single-and double-strand DNA damage, chromatin condensation, loss of DNA repair capacity in human stem cells, reduction in free-radical scavengers (particularly melatonin), abnormal gene transcription, neurotoxicity, carcinogenicity, damage to sperm morphology and function, effects on behavior, and effects on brain development in the fetus of human mothers that use cell phones during pregnancy. Cell phone exposure has been linked to altered fetal brain development and ADHD-like behavior in the offspring of pregnant mice.

1. Exposures have outpaced precautions

There is no question that huge new exposures to EMF/RFRs have occurred over the past few decades. As discussed extensively in other parts of this Bioinitiative 2012 update (Sage, 2012), there is much concern that regulations to date have been based on a very limited sense of the pertinent biology, and particularly that limiting concern to thermal impacts is no longer valid since there is a wealth of evidence by now that non-thermal impacts can be biologically very powerful.

Only in the last two decades have exposures to RFR and wireless technologies become so widespread as to affect virtually every living space, and affect every member of societies around the world. Even as some disease patterns like brain tumors from cell phone use have become 'epidemiologially visible', there are no comprehensive and systematic global health surveillance programs that really keep up to report EMF/RFR health trends (Fragopoulou et al. 2010).

> "*The deployment of new technologies is running ahead of any reasonable estimation of possible health impacts and estimates of probabilities, let alone a solid assessment of risk. However, what has been missing with regard to EMF has been an acknowledgement of the risk that is demonstrated by the scientific studies. There is clear evidence of risk, although the magnitude of the risk is*

uncertain, and the magnitude of doing nothing on the health effects cost to society is similarly uncertain. This situation is very similar to our history of dealing with the hazards of smoking decades ago, where the power of the industry to influence governments and even conflicts of interest within the public health community delayed action for more than a generation, with consequent loss of life and enormous extra health care costs to society." (Sage and Carpenter 2009).

2. The population's exposure has increased

Given the range of physiological impacts described in Part 2, the very rapid global deployment of both old and new forms of emerging wireless technologies in the last two decades needs aggressive evaluation from a public health perspective.

In the United States, the deployment of wireless infrastructure (cell tower sites) to support cell phone use has accelerated greatly in the last decades. The Cellular Telephone Institute of America (CTIA) estimated that in 1997 there were only 36,650 cell sites in the US; but increased rapidly to 131,350 in June 2002; 210,350 in June 2007 and 265,561 in June 2012 (Roche, 2012; Cellular Telephone Industry of America (CTIA) 2012). About 220,500 cell sites existed in 2008 (Reardon, 2007; Cellular Telephone Industry of America (CTIA) 2012; Anonymous, May 2005). These wireless facilities for cellular phone voice and data transmission produce RFR over broad areas in communities and are an involuntary and unavoidable source of radiofrequency radiation exposure. Other new RFR exposures that didn't exist before are from WI-FI access points (hotspots) that radiate 24/7 in cafes, stores, libraries, classrooms, on buses and trains, and from personal WI-FI enabled devices (iPads, tablets, PDAs, etc).

Not surprisingly, the use of cell phones has a parallel growth trend. In the late 1980s and early 1990's, only a few percent of the US population were cell phone users. By 2008, eighty-four percent (84%) of the population of the US owned cell phones [16]. CTIA reports that wireless subscriber connections in the US increased from 49 million in June 1997 to 135 million in June 2002 to 243 million in June 2007 to 322 million in June 2012 (Roche, 2012; Cellular Telephone Industry of America (CTIA), June 2012) This represents more than a 100% penetration rate in the US consumer market, up from just a few percent in the early 1990's. The number of wireless subscribers in June 1997 was 18%; in June 2002 it was 47%; in June 2007 it was 81% and in June 2012 it is 101%.

The annualized use of cell phones in the US was estimated to be 2.23 trillion minutes in 2008 and 2.296 trillion minutes in 2010 (CITA, 2012). There are 6 billion users of cell phones world- wide in 2011 up from 2.2 billion in 2008 and many million more users of cordless phones.

The number of US homes with *only* wireless cell phones has risen from 10.5% in 2007 to 31.6% in June of 2012 (Roche, 2012; Cellular Telephone Industry of America (CTIA),

June 2012). There are no statistics for June 1997 nor for June 2002, since landline (non-wireless) phone use predominated. The shift to wireless communications, more minutes of use, and reliance on cell and cordless phones rather than corded phones is an extremely revealing measure of new EMF and RFR exposures for both adults and children.

3. Infants, children and childbearing families are highly exposed and vulnerable

With regard to children, the spread of cell towers in communities, often placed on pre-school, church day-care, and school campuses, means that young children may have hundreds of thousands of times higher RF exposures in home and school environments than existed even 20-25 years ago. In addition, the nearly universal switch to cordless and cell phones, and away from corded landline phones, means close and repetitive exposures to both EMF and RFR in the home. Wireless laptops and wireless internet in schools, and home offices and for homework mean even more chronic exposures to RFR, a designated IARC 2B Possible Human Carcinogen (International Agency for Research on Cancer of the World Health Organization, May 2011; Baan, 2011) The great utility of handheld devices as communication aids and sources of information and satisfaction for people on the autism spectrum may come with a concerning underbelly.

Exposures prior to conception or during pregnancy and infancy are also important to consider. These exposures can come from faulty wiring, proximity to power lines, or high-frequency transients from a proximate transformer on a utility pole, or internal sources of pulsed RFR in the home (examples include an electronic baby monitor in the crib, a wireless router in the next room, a DECT phone that pulses high emissions of RFR on a continuous basis 24/7, or conversion to all compact fluorescent bulbs that produce significant 'dirty electricity' for occupants due to low-kilohertz frequency fields on electrical wiring and in ambient space. Sick and vulnerable infants in neonatal intensive care units are heavily exposed from being surrounded by equipment, with negative metabolic and autonomic consequences documented and other likely consequences needing further investigation (Bellieni et al. 2008; Bellieni, Tei, et al. 2012).

Wireless phones and laptops exposures produce extremely low frequency pulses from the battery of the wireless device (Sage, 2007; Sage and Carpenter 2009) and the exposures to pulsed radiofrequency microwave radiation when the wireless device is transmitting or receiving calls and emails.

Especially since EMF/RFR exposures are already classified as IARC 2B Possible Human Carcinogens, we should be actively investigating these sources of damage to DNA that could reasonably result in 'de novo mutations' but also be aware that common environmental exposures from EMF and RFR might play a role in the higher rates of concordance for autism (ASD) among twins and siblings.

Researchers also should be aware that common environmental exposures from EMF and RFR might play a role in the higher rates of autism (ASD) among twins and siblings, not solely because of maternal use of wireless devices during pregnancy and paternal sperm exposure to wireless devices peri-conception; but also because such oxidative damage to DNA can occur at levels introduced into the world of the fetus, and young developing infant and child via baby surveillance monitoring devices in the crib and wireless devices in the home. The deployment of technologies poses risks to human fertility and reproduction capacity, to the fetus, to children and adults (Sage and Carpenter 2009).

4. ASD risk and genomic damage to future generations

Barouki and Grandjean (2012) make a persuasive case that public health interventions are critically needed in early childhood development to prevent adult diseases that appear decades later (Barouki et al. 2012). Although they do not include EMF or RFR but only chemicals, they do say that physiological stressors, which EMF and RFR certainly have been established to be, should be reduced during critical development windows. They say: "*The current pandemic of non-communicable diseases and the increased prevalence of important dysfunctions demand an open interrogation of why current interventions appear insufficient. We now know that disease risk can be induced very early in the life course and that it is modifiable by nutrients and environmental chemical exposures (along with drugs. infections, and other types of stresses)*".

Part II of this chapter documents the detailed scientific basis for considering EMF/RFR exposures to be of significance to the ASDs crisis. Public health interventions are warranted now to protect the genetic heritage of humans, as well as the other stocks of genetic material in wildlife and plants in the face of what appears to be on-going impairment of these genomes. The risk of genomic damage for future generations is sufficiently documented to warrant strong preventative action and new public safety limits that observe EMF/RFR levels shown to cause adverse effects.

5. De-tuning the organism

Genetic mutations may lead to cancer and other diseases in the present and future generations, but the exposures that are capable of creating genotoxic impacts also compromise physiological function Even genotoxicity can have not only specific but also non-specific effects due to inefficiencies, misfolded proteins, and cellular debris, as discussed in the section "Implications of Damage" at the end of the first part of Part II, regarding the rescue of a mouse model of Rett syndrome through enabling a probably generic process of microglial phagocytosis, critical to debris removal, rather than through correcting some specific molecular defect of the synapse (Derecki et al. 2012; Derecki, Cronk, and Kipnis 2012).

In the present setting, where the argument about the pertinence of the cascade of physiological and genotoxic compromises to autism includes the degradative impact on oscillatory synchronization, it is also worth considering that oscillation is a property of living and even physical systems much more generally, and not just of brain oscillatory networks (Strogatz 2003). Under certain circumstances, phase transitions occur and synchronization emerges, often rather quickly rather than gradually – more like a state change than a gradual trend. On the other hand, as mentioned, synchronization can be lost, and there are an enormous number of ways for a system to be de-synchronized, which may relate to the heterogeneity amongst people with ASD that so vexes researchers.

In the setting of autism, a baby gestated or developing as a neonate in a milieu with excessively elevated EMF/RFR exposures is bound to have interference with the normal development processes, including the organization of information and experience in the brain. This baby's environment also often nutritional insufficiencies (processed denatured pesticide-laden food low in antioxidants, minerals and essential fatty acids essential to cellular protection). The baby's gestational period may have been complicated by the mother's own health issues such as conditions like obesity and diabetes (Krakowiak, 2012) which converge on inflammation, oxidative stress and other common forms of physiological dysregulation associated with or even just eating nutrient-depleted, pesticide-laden processed food. The exquisite 'tuning up' of the brain and body as it develops will integrate and respond to the environmental inputs it receives, and is particularly sensitive to environmental miscues (whether chemical like endocrine disruptors, EMF/RFR, or other hostile environmental conditions whether hostile or nurturing). To the extent that the baby is burdened with more disorganized or hostile cues than nurturing and organizing cues, that baby may lose resiliency and become more physiologically vulnerable –perhaps approaching a tipping point into decompensation.

From a systems point of view, the phenomenon of 'autistic regression' may occur after an accumulation of multisystem signaling interference leading to a tipping point of loss of some vital systems synchronization and increase in randomization. EMF/RFR exposures could plausibly contribute both to this vulnerability and to the decompensation/desynchronization process – as could other stressors such as infection, toxicity, acute stress. The vulnerability, then, is the 'allostatic load' – the total burden of stressors pressing toward disorganization. The tipping point may come in a variety of ways but upon investigation one is likely to find that unless it is a severe stressor it is not triggered simply by a single source of stress in an otherwise blissfully healthy child, but rather is the "straw that breaks the camel's back' laid atop a prior accumulation of 'allostatic load.'

C. Conclusions and Recommendations

1. Change our deployment of EMF/RFR

The deployment of RFR from wireless technologies has incredible momentum, and it has made many things easier and many other things possible for the first time. On the other hand this momentum can interfere with setting up the technology in a fashion truly respectful of biological tolerances. Other sections in the Bioinitiative 2012 update will address recommendations and guidelines for increasing the safety profile. This will undoubtedly provoke controversy. The problems will not get settled immediately, and transformation to healthier arrangements will take time.

> *"There is no question that global implementation of the safety standards proposed in the Bioinitiative Report, if implemented abruptly and without careful planning, have the potential to not only be very expensive but also disruptive of life and the economy as we know it. Action must be a balance of risk to cost to benefit. The major risk from maintaining the status quo is an increasing number of cancer cases, especially in young people, as well as neurobehavioral problems at increasing frequencies. The benefits of the status quo are expansion and continued development of communication technologies. But we suspect that the true costs of even existing technologies will only become much more apparent with time. Whether the costs of remedial action are worth the societal benefits is a formula that should reward precautionary behavior."* (Sage and Carpenter 2009)

2. Encourage precautions right now based on present knowledge

In the meantime many people have already started taking precautionary measures, and more will wish to do so. Physicians and health care people should raise the visibility of EMF/RFR as a plausible environmental factor in clinical evaluations and treatment protocols. Reducing or removing EMF and wireless RFR stressors from the environment is a reasonable precautionary action given the overall weight of evidence.

- Children with existing neurological problems that include cognitive, learning, attention, memory, or behavioral problems should as much as possible be provided with wired (not wireless) learning, living and sleeping environments,
- Special education classrooms should aim for 'no wireless' conditions to reduce avoidable stressors that may impede social, academic and behavioral progress.
- All children should reasonably be protected from the physiological stressor of significantly elevated EMF/RFR (wireless in classrooms, or home environments).
- School districts that are now considering all-wireless learning environments should be strongly cautioned that wired environments are likely to provide better learning and teaching environments, and prevent possible adverse health consequences for both students and faculty in the long-term.

- Monitoring of the impacts of wireless technology in learning and care environments should be performed with sophisticated measurement and data analysis techniques that are cognizant of the non-linear impacts of EMF/RFR and of data techniques most appropriate for discerning these impacts.
- There is sufficient scientific evidence to warrant the selection of wired internet, wired classrooms and wired learning devices, rather than making an expensive and potentially health-harming commitment to wireless devices that may have to be substituted out later, and
- Wired classrooms should reasonably be provided to all students who opt-out of wireless environments.

Undoubtedly risks and the above recommendations will be dismissed by those poised to benefit from the sale of these new systems. Many people also feel that new possibilities have opened up to themselves and the world through wireless technologies. But the public needs to know that these risks exist, that transition to wireless should not be presumed safe, and that it is very much worth the effort to minimize exposures that still provide the benefits of technology in learning, but without the threat of health risk and development impairments to learning and behavior in the classroom.

Broader recommendations also apply, related to reducing the physiological vulnerability to exposures, reduce allostatic load and build physiological resiliency through high quality nutrition, reducing exposure to toxicants and infectious agents, and reducing stress (Herbert and Weintraub 2012), all of which can be implemented safely based upon presently available knowledge.

3. Build an environmentally physiologically centered research program in ASDs as a platform for investigating the EMR/RFR-ASD linkage

This review has been structured around the physiological parallels between ASDs and the impacts of EMF/RFR. What is missing from the autism research agenda is some cross-study of these two bodies of research evidence. To do this we will need both a recognition of the importance of these risks, and a collaborative multi-site research program centered around a "middle-out" physiological approach that can incorporate the the gene-brain-behavior agenda that has dominated ASD research into a broader framework (Herbert 2013). While the middle-out approach is an emerging framework in systems biology that can incorporate complexity and nonlinear, multileveled modeling (Cristofolini et al. 2008; de Graaf et al. 2009; Majumder and Mukherjee 2011; Vinga et al. 2010; Walker and Southgate 2009), the gene-brain-behavior approach has been based on an expectation of linear mapping across the levels on which it focuses, but instead the systems involved appear to be much more complex, and the physiological levels largely

left out of this linear approach are critically important to helping people with ASDs because they will help not only with understanding how environment impacts function but also with identifying leverage points.

4. Take the evidence as a call to action

Both EMF and RFR exposures are already classified as IARC 2B Possible Human Carcinogens. The substantial scientific literature on EMF and RFR effects on DNA, on immune and blood-brain barrier disruption, on stress proteins, on circadian rhythms and hormone disregulation, and on cognition, sleep, disruption of neural control and altered brainwave activity all argue for reduction of exposures now, and better coordinated research in these areas.

All relevant environmental conditions should be given weight in defining and implementing prudent, precautionary actions to protect public health, including EMF and RFR. Evidence is sufficient to add EMF/RFR prominently to the list of exposures that can degrade the human genome, and impair normal development, health and quality of our physiology. With the rising numbers people with ASDs and other childhood health and developmental disorders, we cannot afford to ignore this component of risk to our children and vulnerable populations. When the risk factors are largely avoidable or preventable, ignoring clear evidence of large-scale health risks to global populations poses unnecessary and unacceptable risks. Taking this evidence as a call to action will be challenging and disruptive in the short term, but constructive in the longer term as we learn to use EMF/RFR in healthier ways.

IV. REFERENCES

Adams, J. B., T. Audhya, S. McDonough-Means, R. A. Rubin, D. Quig, E. Geis, E. Gehn, M. Loresto, J. Mitchell, S. Atwood, S. Barnhouse, and W. Lee. 2011. Effect of a vitamin/mineral supplement on children and adults with autism. *BMC Pediatr* 11:111.

Adams, J. B., T. Audhya, S. McDonough-Means, R. A. Rubin, D. Quig, E. Geis, E. Gehn, M. Loresto, J. Mitchell, S. Atwood, S. Barnhouse, and W. Lee. 2011. Nutritional and metabolic status of children with autism vs. neurotypical children, and the association with autism severity. *Nutr Metab (Lond)* 8 (1):34.

Adey, W. R. 2002. Evidence for Nonthermal Electromagnetic Bioeffects: Potential Health Risks in Evolving Low-Frequency & Microwave Environments. Royal College of Physicians, London May 16-17, 2002.

Adey, WR. 1994. A growing scientific consensus on the cell and molecular biology mediating interactions with EM fields. In *Symposium on Electromagnetic Transmissions, Health Hazards, Scientific Evidence and Recent Steps in Mitigation.*

Agarwal, A., F. Deepinder, R. K. Sharma, G. Ranga, and J. Li. 2008. Effect of cell phone usage on semen analysis in men attending infertility clinic: an observational study. *Fertil Steril* 89 (1):124-8.

Agarwal, A., N. R. Desai, K. Makker, A. Varghese, R. Mouradi, E. Sabanegh, and R. Sharma. 2009. Effects of radiofrequency electromagnetic waves (RF-EMW) from cellular phones on human ejaculated semen: an in vitro pilot study. *Fertil Steril* 92 (4):1318-25.

Ahlbom, A., J. Bridges, R. de Seze, L. Hillert, J. Juutilainen, M. O. Mattsson, G. Neubauer, J. Schuz, M. Simko, and K. Bromen. 2008. Possible effects of electromagnetic fields (EMF) on human health--opinion of the scientific committee on emerging and newly identified health risks (SCENIHR). *Toxicology* 246 (2-3):248-50.

Ahmadlou, M., H. Adeli, and A. Adeli. 2010. Fractality and a wavelet-chaos-neural network methodology for EEG-based diagnosis of autistic spectrum disorder. *J Clin Neurophysiol* 27 (5):328-33.

Aitken, R. J., L. E. Bennetts, D. Sawyer, A. M. Wiklendt, and B. V. King. 2005. Impact of radio frequency electromagnetic radiation on DNA integrity in the male germline. *Int J Androl* 28 (3):171-9.

Al-Demegh, MA. 2012. Rat testicular impairment induced by electromagnetic radiation from a conventional cellular telephone and the protective effects of the antioxidants vitamins C and E. *Clinics* 67 (7):785-792.

Al-Gadani, Y., A. El-Ansary, O. Attas, and L. Al-Ayadhi. 2009. Metabolic biomarkers related to oxidative stress and antioxidant status in Saudi autistic children. *Clin Biochem* 42 (10-11):1032-40.

Albert, E. N., M. F. Sherif, and N. J. Papadopoulos. 1981. Effect of nonionizing radiation on the Purkinje cells of the uvula in squirrel monkey cerebellum. *Bioelectromagnetics* 2 (3):241-6.

Albert, E. N., M. F. Sherif, N. J. Papadopoulos, F. J. Slaby, and J. Monahan. 1981. Effect of nonionizing radiation on the Purkinje cells of the rat cerebellum. *Bioelectromagnetics* 2 (3):247-57.

Aldad, T. S., G. Gan, X. B. Gao, and H. S. Taylor. 2012. Fetal radiofrequency radiation exposure from 800-1900 mhz-rated cellular telephones affects neurodevelopment and behavior in mice. *Sci Rep* 2:312.

Alter, M. D., R. Kharkar, K. E. Ramsey, D. W. Craig, R. D. Melmed, T. A. Grebe, R. C. Bay, S. Ober-Reynolds, J. Kirwan, J. J. Jones, J. B. Turner, R. Hen, and D. A. Stephan. 2011. Autism and increased paternal age related changes in global levels of gene expression regulation. *PLoS One* 6 (2):e16715.

Amaral, D. G., C. M. Schumann, and C. W. Nordahl. 2008. Neuroanatomy of autism. *Trends Neurosci* 31 (3):137-45.

American Psychiatric Association. 2000. *Diagnostic and Statistical Manual of Mental Disorders DSM-IV-TR Fourth Edition (Text Revision)*. Arlington, VA: American Psychiatric Publishing

American Psychiatric Association. 2013, May. *Diagnostic and Statistical Manual of Mental Disorders DSM-v*. Arlington, VA: American Psychiatric Publishing

Ammari, M., E. Brillaud, C. Gamez, A. Lecomte, M. Sakly, H. Abdelmelek, and R. de Seze. 2008. Effect of a chronic GSM 900 MHz exposure on glia in the rat brain. *Biomed Pharmacother* 62 (4):273-81.

Ammari, M., C. Gamez, A. Lecomte, M. Sakly, H. Abdelmelek, and R. De Seze. 2010. GFAP expression in the rat brain following sub-chronic exposure to a 900 MHz electromagnetic field signal. *Int J Radiat Biol* 86 (5):367-75.

Anderson, C. J., and J. Colombo. 2009. Larger tonic pupil size in young children with autism spectrum disorder. *Dev Psychobiol* 51 (2):207-11.

Anderson, C. J., J. Colombo, and K. E. Unruh. 2012. Pupil and salivary indicators of autonomic dysfunction in autism spectrum disorder. *Dev Psychobiol.*

Anderson, G. M. 2008. The potential role for emergence in autism. *Autism Res* 1 (1):18-30.

Anderson, G. M. 2009. Conceptualizing autism: the role for emergence. *J Am Acad Child Adolesc Psychiatry* 48 (7):688-91.

Andrzejak, R., R. Poreba, M. Poreba, A. Derkacz, R. Skalik, P. Gac, B. Beck, A. Steinmetz-Beck, and W. Pilecki. 2008. The influence of the call with a mobile phone on heart rate variability parameters in healthy volunteers. *Ind Health* 46 (4):409-17.

Anitha, A., K. Nakamura, I. Thanseem, H. Matsuzaki, T. Miyachi, M. Tsujii, Y. Iwata, K. Suzuki, T. Sugiyama, and N. Mori. 2012. Downregulation of the Expression of Mitochondrial Electron Transport Complex Genes in Autism Brains. *Brain Pathol.*

Anitha, A., K. Nakamura, I. Thanseem, K. Yamada, Y. Iwayama, T. Toyota, H. Matsuzaki, T. Miyachi, S. Yamada, M. Tsujii, K. J. Tsuchiya, K. Matsumoto, Y. Iwata, K. Suzuki, H. Ichikawa, T. Sugiyama, T. Yoshikawa, and N. Mori. 2012. Brain region-specific altered expression and association of mitochondria-related genes in autism. *Mol Autism* 3 (1):12.

Anney, R., L. Klei, D. Pinto, R. Regan, J. Conroy, T. R. Magalhaes, C. Correia, B. S. Abrahams, N. Sykes, A. T. Pagnamenta, J. Almeida, E. Bacchelli, A. J. Bailey, G. Baird, A. Battaglia, T. Berney, N. Bolshakova, S. Bolte, P. F. Bolton, T. Bourgeron, S. Brennan, J. Brian, A. R. Carson, G. Casallo, J. Casey, S. H. Chu, L. Cochrane, C. Corsello, E. L. Crawford, A. Crossett, G. Dawson, M. de Jonge, R. Delorme, I. Drmic, E. Duketis, F. Duque, A. Estes, P. Farrar, B. A. Fernandez, S. E. Folstein, E. Fombonne, C. M. Freitag, J. Gilbert, C. Gillberg, J. T. Glessner, J. Goldberg, J. Green, S. J. Guter, H. Hakonarson, E. A. Heron, M. Hill, R. Holt, J. L. Howe, G. Hughes, V. Hus, R. Igliozzi, C. Kim, S. M. Klauck, A. Kolevzon, O. Korvatska, V. Kustanovich, C. M. Lajonchere, J. A. Lamb, M. Laskawiec, M. Leboyer, A. Le Couteur, B. L. Leventhal, A. C. Lionel, X. Q. Liu, C. Lord, L. Lotspeich, S. C. Lund, E. Maestrini, W. Mahoney, C. Mantoulan, C. R. Marshall, H. McConachie, C. J. McDougle, J. McGrath, W. M. McMahon, N. M. Melhem, A. Merikangas, O. Migita, N. J. Minshew, G. K. Mirza, J. Munson, S. F. Nelson, C. Noakes, A. Noor, G. Nygren, G. Oliveira, K. Papanikolaou, J. R. Parr, B. Parrini, T. Paton, A. Pickles, J. Piven, D. J. Posey, A. Poustka, F. Poustka, A. Prasad, J. Ragoussis, K. Renshaw, J. Rickaby, W. Roberts, K. Roeder, B. Roge, M. L. Rutter, L. J. Bierut, J. P. Rice, J. Salt, K. Sansom, D. Sato, R. Segurado, L. Senman, N. Shah, V. C. Sheffield, L. Soorya, I. Sousa, V. Stoppioni, C. Strawbridge, R. Tancredi, K. Tansey, B. Thiruvahindrapduram, A. P. Thompson, S. Thomson, A. Tryfon, J. Tsiantis, H. Van Engeland, J. B. Vincent, F. Volkmar, S. Wallace, K. Wang, Z. Wang, T. H. Wassink, K. Wing, K. Wittemeyer, S. Wood, B. L. Yaspan, D. Zurawiecki, L. Zwaigenbaum, C. Betancur, J. D. Buxbaum, R. M. Cantor, E. H. Cook, H. Coon, M. L. Cuccaro, L. Gallagher, D. H. Geschwind, M. Gill, J. L. Haines, J. Miller, A. P. Monaco, J. I. Nurnberger, Jr., A. D. Paterson, M. A. Pericak-Vance, G. D. Schellenberg, S. W. Scherer, J. S. Sutcliffe, P. Szatmari, A. M. Vicente, V. J. Vieland, E. M. Wijsman, B. Devlin, S. Ennis, and J. Hallmayer. 2010. A genome-wide scan for common alleles affecting risk for autism. *Hum Mol Genet* 19 (20):4072-82.

Anonymous. *2.14 billion cell phone subscribers in 2005* 2005 May 20. Available from http://news.softpedia.com/news/2-14-billion-cell-phone-subscribers-in-2005-2120.shtml.

Aon, M. A., S. Cortassa, and B. O'Rourke. 2008. Mitochondrial oscillations in physiology and pathophysiology. *Adv Exp Med Biol* 641:98-117.

Ashwood, P., A. Enstrom, P. Krakowiak, I. Hertz-Picciotto, R. L. Hansen, L. A. Croen, S. Ozonoff, I. N. Pessah, and J. Van de Water. 2008. Decreased transforming growth factor beta1 in autism: a potential link between immune dysregulation and impairment in clinical behavioral outcomes. *J Neuroimmunol* 204 (1-2):149-53.

Ashwood, P., P. Krakowiak, I. Hertz-Picciotto, R. Hansen, I. Pessah, and J. Van de Water. 2011. Elevated plasma cytokines in autism spectrum disorders provide evidence of immune dysfunction and are associated with impaired behavioral outcome. *Brain Behav Immun* 25 (1):40-5.

Astumian, R. D., J. C. Weaver, and R. K. Adair. 1995. Rectification and signal averaging of weak electric fields by biological cells. *Proc Natl Acad Sci U S A* 92 (9):3740-3.

Atasoy, H. I., M. Y. Gunal, P. Atasoy, S. Elgun, and G. Bugdayci. 2012. Immunohistopathologic demonstration of deleterious effects on growing rat testes of radiofrequency waves emitted from conventional Wi-Fi devices. *J Pediatr Urol.*

Atladottir, H. O., T. B. Henriksen, D. E. Schendel, and E. T. Parner. 2012. Autism after infection, febrile episodes, and antibiotic use during pregnancy: an exploratory study. *Pediatrics* 130 (6):e1447-54.

Atladottir, H. O., T. B. Henriksen, D. E. Schendel, and E. T. Parner. 2012. Using maternally reported data to investigate the association between early childhood infection and autism spectrum disorder: the importance of data source. *Paediatr Perinat Epidemiol* 26 (4):373-85.

Atladottir, H. O., P. Thorsen, L. Ostergaard, D. E. Schendel, S. Lemcke, M. Abdallah, and E. T. Parner. 2010. Maternal infection requiring hospitalization during pregnancy and autism spectrum disorders. *J Autism Dev Disord* 40 (12):1423-30.

Baan, R., Y. Grosse, B. Lauby-Secretan, F. El Ghissassi, V. Bouvard, L. Benbrahim-Tallaa, N. Guha, F. Islami, L. Galichet, and K. Straif. 2011. Carcinogenicity of radiofrequency electromagnetic fields. *Lancet Oncol* 12 (7):624-6.

Bachmann, M., J. Kalda, J. Lass, V. Tuulik, M. Sakki, and H. Hinrikus. 2005. Non-linear analysis of the electroencephalogram for detecting effects of low-level electromagnetic fields. *Med Biol Eng Comput* 43 (1):142-9.

Bachmann, M., J. Lass, J. Kalda, M. Sakki, R. Tomson, V. Tuulik, and H. Hinrikus. 2006. Integration of differences in EEG analysis reveals changes in human EEG caused by microwave. *Conf Proc IEEE Eng Med Biol Soc* 1:1597-600.

Bakkaloglu, B., B. Anlar, F. Y. Anlar, F. Oktem, B. Pehlivanturk, F. Unal, C. Ozbesler, and B. Gokler. 2008. Atopic features in early childhood autism. *Eur J Paediatr Neurol* 12 (6):476-9.

Banerjee, A., F. Garcia-Oscos, S. Roychowdhury, L. C. Galindo, S. Hall, M. P. Kilgard, and M. Atzori. 2012. Impairment of cortical GABAergic synaptic transmission in an environmental rat model of autism. *Int J Neuropsychopharmacol*:1-10.

Barnes, FS. 1996. The effects of ELF on chemical reaction rates in biological systems. In *Biological Effects of Magnetic and Electromagnetic Fields*, edited by S. Ueno. New York: Plenum Press.

Baron-Cohen, S., H. A. Ring, E. T. Bullmore, S. Wheelwright, C. Ashwin, and S. C. Williams. 2000. The amygdala theory of autism. *Neurosci Biobehav Rev* 24 (3):355-64.

Barouki, R., P. D. Gluckman, P. Grandjean, M. Hanson, and J. J. Heindel. 2012. Developmental origins of non-communicable disease: implications for research and public health. *Environ Health* 11:42.

Bauman, M. L., and T. L. Kemper. 2005. Neuroanatomic observations of the brain in autism: a review and future directions. *Int J Dev Neurosci* 23 (2-3):183-7.

Bawin, S. M., and W. R. Adey. 1976. Sensitivity of calcium binding in cerebral tissue to weak environmental electric fields oscillating at low frequency. *Proc Natl Acad Sci U S A* 73 (6):1999-2003.

Becerra, T. A., M. Wilhelm, J. Olsen, M. Cockburn, and B. Ritz. 2012. Ambient Air Pollution and Autism in Los Angeles County, California. *Environ Health Perspect.*

Bellieni, C. V., M. Acampa, M. Maffei, S. Maffei, S. Perrone, I. Pinto, N. Stacchini, and G. Buonocore. 2008. Electromagnetic fields produced by incubators influence heart rate variability in newborns. *Arch Dis Child Fetal Neonatal Ed* 93 (4):F298-301.

Bellieni, C. V., I. Pinto, A. Bogi, N. Zoppetti, D. Andreuccetti, and G. Buonocore. 2012. Exposure to electromagnetic fields from laptop use of "laptop" computers. *Arch Environ Occup Health* 67 (1):31-6.

Bellieni, C. V., M. Tei, F. Iacoponi, M. L. Tataranno, S. Negro, F. Proietti, M. Longini, S. Perrone, and G. Buonocore. 2012. Is newborn melatonin production influenced by magnetic fields produced by incubators? *Early Hum Dev* 88 (8):707-10.

Belyaev, I. 2012. Evidence for Disruption by Modulation: Role of Physical and Biological Variables in Bioeffects of Non-Thermal Microwaves for Reproducibility, Cancer Risk and Safety Standards. In *BioInitiative 2012: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF*, edited by C. Sage.

Belyaev, I., E. Markova, and L. Malmgren. 2009. Microwaves from Mobile Phones Inhibit 53BP1 Focus Formation in Human Stem Cells Stronger than in Differentiated Cells: Possible Mechanistic Link to Cancer Risk. *Environ Health Perspect.*

Belyaev, I. Y., L. Hillert, M. Protopopova, C. Tamm, L. O. Malmgren, B. R. Persson, G. Selivanova, and M. Harms-Ringdahl. 2005. 915 MHz microwaves and 50 Hz magnetic field affect chromatin conformation and 53BP1 foci in human lymphocytes from hypersensitive and healthy persons. *Bioelectromagnetics* 26 (3):173-84.

Belyaev, IYa, Y. D. Alipov, and M. Harms-Ringdahl. 1997. Effects of zero magnetic field on the conformation of chromatin in human cells. *Biochim Biophys Acta* 1336 (3):465-73.

Belyaev, SY, and VG Kravchenko. 1994. Resonance effect of low-intensity millimeter waves on the chromatin conformational state of rat thymocytes. *Zeitschrift für Naturforschung [C] Journal of biosciences* 49 (352-358).

Bertone, A., L. Mottron, P. Jelenic, and J. Faubert. 2005. Enhanced and diminished visuo-spatial information processing in autism depends on stimulus complexity. *Brain* 128 (Pt 10):2430-41.

Betancur, C. 2011. Etiological heterogeneity in autism spectrum disorders: more than 100 genetic and genomic disorders and still counting. *Brain Res* 1380:42-77.

Bilbo, S. D., J. P. Jones, and W. Parker. 2012. Is autism a member of a family of diseases resulting from genetic/cultural mismatches? Implications for treatment and prevention. *Autism Res Treat* 2012:910946.

Bilbo, S. D., and J. M. Schwarz. 2009. Early-life programming of later-life brain and behavior: a critical role for the immune system. *Front Behav Neurosci* 3:14.

Bilbo, S. D., and J. M. Schwarz. 2012. The immune system and developmental programming of brain and behavior. *Front Neuroendocrinol* 33 (3):267-86.

Bill, B. R., and D. H. Geschwind. 2009. Genetic advances in autism: heterogeneity and convergence on shared pathways. *Curr Opin Genet Dev* 19 (3):271-8.

Blackman, C. F., S. G. Benane, D. E. House, and W. T. Joines. 1985. Effects of ELF (1-120 Hz) and modulated (50 Hz) RF fields on the efflux of calcium ions from brain tissue in vitro. *Bioelectromagnetics* 6 (1):1-11.

Blackman, CF. 1979. Induction of calcium efflux from brain tissue by radio frequency radiation. *Radio Science* 14:93-98.

Blank, M. 2012. Evidence for Stress Response (Stress Proteins) (Section 7). In *The BioInitiative Report 2012: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF).*

Blank, M., and R. Goodman. 2004. Comment: a biological guide for electromagnetic safety: the stress response. *Bioelectromagnetics* 25 (8):642-6; discussion 647-8.

Blank, M., and R. Goodman. 2011. DNA is a fractal antenna in electromagnetic fields. *Int J Radiat Biol* 87 (4):409-15.

Blatt, G. J., and S. H. Fatemi. 2011. Alterations in GABAergic biomarkers in the autism brain: research findings and clinical implications. *Anat Rec (Hoboken)* 294 (10):1646-52.

Boddaert, N. , N. Chabane, C. Barthelemy, M. Bourgeois, J. B. Poline, F. Brunelle, Y. Samson, and M. Zilbovicius. 2002. [Bitemporal lobe dysfonction in infantile autism: positron emission tomography study]. *J Radiol* 83 (12 Pt 1):1829-33.

Boddaert, N., M. Zilbovicius, A. Philipe, L. Robel, M. Bourgeois, C. Barthelemy, D. Seidenwurm, I. Meresse, L. Laurier, I. Desguerre, N. Bahi-Buisson, F. Brunelle, A. Munnich, Y. Samson, M. C. Mouren, and N. Chabane. 2009. MRI findings in 77 children with non-syndromic autistic disorder. *PLoS One* 4 (2):e4415.

Bode, M. K., M. L. Mattila, V. Kiviniemi, J. Rahko, I. Moilanen, H. Ebeling, O. Tervonen, and J. Nikkinen. 2011. White matter in autism spectrum disorders - evidence of impaired fiber formation. *Acta Radiol* 52 (10):1169-74.

Bohr, H., and J. Bohr. 2000. Microwave enhanced kinetics observed in ORD studies of a protein. *Bioelectromagnetics* 21 (1):68-72.

Boksa, P. 2010. Effects of prenatal infection on brain development and behavior: a review of findings from animal models. *Brain Behav Immun* 24 (6):881-97.

Bolshakov, MA, and SI Alekseev. 1992. Bursting responses of Lymnea neurons to microwave radiation. *Bioelectromagnetics* 13:119-129.

Borbely, A. A., R. Huber, T. Graf, B. Fuchs, E. Gallmann, and P. Achermann. 1999. Pulsed high-frequency electromagnetic field affects human sleep and sleep electroencephalogram. *Neurosci Lett* 275 (3):207-10.

Bortkiewicz, A., E. Gadzicka, M. Zmyslony, and W. Szymczak. 2006. Neurovegetative disturbances in workers exposed to 50 Hz electromagnetic fields. *Int J Occup Med Environ Health* 19 (1):53-60.

Boso, M., E. Emanuele, P. Minoretti, M. Arra, P. Politi, S. Ucelli di Nemi, and F. Barale. 2006. Alterations of circulating endogenous secretory RAGE and S100A9 levels indicating dysfunction of the AGE-RAGE axis in autism. *Neurosci Lett* 410 (3):169-73.

Bottoni, P., B. Giardina, and R. Scatena. 2009. Proteomic profiling of heat shock proteins: An emerging molecular approach with direct pathophysiological and clinical implications. *Proteomics Clin Appl* 3 (6):636-53.

Bourgeron, T. 2007. The possible interplay of synaptic and clock genes in autism spectrum disorders. *Cold Spring Harb Symp Quant Biol* 72:645-54.

Braam, W., H. Keijzer, H. Struijker Boudier, R. Didden, M. Smits, and L. Curfs. 2012. CYP1A2 polymorphisms in slow melatonin metabolisers: a possible relationship with autism spectrum disorder? *J Intellect Disabil Res*.

Braunschweig, D., P. Duncanson, R. Boyce, R. Hansen, P. Ashwood, I. N. Pessah, I. Hertz-Picciotto, and J. Van de Water. 2012. Behavioral correlates of maternal antibody status among children with autism. *J Autism Dev Disord* 42 (7):1435-45.

Braunschweig, D., and J. Van de Water. 2012. Maternal autoantibodies in autism. *Arch Neurol* 69 (6):693-9.

Breece, E., B. Paciotti, C. W. Nordahl, S. Ozonoff, J. A. Van de Water, S. J. Rogers, D. Amaral, and P. Ashwood. 2012. Myeloid dendritic cells frequencies are increased in children with autism spectrum disorder and associated with amygdala volume and repetitive behaviors. *Brain Behav Immun.*

Brickman, A. M., J. Muraskin, and M. E. Zimmerman. 2009. Structural neuroimaging in Altheimer's disease: do white matter hyperintensities matter? *Dialogues Clin Neurosci* 11 (2):181-90.

Brillaud, E., A. Piotrowski, and R. de Seze. 2007. Effect of an acute 900MHz GSM exposure on glia in the rat brain: a time-dependent study. *Toxicology* 238 (1):23-33.

Bristot Silvestrin, R., V. Bambini-Junior, F. Galland, L. Daniele Bobermim, A. Quincozes-Santos, R. Torres Abib, C. Zanotto, C. Batassini, G. Brolese, C. A. Goncalves, R. Riesgo, and C. Gottfried. 2012. Animal model of autism induced by prenatal exposure to valproate: Altered glutamate metabolism in the hippocampus. *Brain Res.*

Broderick, G., and T. J. Craddock. 2012. Systems biology of complex symptom profiles: Capturing interactivity across behavior, brain and immune regulation. *Brain Behav Immun.*

Brown, A. S., and E. J. Derkits. 2010. Prenatal infection and schizophrenia: a review of epidemiologic and translational studies. *Am J Psychiatry* 167 (3):261-80.

Brown, M. S., D. Singel, S. Hepburn, and D. C. Rojas. 2012. Increased Glutamate Concentration in the Auditory Cortex of Persons With Autism and First-Degree Relatives: A (1) H-MRS Study. *Autism Res.*

Buchner, K, and H Eger. 2011. Changes of Clinically Important Neurotransmitters under the Influence of Modulated RF Fields—A Long-term Study under Real-life Conditions (translated; original study in German). *Umwelt-Medizin-Gesellschaft* 24 (1):44-57.

Buckley, A. W., A. J. Rodriguez, K. Jennison, J. Buckley, A. Thurm, S. Sato, and S. Swedo. 2010. Rapid eye movement sleep percentage in children with autism compared with children with developmental delay and typical development. *Arch Pediatr Adolesc Med* 164 (11):1032-7.

Burroni, L. , A. Orsi, L. Monti, Y. Hayek, R. Rocchi, and A. G. Vattimo. 2008. Regional cerebral blood flow in childhood autism: a SPET study with SPM evaluation. *Nucl Med Commun* 29 (2):150-6.

Buzsaki, G. 2006. *Rhythms of the Brain.* New York: Oxford University Press.

Byus, C. V., K. Kartun, S. Pieper, and W. R. Adey. 1988. Increased ornithine decarboxylase activity in cultured cells exposed to low energy modulated microwave fields and phorbol ester tumor promoters. *Cancer Res* 48 (15):4222-6.

Byus, C. V., S. E. Pieper, and W. R. Adey. 1987. The effects of low-energy 60-Hz environmental electromagnetic fields upon the growth-related enzyme ornithine decarboxylase. *Carcinogenesis* 8 (10):1385-9.

Cain, C. D., D. L. Thomas, and W. R. Adey. 1993. 60 Hz magnetic field acts as co-promoter in focus formation of C3H/10T1/2 cells. *Carcinogenesis* 14 (5):955-60.

Campisi, A., M. Gulino, R. Acquaviva, P. Bellia, G. Raciti, R. Grasso, F. Musumeci, A. Vanella, and A. Triglia. 2010. Reactive oxygen species levels and DNA fragmentation on astrocytes in primary culture after acute exposure to low intensity microwave electromagnetic field. *Neurosci Lett* 473 (1):52-5.

Canitano, R. 2007. Epilepsy in autism spectrum disorders. *Eur Child Adolesc Psychiatry* 16 (1):61-6.

Cantor, R. M., J. L. Yoon, J. Furr, and C. M. Lajonchere. 2007. Paternal age and autism are associated in a family-based sample. *Mol Psychiatry* 12 (5):419-21.

Carballo-Quintas, M., I. Martinez-Silva, C. Cadarso-Suarez, M. Alvarez-Figueiras, F. J. Ares-Pena, and E. Lopez-Martin. 2011. A study of neurotoxic biomarkers, c-fos and GFAP after acute exposure to GSM radiation at 900 MHz in the picrotoxin model of rat brains. *Neurotoxicology* 32 (4):478-94.

Careaga, M., and P. Ashwood. 2012. Autism spectrum disorders: from immunity to behavior. *Methods Mol Biol* 934:219-40.

Carrubba, S., C. Frilot, A. L. Chesson, and A. A. Marino. 2007. Nonlinear EEG activation evoked by low-strength low-frequency magnetic fields. *Neurosci Lett* 417 (2):212-6.

Carrubba, S., C. Frilot, A. Chesson, and A. A. Marino. 2006. Detection of nonlinear event-related potentials. *J Neurosci Methods* 157 (1):39-47.

Carrubba, S., and A. A. Marino. 2008. The effects of low-frequency environmental-strength electromagnetic fields on brain electrical activity: a critical review of the literature. *Electromagn Biol Med* 27 (2):83-101.

Carrubba, S., A. Minagar, A. L. Chesson, Jr., C. Frilot, 2nd, and A. A. Marino. 2012. Increased determinism in brain electrical activity occurs in association with multiple sclerosis. *Neurol Res* 34 (3):286-90.

Casanova, M. F. 2006. Neuropathological and genetic findings in autism: the significance of a putative minicolumnopathy. *Neuroscientist* 12 (5):435-41.

Cascio, C., M. Gribbin, S. Gouttard, R. G. Smith, M. Jomier, S. Field, M. Graves, H. C. Hazlett, K. Muller, G. Gerig, and J. Piven. 2012. Fractional anisotropy distributions in 2- to 6-year-old children with autism. *J Intellect Disabil Res.*

Catarino, A., O. Churches, S. Baron-Cohen, A. Andrade, and H. Ring. 2011. Atypical EEG complexity in autism spectrum conditions: a multiscale entropy analysis. *Clin Neurophysiol* 122 (12):2375-83.

Cellular Telephone Industry of America (CTIA). *Wireless Quick Facts: Midyear Figures* 2012 June. Available from http://www.ctia.org/advocacy/research/index.cfm/aid/10323.

Cervellati, F., G. Franceschetti, L. Lunghi, S. Franzellitti, P. Valbonesi, E. Fabbri, C. Biondi, and F. Vesce. 2009. Effect of high-frequency electromagnetic fields on trophoblastic connexins. *Reprod Toxicol* 28 (1):59-65.

Chan, P., L. F. Eng, Y. L. Lee, and V. W. Lin. 1999. Effects of pulsed magnetic stimulation of GFAP levels in cultured astrocytes. *J Neurosci Res* 55 (2):238-44.

Chang, M. C., L. D. Parham, E. I. Blanche, A. Schell, C. P. Chou, M. Dawson, and F. Clark. 2012. Autonomic and behavioral responses of children with autism to auditory stimuli. *Am J Occup Ther* 66 (5):567-76.

Chaste, P., N. Clement, O. Mercati, J. L. Guillaume, R. Delorme, H. G. Botros, C. Pagan, S. Perivier, I. Scheid, G. Nygren, H. Anckarsater, M. Rastam, O. Stahlberg, C. Gillberg, E. Serrano, N. Lemiere, J. M. Launay, M. C. Mouren-Simeoni, M. Leboyer, R. Jockers, and T. Bourgeron. 2010. Identification of pathway-biased and deleterious melatonin receptor mutants in autism spectrum disorders and in the general population. *PLoS One* 5 (7):e11495.

Chauhan, A, V Chauhan, and T. Brown, eds. 2009. *Autism: Oxidative stress, inflammation and immune abnormalities*. Boca Raton, FL: Taylor & Francis / CRC Press.

Chauhan, A. , and V. Chauhan. 2006. Oxidative stress in autism. *Pathophysiology* 13 (3):171-181.

Chauhan, A., T. Audhya, and V. Chauhan. 2012. Brain region-specific glutathione redox imbalance in autism. *Neurochem Res* 37 (8):1681-9.

Chauhan, A., F. Gu, M. M. Essa, J. Wegiel, K. Kaur, W. Ted Brown, and V. Chauhan. 2011. Brain region-specific deficit in mitochondrial electron transport chain complexes in children with autism. *J Neurochem*.

Chen, G., B. L. Upham, W. Sun, C. C. Chang, E. J. Rothwell, K. M. Chen, H. Yamasaki, and J. E. Trosko. 2000. Effect of electromagnetic field exposure on chemically induced differentiation of friend erythroleukemia cells. *Environ Health Perspect* 108 (10):967-72.

Chernysheva, O. N. 1987. [Effect of an alternating magnetic field of industrial frequency on the lipid composition of the rat liver]. *Ukr Biokhim Zh* 59 (3):91-4.

Cheshire, W. P. 2012. Highlights in clinical autonomic neuroscience: New insights into autonomic dysfunction in autism. *Auton Neurosci* 171 (1-2):4-7.

Choudhury, P. R., S. Lahiri, and U. Rajamma. 2012. Glutamate mediated signaling in the pathophysiology of autism spectrum disorders. *Pharmacol Biochem Behav* 100 (4):841-9.

Christophersen, O. A., and A. Haug. 2011. Animal products, diseases and drugs: a plea for better integration between agricultural sciences, human nutrition and human pharmacology. *Lipids Health Dis* 10:16.

Clinton, J. M., C. J. Davis, M. R. Zielinski, K. A. Jewett, and J. M. Krueger. 2011. Biochemical regulation of sleep and sleep biomarkers. *J Clin Sleep Med* 7 (5 Suppl):S38-42.

Cobb, S., J. Guy, and A. Bird. 2010. Reversibility of functional deficits in experimental models of Rett syndrome. *Biochem Soc Trans* 38 (2):498-506.

Coben, R., A. R. Clarke, W. Hudspeth, and R. J. Barry. 2008. EEG power and coherence in autistic spectrum disorder. *Clin Neurophysiol* 119 (5):1002-9.

Coghlan, S., J. Horder, B. Inkster, M. A. Mendez, D. G. Murphy, and D. J. Nutt. 2012. GABA system dysfunction in autism and related disorders: from synapse to symptoms. *Neurosci Biobehav Rev* 36 (9):2044-55.

Cristofolini, L., F. Taddei, M. Baleani, F. Baruffaldi, S. Stea, and M. Viceconti. 2008. Multiscale investigation of the functional properties of the human femur. *Philos Transact A Math Phys Eng Sci* 366 (1879):3319-41.

Croen, L. A., J. K. Grether, C. K. Yoshida, R. Odouli, and J. Van de Water. 2005. Maternal autoimmune diseases, asthma and allergies, and childhood autism spectrum disorders: a case-control study. *Arch Pediatr Adolesc Med* 159 (2):151-7.

Curran, L.K. , C.J. Newschaffer, L.C. Lee, S.O. Crawford, M.V. Johnston, and A.W. Zimmerman. 2007. Behaviors associated with fever in children with autism spectrum disorders. *Pediatrics* 120 (6):e1386-1392.

Custodio, R. J., C. E. Junior, S. L. Milani, A. L. Simoes, M. de Castro, and A. C. Moreira. 2007. The emergence of the cortisol circadian rhythm in monozygotic and dizygotic twin infants: the twin-pair synchrony. *Clin Endocrinol (Oxf)* 66 (2):192-7.

D'Eufemia, P., M. Celli, R. Finocchiaro, L. Pacifico, L. Viozzi, M. Zaccagnini, E. Cardi, and O. Giardini. 1996. Abnormal intestinal permeability in children with autism. *Acta Paediatr* 85 (9):1076-9.

Dager, S.R., S.D. Friedman, H. Petropoulos, and D.W.W. Shaw. 2008. *Imaging evidence for pathological brain development in Autism Spectrum Disorders*. Edited by A. Zimmerman, *Autism: Current theories and evidence*. Totowa, NJ: Humana Press.

Daluwatte, C., J. H. Miles, S. E. Christ, D. Q. Beversdorf, T. N. Takahashi, and G. Yao. 2012. Atypical Pupillary Light Reflex and Heart Rate Variability in Children with Autism Spectrum Disorder. *J Autism Dev Disord*.

Daniells, C., I. Duce, D. Thomas, P. Sewell, J. Tattersall, and D. de Pomerai. 1998. Transgenic nematodes as biomonitors of microwave-induced stress. *Mutat Res* 399 (1):55-64.

Dasdag, S., M. A. Ketani, Z. Akdag, A. R. Ersay, I. Sari, O. C. Demirtas, and M. S. Celik. 1999. Whole-body microwave exposure emitted by cellular phones and testicular function of rats. *Urol Res* 27 (3):219-23.

Davis, J. O., J. A. Phelps, and H. S. Bracha. 1995. Prenatal development of monozygotic twins and concordance for schizophrenia. *Schizophr Bull* 21 (3):357-66.

Dawson, M., I. Soulieres, M. A. Gernsbacher, and L. Mottron. 2007. The level and nature of autistic intelligence. *Psychol Sci* 18 (8):657-62.

De Angelis, M., C. G. Rizzello, A. Fasano, M. G. Clemente, C. De Simone, M. Silano, M. De Vincenzi, I. Losito, and M. Gobbetti. 2006. VSL#3 probiotic preparation has the capacity to hydrolyze gliadin polypeptides responsible for Celiac Sprue. *Biochim Biophys Acta* 1762 (1):80-93.

de Graaf, A. A., A. P. Freidig, B. De Roos, N. Jamshidi, M. Heinemann, J. A. Rullmann, K. D. Hall, M. Adiels, and B. van Ommen. 2009. Nutritional systems biology modeling: from molecular mechanisms to physiology. *PLoS Comput Biol* 5 (11):e1000554.

De Iuliis, G. N., R. J. Newey, B. V. King, and R. J. Aitken. 2009. Mobile phone radiation induces reactive oxygen species production and DNA damage in human spermatozoa in vitro. *PLoS One* 4 (7):e6446.

de Magistris, L., V. Familiari, A. Pascotto, A. Sapone, A. Frolli, P. Iardino, M. Carteni, M. De Rosa, R. Francavilla, G. Riegler, R. Militerni, and C. Bravaccio. 2010. Alterations of the intestinal barrier in patients with autism spectrum disorders and in their first-degree relatives. *J Pediatr Gastroenterol Nutr* 51 (4):418-24.

de Pomerai, D., C. Daniells, H. David, J. Allan, I. Duce, M. Mutwakil, D. Thomas, P. Sewell, J. Tattersall, D. Jones, and P. Candido. 2000. Non-thermal heat-shock response to microwaves. *Nature* 405 (6785):417-8.

Degirmenci, B. , S. Miral, G. C. Kaya, L. Iyilikci, G. Arslan, A. Baykara, I. Evren, and H. Durak. 2008. Technetium-99m HMPAO brain SPECT in autistic children and their families. *Psychiatry Res* 162 (3):236-43.

Derecki, N. C., J. C. Cronk, and J. Kipnis. 2012. The role of microglia in brain maintenance: implications for Rett syndrome. *Trends Immunol.*

Derecki, N. C., J. C. Cronk, Z. Lu, E. Xu, S. B. Abbott, P. G. Guyenet, and J. Kipnis. 2012. Wild-type microglia arrest pathology in a mouse model of Rett syndrome. *Nature* 484 (7392):105-9.

Desai, N. R., K. K. Kesari, and A. Agarwal. 2009. Pathophysiology of cell phone radiation: oxidative stress and carcinogenesis with focus on male reproductive system. *Reprod Biol Endocrinol* 7:114.

Diem, E., C. Schwarz, F. Adlkofer, O. Jahn, and H. Rudiger. 2005. Non-thermal DNA breakage by mobile-phone radiation (1800 MHz) in human fibroblasts and in transformed GFSH-R17 rat granulosa cells in vitro. *Mutat Res* 583 (2):178-83.

Dinstein, I., D. J. Heeger, L. Lorenzi, N. J. Minshew, R. Malach, and M. Behrmann. 2012. Unreliable evoked responses in autism. *Neuron* 75 (6):981-91.

Dragicevic, N., P. C. Bradshaw, M. Mamcarz, X. Lin, L. Wang, C. Cao, and G. W. Arendash. 2011. Long-term electromagnetic field treatment enhances brain mitochondrial function of both Alzheimer's transgenic mice and normal mice: a mechanism for electromagnetic field-induced cognitive benefit? *Neuroscience* 185:135-49.

Duffy, F. H., and H. Als. 2012. A stable pattern of EEG spectral coherence distinguishes children with autism from neuro-typical controls - a large case control study. *BMC Med* 10:64.

Dutta, S. K., K. Das, B. Ghosh, and C. F. Blackman. 1992. Dose dependence of acetylcholinesterase activity in neuroblastoma cells exposed to modulated radio-frequency electromagnetic radiation. *Bioelectromagnetics* 13 (4):317-22.

Dutta, S. K., B. Ghosh, and C. F. Blackman. 1989. Radiofrequency radiation-induced calcium ion efflux enhancement from human and other neuroblastoma cells in culture. *Bioelectromagnetics* 10 (2):197-202.

Dziobek, I., M. Bahnemann, A. Convit, and H. R. Heekeren. 2010. The role of the fusiform-amygdala system in the pathophysiology of autism. *Arch Gen Psychiatry* 67 (4):397-405.

Eberhardt, J. L., B. R. Persson, A. E. Brun, L. G. Salford, and L. O. Malmgren. 2008. Blood-brain barrier permeability and nerve cell damage in rat brain 14 and 28 days after exposure to microwaves from GSM mobile phones. *Electromagn Biol Med* 27 (3):215-29.

Edelson, M.E. 2006. Are the majority of children with autism mentally retarded? A systematic evaluation of the data. *Focus on Autism and Other Developmental Disabilities* 21 (2):66-82.

Ehninger, D., S. Han, C. Shilyansky, Y. Zhou, W. Li, D. J. Kwiatkowski, V. Ramesh, and A. J. Silva. 2008. Reversal of learning deficits in a Tsc2+/- mouse model of tuberous sclerosis. *Nat Med* 14 (8):843-8.

Eimerl, S., and M. Schramm. 1991. Acute glutamate toxicity and its potentiation by serum albumin are determined by the Ca2+ concentration. *Neurosci Lett* 130 (1):125-7.

El-Ansary, A., and L. Al-Ayadhi. 2012. Neuroinflammation in autism spectrum disorders. *J Neuroinflammation* 9 (1):265.

El-Ansary, A., S. Al-Daihan, A. Al-Dbass, and L. Al-Ayadhi. 2010. Measurement of selected ions related to oxidative stress and energy metabolism in Saudi autistic children. *Clin Biochem* 43 (1-2):63-70.

El-Ansary, A. K., A. Ben Bacha, and M. Kotb. 2012. Etiology of autistic features: the persisting neurotoxic effects of propionic acid. *J Neuroinflammation* 9:74.

Enticott, P. G., H. A. Kennedy, N. J. Rinehart, B. J. Tonge, J. L. Bradshaw, and P. B. Fitzgerald. 2012. GABAergic activity in autism spectrum disorders: An investigation of cortical inhibition via transcranial magnetic stimulation. *Neuropharmacology*.

Erickson, M. A., K. Dohi, and W. A. Banks. 2012. Neuroinflammation: a common pathway in CNS diseases as mediated at the blood-brain barrier. *Neuroimmunomodulation* 19 (2):121-30.

Eroglu, C., and B. A. Barres. 2010. Regulation of synaptic connectivity by glia. *Nature* 468 (7321):223-31.

Esmekaya, M. A., E. Aytekin, E. Ozgur, G. Guler, M. A. Ergun, S. Omeroglu, and N. Seyhan. 2011. Mutagenic and morphologic impacts of 1.8GHz radiofrequency radiation on human peripheral blood lymphocytes (hPBLs) and possible protective role of pre-treatment with Ginkgo biloba (EGb 761). *Sci Total Environ* 410-411:59-64.

Esmekaya, M. A., C. Ozer, and N. Seyhan. 2011. 900 MHz pulse-modulated radiofrequency radiation induces oxidative stress on heart, lung, testis and liver tissues. *Gen Physiol Biophys* 30 (1):84-9.

Essa, M. M., N. Braidy, K. R. Vijayan, S. Subash, and G. J. Guillemin. 2012. Excitotoxicity in the Pathogenesis of Autism. *Neurotox Res*.

Evers, M., C. Cunningham-Rundles, and E. Hollander. 2002. Heat shock protein 90 antibodies in autism. *Mol Psychiatry* 7 Suppl 2:S26-8.

Fasano, A. 2009. Surprises from celiac disease. *Sci Am* 301 (2):54-61.

Fatemi, S. H., K. A. Aldinger, P. Ashwood, M. L. Bauman, C. D. Blaha, G. J. Blatt, A. Chauhan, V. Chauhan, S. R. Dager, P. E. Dickson, A. M. Estes, D. Goldowitz, D. H. Heck, T. L. Kemper, B. H. King, L. A. Martin, K. J. Millen, G. Mittleman, M. W. Mosconi, A. M. Persico, J. A. Sweeney, S. J. Webb, and J. P. Welsh. 2012. Consensus Paper: Pathological Role of the Cerebellum in Autism. *Cerebellum*.

Fatemi, S. H., T. D. Folsom, T. J. Reutiman, and S. Lee. 2008. Expression of astrocytic markers aquaporin 4 and connexin 43 is altered in brains of subjects with autism. *Synapse* 62 (7):501-7.

Fatemi, S. H., A. R. Halt, G. Realmuto, J. Earle, D. A. Kist, P. Thuras, and A. Merz. 2002. Purkinje cell size is reduced in cerebellum of patients with autism. *Cell Mol Neurobiol* 22 (2):171-5.

Fejes, I., Z. Zavaczki, J. Szollosi, S. Koloszar, J. Daru, L. Kovacs, and A. Pal. 2005. Is there a relationship between cell phone use and semen quality? *Arch Androl* 51 (5):385-93.

Fields, R. D. 2006. Advances in understanding neuron-glia interactions. *Neuron Glia Biol* 2 (1):23-6.

Fox, E., D. Amaral, and J. Van de Water. 2012. Maternal and fetal antibrain antibodies in development and disease. *Dev Neurobiol* 72 (10):1327-34.

Fragopoulou, A. F., A. Samara, M. H. Antonelou, A. Xanthopoulou, A. Papadopoulou, K. Vougas, E. Koutsogiannopoulou, E. Anastasiadou, D. J. Stravopodis, G. T. Tsangaris, and L. H. Margaritis. 2012. Brain proteome response following whole body exposure of mice to mobile phone or wireless DECT base radiation. *Electromagn Biol Med* 31 (4):250-74.

Fragopoulou, A., Y. Grigoriev, O. Johansson, L. H. Margaritis, L. Morgan, E. Richter, and C. Sage. 2010. Scientific panel on electromagnetic field health risks: consensus points, recommendations, and rationales. *Rev Environ Health* 25 (4):307-17.

Frustaci, A., M. Neri, A. Cesario, J. B. Adams, E. Domenici, B. Dalla Bernardina, and S. Bonassi. 2012. Oxidative stress-related biomarkers in autism: Systematic review and meta-analyses. *Free Radic Biol Med* 52 (10):2128-41.

Galuska, L. , S. Jr Szakall, M. Emri, R. Olah, J. Varga, I. Garai, J. Kollar, I. Pataki, and L. Tron. 2002. [PET and SPECT scans in autistic children]. *Orv Hetil* 143 (21 Suppl 3):1302-4.

Garbett, K. A., E. Y. Hsiao, S. Kalman, P. H. Patterson, and K. Mirnics. 2012. Effects of maternal immune activation on gene expression patterns in the fetal brain. *Transl Psychiatry* 2:e98.

Garbett, K., P. J. Ebert, A. Mitchell, C. Lintas, B. Manzi, K. Mirnics, and A. M. Persico. 2008. Immune transcriptome alterations in the temporal cortex of subjects with autism. *Neurobiol Dis* 30 (3):303-11.

Gardoni, F., M. Boraso, E. Zianni, E. Corsini, C. L. Galli, F. Cattabeni, M. Marinovich, M. Di Luca, and B. Viviani. 2011. Distribution of interleukin-1 receptor complex at the synaptic membrane driven by interleukin-1beta and NMDA stimulation. *J Neuroinflammation* 8 (1):14.

Gargus, J.J. 2009. Mitochondrial component of calcium signaling abnormality in autism. In *Autism: Oxidative Stress, Inflammation, and Immune Abnormalities*, edited by A. Chauhan, V. Chauhan and T. Brown. Boca Raton, FL: CRC Press.

Gargus, JJ/Imtiaz, F aiqa. 2008. Mitochondrial Energy-Deficient Endophenotype in Autism. *American Journal of Biochemistry and Biotechnology* 4 (2):198-207.

George, I., M. S. Geddis, Z. Lill, H. Lin, T. Gomez, M. Blank, M. C. Oz, and R. Goodman. 2008. Myocardial function improved by electromagnetic field induction of stress protein hsp70. *J Cell Physiol* 216 (3):816-23.

George, M. S. , D. C. Costa, K. Kouris, H. A. Ring, and P. J. Ell. 1992. Cerebral blood flow abnormalities in adults with infantile autism. *J Nerv Ment Dis* 180 (7):413-7.

Geschwind, D. H., and P. Levitt. 2007. Autism spectrum disorders: developmental disconnection syndromes. *Curr Opin Neurobiol* 17 (1):103-11.

Ghanizadeh, A., S. Akhondzadeh, Hormozi, A. Makarem, M. Abotorabi, and A. Firoozabadi. 2012. Glutathione-related Factors and Oxidative Stress in Autism, a Review. *Curr Med Chem.*

Giannotti, F., F. Cortesi, A. Cerquiglini, C. Vagnoni, and D. Valente. 2011. Sleep in children with autism with and without autistic regression. *J Sleep Res* 20 (2):338-47.

Giulivi, C., Y. F. Zhang, A. Omanska-Klusek, C. Ross-Inta, S. Wong, I. Hertz-Picciotto, F. Tassone, and I. N. Pessah. 2010. Mitochondrial dysfunction in autism. *JAMA* 304 (21):2389-96.

Goebel-Goody, S. M., E. D. Wilson-Wallis, S. Royston, S. M. Tagliatela, J. R. Naegele, and P. J. Lombroso. 2012. Genetic manipulation of STEP reverses behavioral abnormalities in a fragile X syndrome mouse model. *Genes Brain Behav* 11 (5):586-600.

Goines, P., L. Haapanen, R. Boyce, P. Duncanson, D. Braunschweig, L. Delwiche, R. Hansen, I. Hertz-Picciotto, P. Ashwood, and J. Van de Water. 2011. Autoantibodies to cerebellum in children with autism associate with behavior. *Brain Behav Immun* 25 (3):514-23.

Gonzalez, A., J. Stombaugh, C. Lozupone, P. J. Turnbaugh, J. I. Gordon, and R. Knight. 2011. The mind-body-microbial continuum. *Dialogues Clin Neurosci* 13 (1):55-62.

Graham, C., M. R. Cook, A. Sastre, M. M. Gerkovich, and R. Kavet. 2000. Cardiac autonomic control mechanisms in power-frequency magnetic fields: a multistudy analysis. *Environ Health Perspect* 108 (8):737-42.

Gul, A., H. Celebi, and S. Ugras. 2009. The effects of microwave emitted by cellular phones on ovarian follicles in rats. *Arch Gynecol Obstet* 280 (5):729-33.

Guney, M., F. Ozguner, B. Oral, N. Karahan, and T. Mungan. 2007. 900 MHz radiofrequency-induced histopathologic changes and oxidative stress in rat endometrium: protection by vitamins E and C. *Toxicol Ind Health* 23 (7):411-20.

Gupta, SK, and BV Ratnam. 2009. Cerebral Perfusion Abnormalities in Children with Autism and Mental Retardation A Segmental Quantitative SPECT Study. *Indian Pediatr.* 46 (2):161-4.

Gupta, Y. K., M. Gupta, and K. Kohli. 2003. Neuroprotective role of melatonin in oxidative stress vulnerable brain. *Indian J Physiol Pharmacol* 47 (4):373-86.

Hadjixenofontos, A., M. A. Schmidt, P. L. Whitehead, I. Konidari, D. J. Hedges, H. H. Wright, R. K. Abramson, R. Menon, S. M. Williams, M. L. Cuccaro, J. L. Haines, J. R. Gilbert, M. A. Pericak-Vance, E. R. Martin, and J. L. McCauley. 2012. Evaluating Mitochondrial DNA Variation in Autism Spectrum Disorders. *Ann Hum Genet.*

Hadjixenofontos, A., M. A. Schmidt, P. L. Whitehead, I. Konidari, D. J. Hedges, H. H. Wright, R. K. Abramson, R. Menon, S. M. Williams, M. L. Cuccaro, J. L. Haines, J. R. Gilbert, M. A. Pericak-Vance, E. R. Martin, and J. L. McCauley. 2013. Evaluating mitochondrial DNA variation in autism spectrum disorders. *Ann Hum Genet* 77 (1):9-21.

Hall, D., M. F. Huerta, M. J. McAuliffe, and G. K. Farber. 2012. Sharing heterogeneous data: the national database for autism research. *Neuroinformatics* 10 (4):331-9.

Hall, G. B., K. A. Doyle, J. Goldberg, D. West, and P. Szatmari. 2010. Amygdala engagement in response to subthreshold presentations of anxious face stimuli in adults with autism spectrum disorders: preliminary insights. *PLoS One* 5 (5):e10804.

Hallmayer, J., S. Cleveland, A. Torres, J. Phillips, B. Cohen, T. Torigoe, J. Miller, A. Fedele, J. Collins, K. Smith, L. Lotspeich, L. A. Croen, S. Ozonoff, C. Lajonchere, J. K. Grether, and N. Risch. 2011. Genetic heritability and shared environmental factors among twin pairs with autism. *Arch Gen Psychiatry* 68 (11):1095-102.

Hardeland, R. 2005. Antioxidative protection by melatonin: multiplicity of mechanisms from radical detoxification to radical avoidance. *Endocrine* 27 (2):119-30.

Hashimoto, T. , M. Sasaki, M. Fukumizu, S. Hanaoka, K. Sugai, and H. Matsuda. 2000. Single-photon emission computed tomography of the brain in autism: effect of the developmental level. *Pediatr Neurol* 23 (5):416-20.

Hassel, B., E. G. Iversen, and F. Fonnum. 1994. Neurotoxicity of albumin in vivo. *Neurosci Lett* 167 (1-2):29-32.

Hasselmo, M. E., C. Linster, M. Patil, D. Ma, and M. Cekic. 1997. Noradrenergic suppression of synaptic transmission may influence cortical signal-to-noise ratio. *J Neurophysiol* 77 (6):3326-39.

Helt, M., E. Kelley, M. Kinsbourne, J. Pandey, H. Boorstein, M. Herbert, and D. Fein. 2008. Can children with autism recover? If so, how? *Neuropsychol Rev* 18 (4):339-66.

Henderson, C., L. Wijetunge, M. N. Kinoshita, M. Shumway, R. S. Hammond, F. R. Postma, C. Brynczka, R. Rush, A. Thomas, R. Paylor, S. T. Warren, P. W. Vanderklish, P. C. Kind, R. L. Carpenter, M. F. Bear, and A. M. Healy. 2012. Reversal of disease-related pathologies in the fragile X mouse model by selective activation of GABA(B) receptors with arbaclofen. *Sci Transl Med* 4 (152):152ra128.

Herbert, M. R. 2005. Large brains in autism: the challenge of pervasive abnormality. *Neuroscientist* 11 (5):417-40.

Herbert, M. R. 2010. Contributions of the environment and environmentally vulnerable physiology to autism spectrum disorders. *Curr Opin Neurol* 23 (2):103-10.

Herbert, M.R. 2005. Autism: A Brain disorder or a disorder that affects the brain? *Clinical Neuropsychiatry* 2 (6):354-379 http://www.marthaherbert.com/Herbert%20CN%20autism%20brain%20or%20affecting%20brain%20final.pdf.

Herbert, M.R. 2009. *Autism: The centrality of active pathophysiology and the shift from static to chronic dynamic encephalopathy*. Edited by A. Chauhan, V. Chauhan and T. Brown, *Autism: Oxidative stress, inflammation and immune abnormalities*: Taylor & Francis / CRC Press.

Herbert, M.R. 2012. Why aren't we there yet? Valuable but incomplete measures of brain changes in babies with autism. In *Autism Why and How.*

Herbert, Martha R., and Karen Weintraub. 2012. *The Autism Revolution: Whole Body Strategies for Making Life All It Can Be, Harvard Health Publications.* New York, NY: Random House with Harvard Health Publications.

Herbert, MR. *Emergent Systems Features* 2012. Available from http://www.autismwhyandhow.org/what-is-autism/emergent-systems-features/.

Herbert, MR. 2013. Autism: From Static Genetic Brain Defect to Dynamic Gene-Environment Modulated Pathophysiology. In *Genetic Explanations: Sense and Nonsense*, edited by S. Krimsky and J. Gruber. Cambridge, MA: Harvard University Press.

Herold, S. , R. S. Frackowiak, A. Le Couteur, M. Rutter, and P. Howlin. 1988. Cerebral blood flow and metabolism of oxygen and glucose in young autistic adults. *Psychol Med* 18 (4):823-31.

Hertz-Picciotto, I., and L. Delwiche. 2009. The rise in autism and the role of age at diagnosis. *Epidemiology* 20 (1):84-90.

Heuer, L., P. Ashwood, J. Schauer, P. Goines, P. Krakowiak, I. Hertz-Picciotto, R. Hansen, L. A. Croen, I. N. Pessah, and J. Van de Water. 2008. Reduced levels of immunoglobulin in children with autism correlates with behavioral symptoms. *Autism Res* 1 (5):275-83.

Hinrikus, H., M. Bachmann, J. Lass, R. Tomson, and V. Tuulik. 2008. Effect of 7, 14 and 21 Hz modulated 450 MHz microwave radiation on human electroencephalographic rhythms. *Int J Radiat Biol* 84 (1):69-79.

Hirstein, W., P. Iversen, and V. S. Ramachandran. 2001. Autonomic responses of autistic children to people and objects. *Proc Biol Sci* 268 (1479):1883-8.

Hornig, M., H. Weissenbock, N. Horscroft, and W. I. Lipkin. 1999. An infection-based model of neurodevelopmental damage. *Proc Natl Acad Sci U S A* 96 (21):12102-7.

Horvath, K., and J. A. Perman. 2002. Autism and gastrointestinal symptoms. *Curr Gastroenterol Rep* 4 (3):251-8.

Hountala, C. D., A. E. Maganioti, C. C. Papageorgiou, E. D. Nanou, M. A. Kyprianou, V. G. Tsiafakis, A. D. Rabavilas, and C. N. Capsalis. 2008. The spectral power coherence of the EEG under different EMF conditions. *Neurosci Lett* 441 (2):188-92.

Hoyto, A., J. Luukkonen, J. Juutilainen, and J. Naarala. 2008. Proliferation, oxidative stress and cell death in cells exposed to 872 MHz radiofrequency radiation and oxidants. *Radiat Res* 170 (2):235-43.

Hsiao, E. Y., and P. H. Patterson. 2012. Placental regulation of maternal-fetal interactions and brain development. *Dev Neurobiol* 72 (10):1317-26.

Huber, R., J. Schuderer, T. Graf, K. Jutz, A. A. Borbely, N. Kuster, and P. Achermann. 2003. Radio frequency electromagnetic field exposure in humans: Estimation of SAR distribution in the brain, effects on sleep and heart rate. *Bioelectromagnetics* 24 (4):262-76.

Ilhan, A., A. Gurel, F. Armutcu, S. Kamisli, M. Iraz, O. Akyol, and S. Ozen. 2004. Ginkgo biloba prevents mobile phone-induced oxidative stress in rat brain. *Clin Chim Acta* 340 (1-2):153-62.

Imaida, K., A. Hagiwara, H. Yoshino, S. Tamano, M. Sano, M. Futakuchi, K. Ogawa, M. Asamoto, and T. Shirai. 2000. Inhibitory effects of low doses of melatonin on induction of preneoplastic liver lesions in a medium-term liver bioassay in F344 rats: relation to the influence of electromagnetic near field exposure. *Cancer Lett* 155 (1):105-14.

Indredavik, M. S., T. Vik, K. A. Evensen, J. Skranes, G. Taraldsen, and A. M. Brubakk. 2010. Perinatal risk and psychiatric outcome in adolescents born preterm with very low birth weight or term small for gestational age. *J Dev Behav Pediatr* 31 (4):286-94.

Indredavik, M. S., T. Vik, J. Skranes, and A. M. Brubakk. 2008. Positive screening results for autism in ex-preterm infants. *Pediatrics* 122 (1):222; author reply 222-3.

International Agency for Research on Cancer of the World Health Organization. 2011 May. IARC Classifies Radiofrequency Electromagnetic Fields as Possibly Carcinogenic to Humans. Lyons, France: International Agency for Research on Cancer of the World Health Organization.

Iossifov, I., M. Ronemus, D. Levy, Z. Wang, I. Hakker, J. Rosenbaum, B. Yamrom, Y. H. Lee, G. Narzisi, A. Leotta, J. Kendall, E. Grabowska, B. Ma, S. Marks, L. Rodgers, A. Stepansky, J. Troge, P. Andrews, M. Bekritsky, K. Pradhan, E. Ghiban, M. Kramer, J. Parla, R. Demeter, L. L. Fulton, R. S. Fulton, V. J. Magrini, K. Ye, J. C. Darnell, R. B. Darnell, E. R. Mardis, R. K. Wilson, M. C. Schatz, W. R. McCombie, and M. Wigler. 2012. De novo gene disruptions in children on the autistic spectrum. *Neuron* 74 (2):285-99.

Iotti, S., M. Borsari, and D. Bendahan. 2010. Oscillations in energy metabolism. *Biochim Biophys Acta* 1797 (8):1353-61.

Ishido, M., H. Nitta, and M. Kabuto. 2001. Magnetic fields (MF) of 50 Hz at 1.2 microT as well as 100 microT cause uncoupling of inhibitory pathways of adenylyl cyclase mediated by melatonin 1a receptor in MF-sensitive MCF-7 cells. *Carcinogenesis* 22 (7):1043-8.

Isler, J. R., K. M. Martien, P. G. Grieve, R. I. Stark, and M. R. Herbert. 2010. Reduced functional connectivity in visual evoked potentials in children with autism spectrum disorder. *Clin Neurophysiol.*

Ito, H. , K. Mori, T. Hashimoto, M. Miyazaki, A. Hori, S. Kagami, and Y. Kuroda. 2005. Findings of brain 99mTc-ECD SPECT in high-functioning autism--3-dimensional stereotactic ROI template analysis of brain SPECT. *J Med Invest* 52 (1-2):49-56.

Ivancsits, S., A. Pilger, E. Diem, O. Jahn, and H. W. Rudiger. 2005. Cell type-specific genotoxic effects of intermittent extremely low-frequency electromagnetic fields. *Mutat Res* 583 (2):184-8.

Janigro, D. 2012. Are you in or out? Leukocyte, ion, and neurotransmitter permeability across the epileptic blood-brain barrier. *Epilepsia* 53 Suppl 1:26-34.

Jelodar, G., A. Akbari, and S. Nazifi. 2012. The prophylactic effect of vitamin C on oxidative stress indexes in rat eyes following exposure to radiofrequency wave generated by a BTS antenna model. *Int J Radiat Biol.*

Johannson, O. 2007. Evidence for Effects on Immune Function. In *BioInitiative Report: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF).*

Johansson, M., M. Rastam, E. Billstedt, S. Danielsson, K. Stromland, M. Miller, and C. Gillberg. 2006. Autism spectrum disorders and underlying brain pathology in CHARGE association. *Dev Med Child Neurol* 48 (1):40-50.

Johansson, O. 2009. Disturbance of the immune system by electromagnetic fields-A potentially underlying cause for cellular damage and tissue repair reduction which could lead to disease and impairment. *Pathophysiology* 16 (2-3):157-77.

Johansson, O., S. Gangi, Y. Liang, K. Yoshimura, C. Jing, and P. Y. Liu. 2001. Cutaneous mast cells are altered in normal healthy volunteers sitting in front of ordinary TVs/PCs--results from open-field provocation experiments. *J Cutan Pathol* 28 (10):513-9.

Johnson, R. T., S. M. Breedlove, and C. L. Jordan. 2010. Astrocytes in the amygdala. *Vitam Horm* 82:23-45.

Johnson, S., C. Hollis, E. Hennessy, P. Kochhar, D. Wolke, and N. Marlow. 2011. Screening for autism in preterm children: diagnostic utility of the Social Communication Questionnaire. *Arch Dis Child* 96 (1):73-7.

Johnson, S., C. Hollis, P. Kochhar, E. Hennessy, D. Wolke, and N. Marlow. 2010. Autism spectrum disorders in extremely preterm children. *J Pediatr* 156 (4):525-31 e2.

Johnson, S., and N. Marlow. 2011. Preterm birth and childhood psychiatric disorders. *Pediatr Res* 69 (5 Pt 2):11R-8R.

Jonsson, L., E. Ljunggren, A. Bremer, C. Pedersen, M. Landen, K. Thuresson, M. Giacobini, and J. Melke. 2010. Mutation screening of melatonin-related genes in patients with autism spectrum disorders. *BMC Med Genomics* 3:10.

Jung, J. Y., I. S. Kohane, and D. P. Wall. 2011. Identification of autoimmune gene signatures in autism. *Transl Psychiatry* 1:e63.

Just, M. A., V. L. Cherkassky, T. A. Keller, and N. J. Minshew. 2004. Cortical activation and synchronization during sentence comprehension in high-functioning autism: evidence of underconnectivity. *Brain* 127 (Pt 8):1811-21.

Juutilainen, J. 2008. Do electromagnetic fields enhance the effects of environmental carcinogens? *Radiat Prot Dosimetry* 132 (2):228-31.

Juutilainen, J., and T. Kumlin. 2006. Occupational magnetic field exposure and melatonin: interaction with light-at-night. *Bioelectromagnetics* 27 (5):423-6.

Juutilainen, J., T. Kumlin, and J. Naarala. 2006. Do extremely low frequency magnetic fields enhance the effects of environmental carcinogens? A meta-analysis of experimental studies. *Int J Radiat Biol* 82 (1):1-12.

Jyonouchi, H., L. Geng, D. L. Streck, and G. A. Toruner. 2011. Children with autism spectrum disorders (ASD) who exhibit chronic gastrointestinal (GI) symptoms and marked fluctuation of behavioral symptoms exhibit distinct innate immune abnormalities and transcriptional profiles of peripheral blood (PB) monocytes. *J Neuroimmunol.*

Kaartinen, M., K. Puura, T. Makela, M. Rannisto, R. Lemponen, M. Helminen, R. Salmelin, S. L. Himanen, and J. K. Hietanen. 2012. Autonomic arousal to direct gaze correlates with social impairments among children with ASD. *J Autism Dev Disord* 42 (9):1917-27.

Kang, J. Q., and G. Barnes. 2013. A Common Susceptibility Factor of Both Autism and Epilepsy: Functional Deficiency of GABA(A) Receptors. *J Autism Dev Disord* 43 (1):68-79.

Kanner, L. 1943. Autistic disturbances of affective contact. *Nerv Child (Reprint in Acta Paedopsychiatr 1968b35(4):100-136 PMID 4880460* 2:217-250.

Kanthasamy, A., H. Jin, V. Anantharam, G. Sondarva, V. Rangasamy, and A. Rana. 2012. Emerging neurotoxic mechanisms in environmental factors-induced neurodegeneration. *Neurotoxicology* 33 (4):833-7.

Kaphzan, H., P. Hernandez, J. I. Jung, K. K. Cowansage, K. Deinhardt, M. V. Chao, T. Abel, and E. Klann. 2012. Reversal of impaired hippocampal long-term potentiation and contextual fear memory deficits in Angelman syndrome model mice by ErbB inhibitors. *Biol Psychiatry* 72 (3):182-90.

Kenet, T. 2011. Sensory functions in ASD. In *The Neuropsychology of Autism*, edited by D. Fein. New York: Oxford University Press.

Kenet, T., R. C. Froemke, C. E. Schreiner, I. N. Pessah, and M. M. Merzenich. 2007. Perinatal exposure to a noncoplanar polychlorinated biphenyl alters tonotopy, receptive fields, and plasticity in rat primary auditory cortex. *Proc Natl Acad Sci U S A* 104 (18):7646-51.

Kern, J. K., D. A. Geier, J. B. Adams, and M. R. Geier. 2010. A biomarker of mercury body-burden correlated with diagnostic domain specific clinical symptoms of autism spectrum disorder. *Biometals* 23 (6):1043-51.

Kesari, K. K., S. Kumar, and J. Behari. 2011. 900-MHz microwave radiation promotes oxidation in rat brain. *Electromagn Biol Med* 30 (4):219-34.

Kesari, K. K., S. Kumar, and J. Behari. 2011. Effects of radiofrequency electromagnetic wave exposure from cellular phones on the reproductive pattern in male Wistar rats. *Appl Biochem Biotechnol* 164 (4):546-59.

Khaki, A. A., R. S. Tubbs, M. M. Shoja, J. S. Rad, A. Khaki, R. M. Farahani, S. Zarrintan, and T. C. Nag. 2006. The effects of an electromagnetic field on the boundary tissue of the seminiferous tubules of the rat: A light and transmission electron microscope study. *Folia Morphol (Warsz)* 65 (3):188-94.

King, M., and P. Bearman. 2009. Diagnostic change and the increased prevalence of autism. *Int J Epidemiol* 38 (5):1224-34.

Kinney, D. K., D. H. Barch, B. Chayka, S. Napoleon, and K. M. Munir. 2010. Environmental risk factors for autism: do they help cause de novo genetic mutations that contribute to the disorder? *Med Hypotheses* 74 (1):102-6.

Kittel, A., L. Siklos, G. Thuroczy, and Z. Somosy. 1996. Qualitative enzyme histochemistry and microanalysis reveals changes in ultrastructural distribution of calcium and calcium-activated ATPases after microwave irradiation of the medial habenula. *Acta Neuropathol* 92 (4):362-8.

Knox, S. S. 2010. From 'omics' to complex disease: a systems biology approach to gene-environment interactions in cancer. *Cancer Cell Int* 10:11.

Kocovska, E., E. Fernell, E. Billstedt, H. Minnis, and C. Gillberg. 2012. Vitamin D and autism: clinical review. *Res Dev Disabil* 33 (5):1541-50.

Kohane, I. S., A. McMurry, G. Weber, D. Macfadden, L. Rappaport, L. Kunkel, J. Bickel, N. Wattanasin, S. Spence, S. Murphy, and S. Churchill. 2012. The co-morbidity burden of children and young adults with autism spectrum disorders. *PLoS One* 7 (4):e33224.

Kong, S. W., C. D. Collins, Y. Shimizu-Motohashi, I. A. Holm, M. G. Campbell, I. H. Lee, S. J. Brewster, E. Hanson, H. K. Harris, K. R. Lowe, A. Saada, A. Mora, K. Madison, R. Hundley, J. Egan, J. McCarthy, A. Eran, M. Galdzicki, L. Rappaport, L. M. Kunkel, and I. S. Kohane. 2012. Characteristics and predictive value of blood transcriptome signature in males with autism spectrum disorders. *PLoS One* 7 (12):e49475.

Korson, M. 2007. Intermittent autism in patients with mitochondrial disease. In *Autism: Genes, Brains, Babies and Beyond*. Massachusetts General Hospital.

Kotagal, S., and E. Broomall. 2012. Sleep in children with autism spectrum disorder. *Pediatr Neurol* 47 (4):242-51.

Krakowiak, P., C. K. Walker, A. A. Bremer, A. S. Baker, S. Ozonoff, R. L. Hansen, and I. Hertz-Picciotto. 2012. Maternal metabolic conditions and risk for autism and other neurodevelopmental disorders. *Pediatrics* 129 (5):e1121-8.

Krey, J. F., and R. E. Dolmetsch. 2007. Molecular mechanisms of autism: a possible role for Ca2+ signaling. *Curr Opin Neurobiol* 17 (1):112-9.

Krueger, J. M., and F. Obal, Jr. 2003. Sleep function. *Front Biosci* 8:d511-9.

Krueger, J. M., D. M. Rector, S. Roy, H. P. Van Dongen, G. Belenky, and J. Panksepp. 2008. Sleep as a fundamental property of neuronal assemblies. *Nat Rev Neurosci* 9 (12):910-9.

Kues, H. A., J. C. Monahan, S. A. D'Anna, D. S. McLeod, G. A. Lutty, and S. Koslov. 1992. Increased sensitivity of the non-human primate eye to microwave radiation following ophthalmic drug pretreatment. *Bioelectromagnetics* 13 (5):379-93.

Kuhn, D. M., and R. E. Arthur, Jr. 1999. L-DOPA-quinone inactivates tryptophan hydroxylase and converts the enzyme to a redox-cycling quinoprotein. *Brain Res Mol Brain Res* 73 (1-2):78-84.

Kuhn, D. M., and R. Arthur, Jr. 1997. Molecular mechanism of the inactivation of tryptophan hydroxylase by nitric oxide: attack on critical sulfhydryls that spare the enzyme iron center. *J Neurosci* 17 (19):7245-51.

Kuhn, D. M., and T. J. Geddes. 1999. Peroxynitrite inactivates tryptophan hydroxylase via sulfhydryl oxidation. Coincident nitration of enzyme tyrosyl residues has minimal impact on catalytic activity. *J Biol Chem* 274 (42):29726-32.

Kuhn, D. M., C. E. Sykes, T. J. Geddes, K. L. Jaunarajs, and C. Bishop. 2011. Tryptophan hydroxylase 2 aggregates through disulfide cross-linking upon oxidation: possible link to serotonin deficits and non-motor symptoms in Parkinson's disease. *J Neurochem* 116 (3):426-37.

Kuhn, S, U Lott, A Kramer, and N. Kuster. 2012. Assessment of Human Exposure to Electromagnetic Radiation from Wireless Devices in Home and Office Environments.http://www.who.int/peh-emf/meetings/archive/bsw_kuster.pdf.

Kumaf, Girish. 2010 December. Report on Cell Tower Radiation Submitted to Secretary, DOT, Delhi. Electrical Engineering Dept, IIT Bombay, Powai, Mumai – 400 076, gkumar@ee.iitb.ac.in

Kwon, M. S., V. Vorobyev, S. Kannala, M. Laine, J. O. Rinne, T. Toivonen, J. Johansson, M. Teras, H. Lindholm, T. Alanko, and H. Hamalainen. 2011. GSM mobile phone radiation suppresses brain glucose metabolism. *J Cereb Blood Flow Metab* 31 (12):2293-301.

Lahijani, M. S., D. M. Tehrani, and E. Sabouri. 2009. Histopathological and ultrastructural studies on the effects of electromagnetic fields on the liver of preincubated white Leghorn chicken embryo. *Electromagn Biol Med* 28 (4):391-413.

Lai, H. 2007. Evidence for Genotoxic Effects - RFR and ELF DNA Damage (Section 6). In *The BioInitiative Report 2012: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF)*.

Lai, H. 2012. Evidence for Genotoxic Effects - RFR and ELF DNA Damage (Section 6). In *The BioInitiative Report 2012: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF)*.

Lai, H., and N. P. Singh. 1997. Melatonin and a spin-trap compound block radiofrequency electromagnetic radiation-induced DNA strand breaks in rat brain cells. *Bioelectromagnetics* 18 (6):446-54.

Lai, H., and N. P. Singh. 2004. Magnetic-field-induced DNA strand breaks in brain cells of the rat. *Environ Health Perspect* 112 (6):687-94.

Lai, M. C., M. V. Lombardo, B. Chakrabarti, S. A. Sadek, G. Pasco, S. J. Wheelwright, E. T. Bullmore, S. Baron-Cohen, and J. Suckling. 2010. A shift to randomness of brain oscillations in people with autism. *Biol Psychiatry* 68 (12):1092-9.

Lammers, K. M., R. Lu, J. Brownley, B. Lu, C. Gerard, K. Thomas, P. Rallabhandi, T. Shea-Donohue, A. Tamiz, S. Alkan, S. Netzel-Arnett, T. Antalis, S. N. Vogel, and A. Fasano. 2008. Gliadin induces an increase in intestinal permeability and zonulin release by binding to the chemokine receptor CXCR3. *Gastroenterology* 135 (1):194-204 e3.

Lampi, K. M., L. Lehtonen, P. L. Tran, A. Suominen, V. Lehti, P. N. Banerjee, M. Gissler, A. S. Brown, and A. Sourander. 2012. Risk of autism spectrum disorders in low birth weight and small for gestational age infants. *J Pediatr* 161 (5):830-6.

Landrigan, P. J. 2010. What causes autism? Exploring the environmental contribution. *Curr Opin Pediatr* 22 (2):219-25.

Lange, D. G., M. E. D'Antuono, R. R. Timm, T. K. Ishii, and J. M. Fujimoto. 1993. Differential response of the permeability of the rat liver canalicular membrane to sucrose and mannitol following in vivo acute single and multiple exposures to microwave radiation (2.45 GHz) and radiant-energy thermal stress. *Radiat Res* 134 (1):54-62.

Laurence, J. A., and S. H. Fatemi. 2005. Glial fibrillary acidic protein is elevated in superior frontal, parietal and cerebellar cortices of autistic subjects. *Cerebellum* 4 (3):206-10.

Lee, D. H., D. R. Jacobs, Jr., and M. Porta. 2009. Hypothesis: a unifying mechanism for nutrition and chemicals as lifelong modulators of DNA hypomethylation. *Environ Health Perspect* 117 (12):1799-802.

Leon, J., D. Acuna-Castroviejo, G. Escames, D. X. Tan, and R. J. Reiter. 2005. Melatonin mitigates mitochondrial malfunction. *J Pineal Res* 38 (1):1-9.

Leszczynski, D., S. Joenvaara, J. Reivinen, and R. Kuokka. 2002. Non-thermal activation of the hsp27/p38MAPK stress pathway by mobile phone radiation in human endothelial cells: molecular mechanism for cancer- and blood-brain barrier-related effects. *Differentiation* 70 (2-3):120-9.

Leszczynski, D., R. Nylund, S. Joenvaara, and J. Reivinen. 2004. Applicability of discovery science approach to determine biological effects of mobile phone radiation. *Proteomics* 4 (2):426-31.

Levitt, P., and D. B. Campbell. 2009. The genetic and neurobiologic compass points toward common signaling dysfunctions in autism spectrum disorders. *J Clin Invest* 119 (4):747-54.

Librizzi, L., F. Noe, A. Vezzani, M. de Curtis, and T. Ravizza. 2012. Seizure-induced brain-borne inflammation sustains seizure recurrence and blood-brain barrier damage. *Ann Neurol* 72 (1):82-90.

Liburdy, RP. 1995. Cellular studies and interaction mechanisms of extremely low frequency fields. *Radio Science* 20:179-203.

Limon-Pacheco, J. H., and M. E. Gonsebatt. 2010. The glutathione system and its regulation by neurohormone melatonin in the central nervous system. *Cent Nerv Syst Agents Med Chem* 10 (4):287-97.

Limperopoulos, C. 2009. Autism spectrum disorders in survivors of extreme prematurity. *Clin Perinatol* 36 (4):791-805, vi.

Limperopoulos, C. 2010. Extreme prematurity, cerebellar injury, and autism. *Semin Pediatr Neurol* 17 (1):25-9.

Limperopoulos, C., H. Bassan, N. R. Sullivan, J. S. Soul, R. L. Robertson, Jr., M. Moore, S. A. Ringer, J. J. Volpe, and A. J. du Plessis. 2008. Positive screening for autism in ex-preterm infants: prevalence and risk factors. *Pediatrics* 121 (4):758-65.

Lin-Liu, S., and W. R. Adey. 1982. Low frequency amplitude modulated microwave fields change calcium efflux rates from synaptosomes. *Bioelectromagnetics* 3 (3):309-22.

Lintas, C., R. Sacco, and A. M. Persico. 2012. Genome-wide expression studies in autism spectrum disorder, Rett syndrome, and Down syndrome. *Neurobiol Dis* 45 (1):57-68.

Litovitz, T. A., D. Krause, M. Penafiel, E. C. Elson, and J. M. Mullins. 1993. The role of coherence time in the effect of microwaves on ornithine decarboxylase activity. *Bioelectromagnetics* 14 (5):395-403.

Liu, Z. H., T. Huang, and C. B. Smith. 2012. Lithium reverses increased rates of cerebral protein synthesis in a mouse model of fragile X syndrome. *Neurobiol Dis* 45 (3):1145-52.

Lu, A. T., X. Dai, J. A. Martinez-Agosto, and R. M. Cantor. 2012. Support for calcium channel gene defects in autism spectrum disorders. *Mol Autism* 3 (1):18.

Lucarelli, S., T. Frediani, A. M. Zingoni, F. Ferruzzi, O. Giardini, F. Quintieri, M. Barbato, P. D'Eufemia, and E. Cardi. 1995. Food allergy and infantile autism. *Panminerva Med* 37 (3):137-41.

Luchetti, F., B. Canonico, M. Betti, M. Arcangeletti, F. Pilolli, M. Piroddi, L. Canesi, S. Papa, and F. Galli. 2010. Melatonin signaling and cell protection function. *FASEB J* 24 (10):3603-24.

Luukkonen, J., P. Hakulinen, J. Maki-Paakkanen, J. Juutilainen, and J. Naarala. 2009. Enhancement of chemically induced reactive oxygen species production and DNA damage in human SH-SY5Y neuroblastoma cells by 872 MHz radiofrequency radiation. *Mutat Res* 662 (1-2):54-8.

Magras, I. N., and T. D. Xenos. 1997. RF radiation-induced changes in the prenatal development of mice. *Bioelectromagnetics* 18 (6):455-61.

Main, P. A., M. T. Angley, C. E. O'Doherty, P. Thomas, and M. Fenech. 2012. The potential role of the antioxidant and detoxification properties of glutathione in autism spectrum disorders: a systematic review and meta-analysis. *Nutr Metab (Lond)* 9:35.

Majumder, D., and A. Mukherjee. 2011. A passage through systems biology to systems medicine: adoption of middle-out rational approaches towards the understanding of therapeutic outcomes in cancer. *Analyst* 136 (4):663-78.

Mak-Fan, K. M., D. Morris, J. Vidal, E. Anagnostou, W. Roberts, and M. J. Taylor. 2012. White matter and development in children with an autism spectrum disorder. *Autism*.

Malow, B. A. 2004. Sleep disorders, epilepsy, and autism. *Ment Retard Dev Disabil Res Rev* 10 (2):122-5.

Mancinelli, F., M. Caraglia, A. Abbruzzese, G. d'Ambrosio, R. Massa, and E. Bismuto. 2004. Non-thermal effects of electromagnetic fields at mobile phone frequency on the refolding of an intracellular protein: myoglobin. *J Cell Biochem* 93 (1):188-96.

Mandell, D. 2011. The heterogeneity in clinical presentation among individuals on the autism spectrum is a remarkably puzzling facet of this set of disorders. *Autism* 15 (3):259-61.

Marchi, N., Q. Teng, C. Ghosh, Q. Fan, M. T. Nguyen, N. K. Desai, H. Bawa, P. Rasmussen, T. K. Masaryk, and D. Janigro. 2010. Blood-brain barrier damage, but not parenchymal white blood cells, is a hallmark of seizure activity. *Brain Res* 1353:176-86.

Marco, E. J., L. B. Hinkley, S. S. Hill, and S. S. Nagarajan. 2011. Sensory processing in autism: a review of neurophysiologic findings. *Pediatr Res* 69 (5 Pt 2):48R-54R.

Marino, A. A., and S. Carrubba. 2009. The effects of mobile-phone electromagnetic fields on brain electrical activity: a critical analysis of the literature. *Electromagn Biol Med* 28 (3):250-74.

Marino, A. A., and C. Frilot, Jr. 2003. Comment on "proposed test for detection of nonlinear responses in biological preparations exposed to RF energy". *Bioelectromagnetics* 24 (1):70-2; discussion 73.

Marino, A. A., E. Nilsen, and C. Frilot. 2003. Nonlinear changes in brain electrical activity due to cell phone radiation. *Bioelectromagnetics* 24 (5):339-46.

Marino, A. A., R. M. Wolcott, R. Chervenak, F. Jourd'Heuil, E. Nilsen, and C. Frilot, 2nd. 2000. Nonlinear response of the immune system to power-frequency magnetic fields. *Am J Physiol Regul Integr Comp Physiol* 279 (3):R761-8.

Marino, A. A., R. M. Wolcott, R. Chervenak, F. Jourd'heuil, E. Nilsen, and C. Frilot, 2nd. 2001. Nonlinear determinism in the immune system. In vivo influence of electromagnetic fields on different functions of murine lymphocyte subpopulations. *Immunol Invest* 30 (4):313-34.

Marino, A. A., R. M. Wolcott, R. Chervenak, F. Jourd'heuil, E. Nilsen, and C. Frilot, 2nd. 2001. Nonlinear dynamical law governs magnetic field induced changes in lymphoid phenotype. *Bioelectromagnetics* 22 (8):529-46.

Marino, A. A., R. M. Wolcott, R. Chervenak, F. Jourd'heuil, E. Nilsen, C. Frilot, 2nd, and S. B. Pruett. 2001. Coincident nonlinear changes in the endocrine and immune systems due to low-frequency magnetic fields. *Neuroimmunomodulation* 9 (2):65-77.

Markkanen, A., J. Juutilainen, and J. Naarala. 2008. Pre-exposure to 50 Hz magnetic fields modifies menadione-induced DNA damage response in murine L929 cells. *Int J Radiat Biol* 84 (9):742-51.

Markova, E., L. Hillert, L. Malmgren, B. R. Persson, and I. Y. Belyaev. 2005. Microwaves from GSM mobile telephones affect 53BP1 and gamma-H2AX foci in human lymphocytes from hypersensitive and healthy persons. *Environ Health Perspect* 113 (9):1172-7.

Martin, L. A., P. Ashwood, D. Braunschweig, M. Cabanlit, J. Van de Water, and D. G. Amaral. 2008. Stereotypies and hyperactivity in rhesus monkeys exposed to IgG from mothers of children with autism. *Brain Behav Immun* 22 (6):806-16.

Maskey, D., H. J. Kim, H. G. Kim, and M. J. Kim. 2012. Calcium-binding proteins and GFAP immunoreactivity alterations in murine hippocampus after 1 month of exposure to 835 MHz radiofrequency at SAR values of 1.6 and 4.0 W/kg. *Neurosci Lett* 506 (2):292-6.

Maskey, D., M. Kim, B. Aryal, J. Pradhan, I. Y. Choi, K. S. Park, T. Son, S. Y. Hong, S. B. Kim, H. G. Kim, and M. J. Kim. 2010. Effect of 835 MHz radiofrequency radiation exposure on calcium binding proteins in the hippocampus of the mouse brain. *Brain Res* 1313:232-41.

Mathewson, K. J., I. E. Drmic, M. K. Jetha, S. E. Bryson, J. O. Goldberg, G. B. Hall, D. L. Santesso, S. J. Segalowitz, and L. A. Schmidt. 2011. Behavioral and cardiac responses

to emotional stroop in adults with autism spectrum disorders: influence of medication. *Autism Res* 4 (2):98-108.

Mathewson, K. J., M. K. Jetha, I. E. Drmic, S. E. Bryson, J. O. Goldberg, and L. A. Schmidt. 2012. Regional EEG alpha power, coherence, and behavioral symptomatology in autism spectrum disorder. *Clin Neurophysiol* 123 (9):1798-809.

Matson, M. L., J. L. Matson, and J. S. Beighley. 2011. Comorbidity of physical and motor problems in children with autism. *Res Dev Disabil* 32 (6):2304-8.

McKelvey, J. R. , R. Lambert, L. Mottron, and M. I. Shevell. 1995. Right-hemisphere dysfunction in Asperger's syndrome. *J Child Neurol* 10 (4):310-4.

Mehta, M. V., M. J. Gandal, and S. J. Siegel. 2011. mGluR5-antagonist mediated reversal of elevated stereotyped, repetitive behaviors in the VPA model of autism. *PLoS One* 6 (10):e26077.

Melke, J., H. Goubran Botros, P. Chaste, C. Betancur, G. Nygren, H. Anckarsater, M. Rastam, O. Stahlberg, I. C. Gillberg, R. Delorme, N. Chabane, M. C. Mouren-Simeoni, F. Fauchereau, C. M. Durand, F. Chevalier, X. Drouot, C. Collet, J. M. Launay, M. Leboyer, C. Gillberg, and T. Bourgeron. 2008. Abnormal melatonin synthesis in autism spectrum disorders. *Mol Psychiatry* 13 (1):90-8.

Mendez, M. A., J. Horder, J. Myers, S. Coghlan, P. Stokes, D. Erritzoe, O. Howes, A. Lingford-Hughes, D. Murphy, and D. Nutt. 2012. The brain GABA-benzodiazepine receptor alpha-5 subtype in autism spectrum disorder: A pilot [(11)C]Ro15-4513 positron emission tomography study. *Neuropharmacology*.

Meral, I., H. Mert, N. Mert, Y. Deger, I. Yoruk, A. Yetkin, and S. Keskin. 2007. Effects of 900-MHz electromagnetic field emitted from cellular phone on brain oxidative stress and some vitamin levels of guinea pigs. *Brain Res* 1169:120-4.

Mercadante, M. T., R. M. Cysneiros, J. S. Schwartzman, R. M. Arida, E. A. Cavalheiro, and F. A. Scorza. 2008. Neurogenesis in the amygdala: a new etiologic hypothesis of autism? *Med Hypotheses* 70 (2):352-7.

Mevissen, M., M. Haussler, and W. Loscher. 1999. Alterations in ornithine decarboxylase activity in the rat mammary gland after different periods of 50 Hz magnetic field exposure. *Bioelectromagnetics* 20 (6):338-46.

Mihaly, A., and B. Bozoky. 1984. Immunohistochemical localization of extravasated serum albumin in the hippocampus of human subjects with partial and generalized epilepsies and epileptiform convulsions. *Acta Neuropathol* 65 (1):25-34.

Ming, X. , T. P. Stein, M. Brimacombe, W. G. Johnson, G. H. Lambert, and G. C. Wagner. 2005. Increased excretion of a lipid peroxidation biomarker in autism. *Prostaglandins Leukot Essent Fatty Acids* 73 (5):379-384.

Ming, X., J. M. Bain, D. Smith, M. Brimacombe, G. Gold von-Simson, and F. B. Axelrod. 2011. Assessing autonomic dysfunction symptoms in children: a pilot study. *J Child Neurol* 26 (4):420-7.

Ming, X., P. O. Julu, M. Brimacombe, S. Connor, and M. L. Daniels. 2005. Reduced cardiac parasympathetic activity in children with autism. *Brain Dev* 27 (7):509-16.

Ming, X., T. P. Stein, V. Barnes, N. Rhodes, and L. Guo. 2012. Metabolic perturbance in autism spectrum disorders: a metabolomics study. *J Proteome Res* 11 (12):5856-62.

Mironova, G. D., M. Baumann, O. Kolomytkin, Z. Krasichkova, A. Berdimuratov, T. Sirota, I. Virtanen, and N. E. Saris. 1994. Purification of the channel component of the mitochondrial calcium uniporter and its reconstitution into planar lipid bilayers. *J Bioenerg Biomembr* 26 (2):231-8.

Morgan, J. T., G. Chana, I. Abramson, K. Semendeferi, E. Courchesne, and I. P. Everall. 2012. Abnormal microglial-neuronal spatial organization in the dorsolateral prefrontal cortex in autism. *Brain Res* 1456:72-81.

Mostafa, G. A., E. S. El-Hadidi, D. H. Hewedi, and M. M. Abdou. 2010. Oxidative stress in Egyptian children with autism: relation to autoimmunity. *J Neuroimmunol* 219 (1-2):114-8.

Mottron, L. 2004. Matching strategies in cognitive research with individuals with high-functioning autism: current practices, instrument biases, and recommendations. *J Autism Dev Disord* 34 (1):19-27.

Mottron, L., M. Dawson, I. Soulieres, B. Hubert, and J. Burack. 2006. Enhanced perceptual functioning in autism: an update, and eight principles of autistic perception. *J Autism Dev Disord* 36 (1):27-43.

Moustafa, Y. M., R. M. Moustafa, A. Belacy, S. H. Abou-El-Ela, and F. M. Ali. 2001. Effects of acute exposure to the radiofrequency fields of cellular phones on plasma lipid peroxide and antioxidase activities in human erythrocytes. *J Pharm Biomed Anal* 26 (4):605-8.

Muller, R. A. 2008. From loci to networks and back again: anomalies in the study of autism. *Ann N Y Acad Sci* 1145:300-15.

Muller, R. A., N. Kleinhans, N. Kemmotsu, K. Pierce, and E. Courchesne. 2003. Abnormal variability and distribution of functional maps in autism: an FMRI study of visuomotor learning. *Am J Psychiatry* 160 (10):1847-62.

Muller, R. A., P. Shih, B. Keehn, J. R. Deyoe, K. M. Leyden, and D. K. Shukla. 2011. Underconnected, but how? A survey of functional connectivity MRI studies in autism spectrum disorders. *Cereb Cortex* 21 (10):2233-43.

Murias, M., J. M. Swanson, and R. Srinivasan. 2007. Functional connectivity of frontal cortex in healthy and ADHD children reflected in EEG coherence. *Cereb Cortex* 17 (8):1788-99.

Murias, M., S. J. Webb, J. Greenson, and G. Dawson. 2007. Resting state cortical connectivity reflected in EEG coherence in individuals with autism. *Biol Psychiatry* 62 (3):270-3.

Napolioni, V., A. M. Persico, V. Porcelli, and L. Palmieri. 2011. The mitochondrial aspartate/glutamate carrier AGC1 and calcium homeostasis: physiological links and abnormalities in autism. *Mol Neurobiol* 44 (1):83-92.

Narayanan, A., C. A. White, S. Saklayen, M. J. Scaduto, A. L. Carpenter, A. Abduljalil, P. Schmalbrock, and D. Q. Beversdorf. 2010. Effect of propranolol on functional connectivity in autism spectrum disorder--a pilot study. *Brain Imaging Behav* 4 (2):189-97.

Naviaux, R. K. 2012. Oxidative shielding or oxidative stress? *J Pharmacol Exp Ther* 342 (3):608-18.

Neale, B. M., Y. Kou, L. Liu, A. Ma'ayan, K. E. Samocha, A. Sabo, C. F. Lin, C. Stevens, L. S. Wang, V. Makarov, P. Polak, S. Yoon, J. Maguire, E. L. Crawford, N. G. Campbell, E. T. Geller, O. Valladares, C. Schafer, H. Liu, T. Zhao, G. Cai, J. Lihm, R. Dannenfelser, O. Jabado, Z. Peralta, U. Nagaswamy, D. Muzny, J. G. Reid, I. Newsham, Y. Wu, L. Lewis, Y. Han, B. F. Voight, E. Lim, E. Rossin, A. Kirby, J. Flannick, M. Fromer, K. Shakir, T. Fennell, K. Garimella, E. Banks, R. Poplin, S. Gabriel, M. DePristo, J. R. Wimbish, B. E. Boone, S. E. Levy, C. Betancur, S. Sunyaev, E. Boerwinkle, J. D. Buxbaum, E. H. Cook, Jr., B. Devlin, R. A. Gibbs, K. Roeder, G. D. Schellenberg, J. S. Sutcliffe, and M. J. Daly. 2012. Patterns and rates of exonic de novo mutations in autism spectrum disorders. *Nature* 485 (7397):242-5.

Nesin, V., A. M. Bowman, S. Xiao, and A. G. Pakhomov. 2012. Cell permeabilization and inhibition of voltage-gated Ca(2+) and Na(+) channel currents by nanosecond pulsed electric field. *Bioelectromagnetics* 33 (5):394-404.

Nikolov, R. N., K. E. Bearss, J. Lettinga, C. Erickson, M. Rodowski, M. G. Aman, J. T. McCracken, C. J. McDougle, E. Tierney, B. Vitiello, L. E. Arnold, B. Shah, D. J. Posey, L. Ritz, and L. Scahill. 2009. Gastrointestinal symptoms in a sample of children with pervasive developmental disorders. *J Autism Dev Disord* 39 (3):405-13.

Nittby, H., A. Brun, J. Eberhardt, L. Malmgren, B. R. Persson, and L. G. Salford. 2009. Increased blood-brain barrier permeability in mammalian brain 7 days after exposure to the radiation from a GSM-900 mobile phone. *Pathophysiology* 16 (2-3):103-12.

Nittby, H., G. Grafstrom, J. L. Eberhardt, L. Malmgren, A. Brun, B. R. Persson, and L. G. Salford. 2008. Radiofrequency and extremely low-frequency electromagnetic field effects on the blood-brain barrier. *Electromagn Biol Med* 27 (2):103-26.

Nordahl, C. W., R. Scholz, X. Yang, M. H. Buonocore, T. Simon, S. Rogers, and D. G. Amaral. 2012. Increased rate of amygdala growth in children aged 2 to 4 years with autism spectrum disorders: a longitudinal study. *Arch Gen Psychiatry* 69 (1):53-61.

O'Roak, B. J., L. Vives, S. Girirajan, E. Karakoc, N. Krumm, B. P. Coe, R. Levy, A. Ko, C. Lee, J. D. Smith, E. H. Turner, I. B. Stanaway, B. Vernot, M. Malig, C. Baker, B. Reilly, J. M. Akey, E. Borenstein, M. J. Rieder, D. A. Nickerson, R. Bernier, J. Shendure, and E. E. Eichler. 2012. Sporadic autism exomes reveal a highly interconnected protein network of de novo mutations. *Nature* 485 (7397):246-50.

Oberman, L. M. 2012. mGluR antagonists and GABA agonists as novel pharmacological agents for the treatment of autism spectrum disorders. *Expert Opin Investig Drugs* 21 (12):1819-25.

Ohnishi, T. , H. Matsuda, T. Hashimoto, T. Kunihiro, M. Nishikawa, T. Uema, and M. Sasaki. 2000. Abnormal regional cerebral blood flow in childhood autism. *Brain* 123 (Pt 9):1838-44.

Oktem, F., F. Ozguner, H. Mollaoglu, A. Koyu, and E. Uz. 2005. Oxidative damage in the kidney induced by 900-MHz-emitted mobile phone: protection by melatonin. *Arch Med Res* 36 (4):350-5.

Onore, C. E., C. W. Nordahl, G. S. Young, J. A. Van de Water, S. J. Rogers, and P. Ashwood. 2012. Levels of soluble platelet endothelial cell adhesion molecule-1 and p-selectin are decreased in children with autism spectrum disorder. *Biol Psychiatry* 72 (12):1020-5.

Orekhova, E. V., T. A. Stroganova, G. Nygren, M. M. Tsetlin, I. N. Posikera, C. Gillberg, and M. Elam. 2007. Excess of high frequency electroencephalogram oscillations in boys with autism. *Biol Psychiatry* 62 (9):1022-9.

Otitoloju, A. A., I. A. Obe, O. A. Adewale, O. A. Otubanjo, and V. O. Osunkalu. 2010. Preliminary study on the induction of sperm head abnormalities in mice, Mus musculus, exposed to radiofrequency radiations from global system for mobile communication base stations. *Bull Environ Contam Toxicol* 84 (1):51-4.

Otsuka, H., M. Harada, K. Mori, S. Hisaoka, and H. Nishitani. 1999. Brain metabolites in the hippocampus-amygdala region and cerebellum in autism: an 1H-MR spectroscopy study. *Neuroradiology* 41 (7):517-9.

Ozguner, F. 2006. Protective effects of melatonin and caffeic acid phenethyl ester against retinal oxidative stress in long-term use of mobile phone: A comparative study. *Molecular and Cellular Biochemistry* 282:83-88.

Ozguner, F., A. Altinbas, M. Ozaydin, A. Dogan, H. Vural, A. N. Kisioglu, G. Cesur, and N. G. Yildirim. 2005. Mobile phone-induced myocardial oxidative stress: protection by a novel antioxidant agent caffeic acid phenethyl ester. *Toxicol Ind Health* 21 (9):223-30.

Ozguner, F., G. Aydin, H. Mollaoglu, O. Gokalp, A. Koyu, and G. Cesur. 2004. Prevention of mobile phone induced skin tissue changes by melatonin in rat: an experimental study. *Toxicol Ind Health* 20 (6-10):133-9.

Ozguner, F., Y. Bardak, and S. Comlekci. 2006. Protective effects of melatonin and caffeic acid phenethyl ester against retinal oxidative stress in long-term use of mobile phone: a comparative study. *Mol Cell Biochem* 282 (1-2):83-8.

Ozgur, E., G. Guler, and N. Seyhan. 2010. Mobile phone radiation-induced free radical damage in the liver is inhibited by the antioxidants N-acetyl cysteine and epigallocatechin-gallate. *Int J Radiat Biol* 86 (11):935-45.

Padmini, E. 2010. Physiological adaptations of stressed fish to polluted environments: role of heat shock proteins. *Rev Environ Contam Toxicol* 206:1-27.

Pagan, C., H. G. Botros, K. Poirier, A. Dumaine, S. Jamain, S. Moreno, A. de Brouwer, H. Van Esch, R. Delorme, J. M. Launay, A. Tzschach, V. Kalscheuer, D. Lacombe, S. Briault, F. Laumonnier, M. Raynaud, B. W. van Bon, M. H. Willemsen, M. Leboyer, J. Chelly, and T. Bourgeron. 2011. Mutation screening of ASMT, the last enzyme of the melatonin pathway, in a large sample of patients with intellectual disability. *BMC Med Genet* 12:17.

Palfia, Z., Z. Somosy, and G. Rez. 2001. Tight junctional changes upon microwave and x-ray irradiation. *Acta Biol Hung* 52 (4):411-6.

Palmieri, L., V. Papaleo, V. Porcelli, P. Scarcia, L. Gaita, R. Sacco, J. Hager, F. Rousseau, P. Curatolo, B. Manzi, R. Militerni, C. Bravaccio, S. Trillo, C. Schneider, R. Melmed, M. Elia, C. Lenti, M. Saccani, T. Pascucci, S. Puglisi-Allegra, K. L. Reichelt, and A. M. Persico. 2010. Altered calcium homeostasis in autism-spectrum disorders: evidence from biochemical and genetic studies of the mitochondrial aspartate/glutamate carrier AGC1. *Mol Psychiatry* 15 (1):38-52.

Palmieri, L., and A. M. Persico. 2010. Mitochondrial dysfunction in autism spectrum disorders: cause or effect? *Biochim Biophys Acta* 1797 (6-7):1130-7.

Panagopoulos, D. J. 2012. Effect of microwave exposure on the ovarian development of Drosophila melanogaster. *Cell Biochem Biophys* 63 (2):121-32.

Parathath, S. R., S. Parathath, and S. E. Tsirka. 2006. Nitric oxide mediates neurodegeneration and breakdown of the blood-brain barrier in tPA-dependent excitotoxic injury in mice. *J Cell Sci* 119 (Pt 2):339-49.

Pasca, S. P., T. Portmann, I. Voineagu, M. Yazawa, A. Shcheglovitov, A. M. Pasca, B. Cord, T. D. Palmer, S. Chikahisa, S. Nishino, J. A. Bernstein, J. Hallmayer, D. H. Geschwind, and R. E. Dolmetsch. 2011. Using iPSC-derived neurons to uncover cellular phenotypes associated with Timothy syndrome. *Nat Med* 17 (12):1657-62.

Pascual, O., S. Ben Achour, P. Rostaing, A. Triller, and A. Bessis. 2012. Microglia activation triggers astrocyte-mediated modulation of excitatory neurotransmission. *Proc Natl Acad Sci U S A* 109 (4):E197-205.

Pastural, E., S. Ritchie, Y. Lu, W. Jin, A. Kavianpour, K. Khine Su-Myat, D. Heath, P. L. Wood, M. Fisk, and D. B. Goodenowe. 2009. Novel plasma phospholipid biomarkers of

autism: mitochondrial dysfunction as a putative causative mechanism. *Prostaglandins Leukot Essent Fatty Acids* 81 (4):253-64.

Patterson, P. H. 2009. Immune involvement in schizophrenia and autism: etiology, pathology and animal models. *Behav Brain Res* 204 (2):313-21.

Patterson, P. H. 2011. Maternal infection and immune involvement in autism. *Trends Mol Med.*

Patterson, P. H. 2012. Maternal infection and autism. *Brain Behav Immun* 26 (3):393.

Paul, C., M. Nagano, and B. Robaire. 2011. Aging results in differential regulation of DNA repair pathways in pachytene spermatocytes in the Brown Norway rat. *Biol Reprod* 85 (6):1269-78.

Paylor, R., L. A. Yuva-Paylor, D. L. Nelson, and C. M. Spencer. 2008. Reversal of sensorimotor gating abnormalities in Fmr1 knockout mice carrying a human Fmr1 transgene. *Behav Neurosci* 122 (6):1371-7.

Pecorelli, A., S. Leoncini, C. De Felice, C. Signorini, C. Cerrone, G. Valacchi, L. Ciccoli, and J. Hayek. 2012. Non-protein-bound iron and 4-hydroxynonenal protein adducts in classic autism. *Brain Dev.*

Pelphrey, K. A., S. Shultz, C. M. Hudac, and B. C. Vander Wyk. 2011. Research review: Constraining heterogeneity: the social brain and its development in autism spectrum disorder. *J Child Psychol Psychiatry* 52 (6):631-44.

Penafiel, L. M., T. Litovitz, D. Krause, A. Desta, and J. M. Mullins. 1997. Role of modulation on the effect of microwaves on ornithine decarboxylase activity in L929 cells. *Bioelectromagnetics* 18 (2):132-41.

Peng, T. I., and M. J. Jou. 2010. Oxidative stress caused by mitochondrial calcium overload. *Ann N Y Acad Sci* 1201:183-8.

Perreault, A., R. Gurnsey, M. Dawson, L. Mottron, and A. Bertone. 2011. Increased sensitivity to mirror symmetry in autism. *PLoS One* 6 (4):e19519.

Perry, W., A. Minassian, B. Lopez, L. Maron, and A. Lincoln. 2007. Sensorimotor gating deficits in adults with autism. *Biol Psychiatry* 61 (4):482-6.

Persico, A. M., J. Van de Water, and C. A. Pardo. 2012. Autism: where genetics meets the immune system. *Autism Res Treat* 2012:486359.

Pessah, I.N., and P.J. Lein. 2008. *Evidence for Environmental Susceptibility in Autism: What We Need to Know About Gene x Environment Interactions*. Edited by A. Zimmerman, *Autism: Current Theories and Models*: Humana.

Phelan, A. M., D. G. Lange, H. A. Kues, and G. A. Lutty. 1992. Modification of membrane fluidity in melanin-containing cells by low-level microwave radiation. *Bioelectromagnetics* 13 (2):131-46.

Phillips, J. L., N. P. Singh, and H. Lai. 2009. Electromagnetic fields and DNA damage. *Pathophysiology* 16 (2-3):79-88.

Pieczenik, S. R., and J. Neustadt. 2007. Mitochondrial dysfunction and molecular pathways of disease. *Exp Mol Pathol* 83 (1):84-92.

Pinto-Martin, J. A., S. E. Levy, J. F. Feldman, J. M. Lorenz, N. Paneth, and A. H. Whitaker. 2011. Prevalence of autism spectrum disorder in adolescents born weighing <2000 grams. *Pediatrics* 128 (5):883-91.

Piton, A., L. Jouan, D. Rochefort, S. Dobrzeniecka, K. Lachapelle, P. A. Dion, J. Gauthier, and G. A. Rouleau. 2012. Analysis of the effects of rare variants on splicing identifies alterations in GABA(A) receptor genes in autism spectrum disorder individuals. *Eur J Hum Genet.*

Polleux, F., and J. M. Lauder. 2004. Toward a developmental neurobiology of autism. *Ment Retard Dev Disabil Res Rev* 10 (4):303-17.

Ragbetli, M. C., A. Aydinlioglu, N. Koyun, C. Ragbetli, S. Bektas, and S. Ozdemir. 2010. The effect of mobile phone on the number of Purkinje cells: a stereological study. *Int J Radiat Biol* 86 (7):548-54.

Rapin, I., and R. Katzman. 1998. Neurobiology of autism. *Ann Neurol* 43 (1):7-14.

Reardon, M. *Emerging markets fuel cell phone growth* 2007. Available from http://news.cnet.com/Emerging-markets-fuel-cell-phone-growth/2100-1039_3-6159491.html.

REFLEX. 31 May 2004. Final Report. REFLEX (Risk Evaluation of Potential Environmental Hazards From Low-Energy Electromagnetic Field Exposure Using Sensitive in vitro Methods. Key Action 4 "Environment and Health". Quality of Life and Management of Living Resources. European Union.

Ring, H., M. Woodbury-Smith, P. Watson, S. Wheelwright, and S. Baron-Cohen. 2008. Clinical heterogeneity among people with high functioning autism spectrum conditions: evidence favouring a continuous severity gradient. *Behav Brain Funct* 4:11.

Rippon, G., J. Brock, C. Brown, and J. Boucher. 2007. Disordered connectivity in the autistic brain: challenges for the "new psychophysiology". *Int J Psychophysiol* 63 (2):164-72.

Roberts, E. M., P. B. English, J. K. Grether, G. C. Windham, L. Somberg, and C. Wolff. 2007. Maternal residence near agricultural pesticide applications and autism spectrum disorders among children in the California Central Valley. *Environ Health Perspect. 2007 Oct;115(10):1482-9.*

Roberts, R. A., R. A. Smith, S. Safe, C. Szabo, R. B. Tjalkens, and F. M. Robertson. 2010. Toxicological and pathophysiological roles of reactive oxygen and nitrogen species. *Toxicology* 276 (2):85-94.

Robertson, M. A., D. L. Sigalet, J. J. Holst, J. B. Meddings, J. Wood, and K. A. Sharkey. 2008. Intestinal permeability and glucagon-like peptide-2 in children with autism: a controlled pilot study. *J Autism Dev Disord* 38 (6):1066-71.

Robledo, J., A. M. Donnellan, and K. Strandt-Conroy. 2012. An exploration of sensory and movement differences from the perspective of individuals with autism. *Front Integr Neurosci* 6:107.

Roche, R. *CTIA Wireless Industry Indices Report: Now Available* 2012 Available from http://blog.ctia.org/2012/05/17/indices-report/#comment-41703.

Rodgers, K. M., M. R. Hutchinson, A. Northcutt, S. F. Maier, L. R. Watkins, and D. S. Barth. 2009. The cortical innate immune response increases local neuronal excitability leading to seizures. *Brain* 132 (Pt 9):2478-86.

Rojas, D. C., K. Maharajh, P. Teale, and S. J. Rogers. 2008. Reduced neural synchronization of gamma-band MEG oscillations in first-degree relatives of children with autism. *BMC Psychiatry* 8:66.

Rose, S., S. Melnyk, O. Pavliv, S. Bai, T. G. Nick, R. E. Frye, and S. J. James. 2012. Evidence of oxidative damage and inflammation associated with low glutathione redox status in the autism brain. *Transl Psychiatry* 2:e134.

Rose, S., S. Melnyk, T. A. Trusty, O. Pavliv, L. Seidel, J. Li, T. Nick, and S. J. James. 2012. Intracellular and extracellular redox status and free radical generation in primary immune cells from children with autism. *Autism Res Treat* 2012:986519.

Rossignol, D. A., and R. E. Frye. 2011. Melatonin in autism spectrum disorders: a systematic review and meta-analysis. *Dev Med Child Neurol* 53 (9):783-92.

Rossignol, D. A., and R. E. Frye. 2011. Mitochondrial dysfunction in autism spectrum disorders: a systematic review and meta-analysis. *Mol Psychiatry*.

Rossignol, D. A., and R. E. Frye. 2011. Mitochondrial dysfunction in autism spectrum disorders: a systematic review and meta-analysis. *Mol Psychiatry*:1-25.

Rossignol, D. A., and R. E. Frye. 2011. A review of research trends in physiological abnormalities in autism spectrum disorders: immune dysregulation, inflammation, oxidative stress, mitochondrial dysfunction and environmental toxicant exposures. *Mol Psychiatry*.

Rotschafer, S. E., M. S. Trujillo, L. E. Dansie, I. M. Ethell, and K. A. Razak. 2012. Minocycline treatment reverses ultrasonic vocalization production deficit in a mouse model of Fragile X Syndrome. *Brain Res* 1439:7-14.

Rubenstein, J. L., and M. M. Merzenich. 2003. Model of autism: increased ratio of excitation/inhibition in key neural systems. *Genes Brain Behav* 2 (5):255-67.

Ruediger, H. W. 2009. Genotoxic effects of radiofrequency electromagnetic fields. *Pathophysiology* 16 (2-3):89-102.

Ryu, Y. H. , J. D. Lee, P. H. Yoon, D. I. Kim, H. B. Lee, and Y. J. Shin. 1999. Perfusion impairments in infantile autism on technetium-99m ethyl cysteinate dimer brain single-photon emission tomography: comparison with findings on magnetic resonance imaging. *Eur J Nucl Med* 26 (3):253-9.

Sacco, R., P. Curatolo, B. Manzi, R. Militerni, C. Bravaccio, A. Frolli, C. Lenti, M. Saccani, M. Elia, K. L. Reichelt, T. Pascucci, S. Puglisi-Allegra, and A. M. Persico. 2010. Principal pathogenetic components and biological endophenotypes in autism spectrum disorders. *Autism Res* 3 (5):237-52.

Sage, C., and D. O. Carpenter. 2009. Public health implications of wireless technologies. *Pathophysiology* 16 (2-3):233-46.

Sage, C., D. O. Carpenter, and Eds. 2012. The BioInitiative Report 2012: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF).

Sage, C., and DO Carpenter. 2012. Key Scientific Evidence and Public Health Policy Recommendations. In *The BioInitiative Report 2012: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF)*.

Sage, C., O. Johansson, and S. A. Sage. 2007. Personal digital assistant (PDA) cell phone units produce elevated extremely-low frequency electromagnetic field emissions. *Bioelectromagnetics* 28 (5):386-92.

Sajdel-Sulkowska, E. M., M. Xu, and N. Koibuchi. 2009. Increase in cerebellar neurotrophin-3 and oxidative stress markers in autism. *Cerebellum* 8 (3):366-72.

Salama, N., T. Kishimoto, H. O. Kanayama, and S. Kagawa. 2009. The mobile phone decreases fructose but not citrate in rabbit semen: a longitudinal study. *Syst Biol Reprod Med* 55 (5-6):181-7.

Salford, L. G., A. E. Brun, J. L. Eberhardt, L. Malmgren, and B. R. Persson. 2003. Nerve cell damage in mammalian brain after exposure to microwaves from GSM mobile phones. *Environ Health Perspect* 111 (7):881-3; discussion A408.

Salford, L. G., A. Brun, G. Grafstrom, J. Eberhardt, L. Malmgren, and BRR Persson. 2007. Non-thermal effects of EMF upon the mammalian brain: the Lund experience. *Environmentalist*:493-500.

Salford, L. G., A. Brun, K. Sturesson, J. L. Eberhardt, and B. R. Persson. 1994. Permeability of the blood-brain barrier induced by 915 MHz electromagnetic radiation, continuous wave and modulated at 8, 16, 50, and 200 Hz. *Microsc Res Tech* 27 (6):535-42.

Salford, L. G., J. Eberhardt, L. Malmgren, and BRR Perrson. 1992. Electromagnetic field-induced permeability of the blood-brain barrier shown by immunohistochemical methods. In *Interaction mechanism of low-level electromagnetic fields, living systems*. Oxford: Oxford Univerfsity Press.

Salford, L. G., H. Nittby, and B. R. Persson. 2012. Effects of EMF from Wireless Communication Upon the Blood-Brain Barrier. In *BioInitiative 2012: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF*, edited by C. Sage.

Samson, F., L. Mottron, I. Soulieres, and T. A. Zeffiro. 2011. Enhanced visual functioning in autism: An ALE meta-analysis. *Hum Brain Mapp.*

Sanders, S. J., M. T. Murtha, A. R. Gupta, J. D. Murdoch, M. J. Raubeson, A. J. Willsey, A. G. Ercan-Sencicek, N. M. DiLullo, N. N. Parikshak, J. L. Stein, M. F. Walker, G. T. Ober, N. A. Teran, Y. Song, P. El-Fishawy, R. C. Murtha, M. Choi, J. D. Overton, R. D. Bjornson, N. J. Carriero, K. A. Meyer, K. Bilguvar, S. M. Mane, N. Sestan, R. P. Lifton, M. Gunel, K. Roeder, D. H. Geschwind, B. Devlin, and M. W. State. 2012. De novo mutations revealed by whole-exome sequencing are strongly associated with autism. *Nature* 485 (7397):237-41.

Sandler, R. H., S. M. Finegold, E. R. Bolte, C. P. Buchanan, A. P. Maxwell, M. L. Vaisanen, M. N. Nelson, and H. M. Wexler. 2000. Short-term benefit from oral vancomycin treatment of regressive-onset autism. *J Child Neurol* 15 (7):429-35.

Sapone, A., K. M. Lammers, V. Casolaro, M. Cammarota, M. T. Giuliano, M. De Rosa, R. Stefanile, G. Mazzarella, C. Tolone, M. I. Russo, P. Esposito, F. Ferraraccio, M. Carteni, G. Riegler, L. de Magistris, and A. Fasano. 2011. Divergence of gut permeability and mucosal immune gene expression in two gluten-associated conditions: celiac disease and gluten sensitivity. *BMC Med* 9:23.

Sato, A., S. Kasai, T. Kobayashi, Y. Takamatsu, O. Hino, K. Ikeda, and M. Mizuguchi. 2012. Rapamycin reverses impaired social interaction in mouse models of tuberous sclerosis complex. *Nat Commun* 3:1292.

Saunders, R. D., and J. G. Jefferys. 2007. A neurobiological basis for ELF guidelines. *Health Phys* 92 (6):596-603.

Schmidt, R. J., R. L. Hansen, J. Hartiala, H. Allayee, L. C. Schmidt, D. J. Tancredi, F. Tassone, and I. Hertz-Picciotto. 2011. Prenatal Vitamins, One-carbon Metabolism Gene Variants, and Risk for Autism. *Epidemiology* 22 (4):476-485.

Schulkin, J. 2007. Autism and the amygdala: an endocrine hypothesis. *Brain Cogn* 65 (1):87-99.

Schumann, C. M., and D. G. Amaral. 2006. Stereological analysis of amygdala neuron number in autism. *J Neurosci* 26 (29):7674-9.

Schumann, C. M., C. C. Barnes, C. Lord, and E. Courchesne. 2009. Amygdala enlargement in toddlers with autism related to severity of social and communication impairments. *Biol Psychiatry* 66 (10):942-9.

Schwarz, J. M., and S. D. Bilbo. 2012. Sex, glia, and development: interactions in health and disease. *Horm Behav* 62 (3):243-53.

Seitz, H., D. Stinner, T. Eikmann, C. Herr, and M. Roosli. 2005. Electromagnetic hypersensitivity (EHS) and subjective health complaints associated with electromagnetic fields of mobile phone communication--a literature review published between 2000 and 2004. *Sci Total Environ* 349 (1-3):45-55.

Shapiro, M., G. Akiri, C. Chin, J. P. Wisnivesky, M. B. Beasley, T. S. Weiser, S. J. Swanson, and S. A. Aaronson. 2012. Wnt Pathway Activation Predicts Increased Risk of Tumor Recurrence in Patients With Stage I Nonsmall Cell Lung Cancer. *Ann Surg.*

Shelton, J. F., I. Hertz-Picciotto, and I. N. Pessah. 2012. Tipping the balance of autism risk: potential mechanisms linking pesticides and autism. *Environ Health Perspect* 120 (7):944-51.

Shi, L., S. H. Fatemi, R. W. Sidwell, and P. H. Patterson. 2003. Maternal influenza infection causes marked behavioral and pharmacological changes in the offspring. *J Neurosci* 23 (1):297-302.

Shi, L., S. E. Smith, N. Malkova, D. Tse, Y. Su, and P. H. Patterson. 2009. Activation of the maternal immune system alters cerebellar development in the offspring. *Brain Behav Immun* 23 (1):116-23.

Sieb, R. A. 2004. The emergence of consciousness. *Med Hypotheses* 63 (5):900-4.

Silberman, S. 2001. The Geek Syndrome. *Wired*, 2001 December.

Silva, M. A., J. Jury, Y. Sanz, M. Wiepjes, X. Huang, J. A. Murray, C. S. David, A. Fasano, and E. F. Verdu. 2012. Increased bacterial translocation in gluten-sensitive mice is independent of small intestinal paracellular permeability defect. *Dig Dis Sci* 57 (1):38-47.

Simpson, M., M. Mojibian, K. Barriga, F. W. Scott, A. Fasano, M. Rewers, and J. M. Norris. 2009. An exploration of Glo-3A antibody levels in children at increased risk for type 1 diabetes mellitus. *Pediatr Diabetes* 10 (8):563-72.

Singh, V. K., R. Warren, R. Averett, and M. Ghaziuddin. 1997. Circulating autoantibodies to neuronal and glial filament proteins in autism. *Pediatr Neurol* 17 (1):88-90.

Smith, L. B., and E. Thelen. 2003. Development as a dynamic system. *Trends Cogn Sci* 7 (8):343-348.

Smith, S. E., J. Li, K. Garbett, K. Mirnics, and P. H. Patterson. 2007. Maternal immune activation alters fetal brain development through interleukin-6. *J Neurosci* 27 (40):10695-702.

Sokolovic, D., B. Djindjic, J. Nikolic, G. Bjelakovic, D. Pavlovic, G. Kocic, D. Krstic, T. Cvetkovic, and V. Pavlovic. 2008. Melatonin reduces oxidative stress induced by chronic exposure of microwave radiation from mobile phones in rat brain. *J Radiat Res* 49 (6):579-86.

Somosy, Z., G. Thuroczy, and J. Kovacs. 1993. Effects of modulated and continuous microwave irradiation on pyroantimonate precipitable calcium content in junctional complex of mouse small intestine. *Scanning Microsc* 7 (4):1255-61.

Soulieres, I., M. Dawson, M. A. Gernsbacher, and L. Mottron. 2011. The level and nature of autistic intelligence II: what about Asperger syndrome? *PLoS One* 6 (9):e25372.

Soulieres, I., M. Dawson, F. Samson, E. B. Barbeau, C. P. Sahyoun, G. E. Strangman, T. A. Zeffiro, and L. Mottron. 2009. Enhanced visual processing contributes to matrix reasoning in autism. *Hum Brain Mapp* 30 (12):4082-107.

Soulieres, I., B. Hubert, N. Rouleau, L. Gagnon, P. Tremblay, X. Seron, and L. Mottron. 2010. Superior estimation abilities in two autistic spectrum children. *Cogn Neuropsychol* 27 (3):261-76.

Soulieres, I., T. A. Zeffiro, M. L. Girard, and L. Mottron. 2011. Enhanced mental image mapping in autism. *Neuropsychologia* 49 (5):848-57.

Soumiya, H., H. Fukumitsu, and S. Furukawa. 2011. Prenatal immune challenge compromises the normal course of neurogenesis during development of the mouse cerebral cortex. *J Neurosci Res* 89 (10):1575-85.

Souza, N. C., J. N. Mendonca, G. V. Portari, A. A. Jordao Junior, J. S. Marchini, and P. G. Chiarello. 2012. Intestinal permeability and nutritional status in developmental disorders. *Altern Ther Health Med* 18 (2):19-24.

St-Pierre, L. S., G. H. Parker, G. A. Bubenik, and M. A. Persinger. 2007. Enhanced mortality of rat pups following inductions of epileptic seizures after perinatal exposures to 5 nT, 7 Hz magnetic fields. *Life Sci* 81 (21-22):1496-500.

Stamou, M., K. M. Streifel, P. E. Goines, and P. J. Lein. 2012. Neuronal connectivity as a convergent target of gene-environment interactions that confer risk for Autism Spectrum Disorders. *Neurotoxicol Teratol.*

Starkstein, S. E. , S. Vazquez, D. Vrancic, V. Nanclares, F. Manes, J. Piven, and C. Plebst. 2000. SPECT findings in mentally retarded autistic individuals. *J Neuropsychiatry Clin Neurosci* 12 (3):370-5.

Strogatz, S. 2003. *Sync: The Emerging Science of Spontaneous Order.* New York: Hyperion.

Strogatz, S. H. 2001. Exploring complex networks. *Nature* 410 (6825):268-76.

Sun, L., C. Grutzner, S. Bolte, M. Wibral, T. Tozman, S. Schlitt, F. Poustka, W. Singer, C. M. Freitag, and P. J. Uhlhaas. 2012. Impaired gamma-band activity during perceptual organization in adults with autism spectrum disorders: evidence for dysfunctional network activity in frontal-posterior cortices. *J Neurosci* 32 (28):9563-73.

Sundaram, S. K., A. Kumar, M. I. Makki, M. E. Behen, H. T. Chugani, and D. C. Chugani. 2008. Diffusion tensor imaging of frontal lobe in autism spectrum disorder. *Cereb Cortex* 18 (11):2659-65.

Suvrathan, A., C. A. Hoeffer, H. Wong, E. Klann, and S. Chattarji. 2010. Characterization and reversal of synaptic defects in the amygdala in a mouse model of fragile X syndrome. *Proc Natl Acad Sci U S A* 107 (25):11591-6.

Suzuki, K., G Sugihara, Y Ouchi, K. Nakamura, and M Futatsubashi. 2013. Microglial Activation in Young Adults With Autism Spectrum Disorder. *JAMA Psychiatry* 70 (1):49-58.

Szmigielski, S., A. Bortkiewicz, E. Gadzicka, M. Zmyslony, and R. Kubacki. 1998. Alteration of diurnal rhythms of blood pressure and heart rate to workers exposed to radiofrequency electromagnetic fields. *Blood Press Monit* 3 (6):323-30.

Takeshita, Y., and R. M. Ransohoff. 2012. Inflammatory cell trafficking across the blood-brain barrier: chemokine regulation and in vitro models. *Immunol Rev* 248 (1):228-39.

Tasker, J. G., S. H. Oliet, J. S. Bains, C. H. Brown, and J. E. Stern. 2012. Glial regulation of neuronal function: from synapse to systems physiology. *J Neuroendocrinol* 24 (4):566-76.

Tattersall, J. E., I. R. Scott, S. J. Wood, J. J. Nettell, M. K. Bevir, Z. Wang, N. P. Somasiri, and X. Chen. 2001. Effects of low intensity radiofrequency electromagnetic fields on electrical activity in rat hippocampal slices. *Brain Res* 904 (1):43-53.

Teixeira, A. L., and T. Barichello. 2012. Psychiatric syndromes secondary to central nervous system infection. *Rev Bras Psiquiatr* 34 (2):221.

Tetreault, N. A., A. Y. Hakeem, S. Jiang, B. A. Williams, E. Allman, B. J. Wold, and J. M. Allman. 2012. Microglia in the cerebral cortex in autism. *J Autism Dev Disord* 42 (12):2569-84.

Thar, R., and M. Kuhl. 2004. Propagation of electromagnetic radiation in mitochondria? *J Theor Biol* 230 (2):261-70.

Theoharides, T. C., A. Angelidou, K. D. Alysandratos, B. Zhang, S. Asadi, K. Francis, E. Toniato, and D. Kalogeromitros. 2010. Mast cell activation and autism. *Biochim Biophys Acta*.

Theoharides, T. C., A. Angelidou, K. D. Alysandratos, B. Zhang, S. Asadi, K. Francis, E. Toniato, and D. Kalogeromitros. 2012. Mast cell activation and autism. *Biochim Biophys Acta* 1822 (1):34-41.

Theoharides, T. C., and R. Doyle. 2008. Autism, gut-blood-brain barrier, and mast cells. *J Clin Psychopharmacol* 28 (5):479-83.

Thomas, R. H., M. M. Meeking, J. R. Mepham, L. Tichenoff, F. Possmayer, S. Liu, and D. F. MacFabe. 2012. The enteric bacterial metabolite propionic acid alters brain and plasma phospholipid molecular species: further development of a rodent model of autism spectrum disorders. *J Neuroinflammation* 9:153.

Tierney, A. L., L. Gabard-Durnam, V. Vogel-Farley, H. Tager-Flusberg, and C. A. Nelson. 2012. Developmental trajectories of resting EEG power: an endophenotype of autism spectrum disorder. *PLoS One* 7 (6):e39127.

Toichi, M., and Y. Kamio. 2003. Paradoxical autonomic response to mental tasks in autism. *J Autism Dev Disord* 33 (4):417-26.

Tombini, M., G. Pellegrino, P. Pasqualetti, G. Assenza, A. Benvenga, E. Fabrizio, and P. M. Rossini. 2012. Mobile phone emissions modulate brain excitability in patients with focal epilepsy. *Brain Stimul.*

Tore, F, PE dulou, E Haro, B Veyret, and P Aubineau. 2002. Effect of 2 h GSM-900 microwave exposures at 2.0, 0.5 and 0.12 W/kg on plasma protein extravasation in rat brain and dura mater. Paper read at Proceedings of the 24th annual meeting of the BEMS2002.

Tore, F, PE Dulou, E Hoaro, B Veyret, and P Aubineau. 2001. Two-hour exposure to 2-W/kg, 900-MHZ GSM microwaves induces plasma protein extravasation in rat brain and dura mater. Paper read at Proceedings of the 5th International congress of the EBEA, at Helsinki, Finland.

Travers, B. G., N. Adluru, C. Ennis, P. M. Tromp do, D. Destiche, S. Doran, E. D. Bigler, N. Lange, J. E. Lainhart, and A. L. Alexander. 2012. Diffusion tensor imaging in autism spectrum disorder: a review. *Autism Res* 5 (5):289-313.

Trikalinos, T. A., A. Karvouni, E. Zintzaras, T. Ylisaukko-oja, L. Peltonen, I. Jarvela, and J. P. Ioannidis. 2006. A heterogeneity-based genome search meta-analysis for autism-spectrum disorders. *Mol Psychiatry* 11 (1):29-36.

Truitt, W. A., T. J. Sajdyk, A. D. Dietrich, B. Oberlin, C. J. McDougle, and A. Shekhar. 2007. From anxiety to autism: spectrum of abnormal social behaviors modeled by progressive disruption of inhibitory neuronal function in the basolateral amygdala in Wistar rats. *Psychopharmacology (Berl)* 191 (1):107-18.

Tsaluchidu, S., M. Cocchi, L. Tonello, and B. K. Puri. 2008. Fatty acids and oxidative stress in psychiatric disorders. *BMC Psychiatry* 8 Suppl 1:S5.

Tuchman, R., and M. Cuccaro. 2011. Epilepsy and Autism: Neurodevelopmental Perspective. *Curr Neurol Neurosci Rep.*

van Vliet, E. A., S. da Costa Araujo, S. Redeker, R. van Schaik, E. Aronica, and J. A. Gorter. 2007. Blood-brain barrier leakage may lead to progression of temporal lobe epilepsy. *Brain* 130 (Pt 2):521-34.

Vardi, N., N. Freedman, H. Lester, J. M. Gomori, R. Chisin, B. Lerer, and O. Bonne. 2011. Hyperintensities on T2-weighted images in the basal ganglia of patients with major depression: cerebral perfusion and clinical implications. *Psychiatry Res* 192 (2):125-30.

Vargas, D.L. , C. Nascimbene, C. Krishnan, A.W. Zimmerman, and C.A. Pardo. 2005. Neuroglial activation and neuroinflammation in the brain of patients with autism. *Ann Neurol* 57 (1):67-81.

Varro, P., R. Szemerszky, G. Bardos, and I. Vilagi. 2009. Changes in synaptic efficacy and seizure susceptibility in rat brain slices following extremely low-frequency electromagnetic field exposure. *Bioelectromagnetics* 30 (8):631-40.

Vecchio, F., C. Babiloni, F. Ferreri, G. Curcio, R. Fini, C. Del Percio, and P. M. Rossini. 2007. Mobile phone emission modulates interhemispheric functional coupling of EEG alpha rhythms. *Eur J Neurosci* 25 (6):1908-13.

Vecchio, F., M. Tombini, P. Buffo, G. Assenza, G. Pellegrino, A. Benvenga, C. Babiloni, and P. M. Rossini. 2012. Mobile phone emission increases inter-hemispheric functional coupling of electroencephalographic alpha rhythms in epileptic patients. *Int J Psychophysiol* 84 (2):164-71.

Velizarov, S., P. Raskmark, and S. Kwee. 1999. The effects of radiofrequency fields on cell proliferation are non-thermal. *Bioelectrochem Bioenerg* 48 (1):177-80.

Verschaeve, L., P. Heikkinen, G. Verheyen, U. Van Gorp, F. Boonen, F. Vander Plaetse, A. Maes, T. Kumlin, J. Maki-Paakkanen, L. Puranen, and J. Juutilainen. 2006. Investigation of co-genotoxic effects of radiofrequency electromagnetic fields in vivo. *Radiat Res* 165 (5):598-607.

Vezzani, A., J. French, T. Bartfai, and T. Z. Baram. 2011. The role of inflammation in epilepsy. *Nat Rev Neurol* 7 (1):31-40.

Vinga, S., A. R. Neves, H. Santos, B. W. Brandt, and S. A. Kooijman. 2010. Subcellular metabolic organization in the context of dynamic energy budget and biochemical systems theories. *Philos Trans R Soc Lond B Biol Sci* 365 (1557):3429-42.

Visser, J., J. Rozing, A. Sapone, K. Lammers, and A. Fasano. 2009. Tight junctions, intestinal permeability, and autoimmunity: celiac disease and type 1 diabetes paradigms. *Ann N Y Acad Sci* 1165:195-205.

Voineagu, I., X. Wang, P. Johnston, J. K. Lowe, Y. Tian, S. Horvath, J. Mill, R. M. Cantor, B. J. Blencowe, and D. H. Geschwind. 2011. Transcriptomic analysis of autistic brain reveals convergent molecular pathology. *Nature* 474 (7351):380-4.

Vojdani, A., M. Bazargan, E. Vojdani, J. Samadi, A. A. Nourian, N. Eghbalieh, and E. L. Cooper. 2004. Heat shock protein and gliadin peptide promote development of peptidase antibodies in children with autism and patients with autoimmune disease. *Clin Diagn Lab Immunol* 11 (3):515-24.

Volk, H. E., I. Hertz-Picciotto, L. Delwiche, F. Lurmann, and R. McConnell. 2011. Residential proximity to freeways and autism in the CHARGE study. *Environ Health Perspect* 119 (6):873-7.

Volkow, N. D., D. Tomasi, G. J. Wang, P. Vaska, J. S. Fowler, F. Telang, D. Alexoff, J. Logan, and C. Wong. 2011. Effects of cell phone radiofrequency signal exposure on brain glucose metabolism. *JAMA* 305 (8):808-13.

Walker, D. C., and J. Southgate. 2009. The virtual cell--a candidate co-ordinator for 'middle-out' modelling of biological systems. *Brief Bioinform* 10 (4):450-61.

Walker, L., M. Gozzi, R. Lenroot, A. Thurm, B. Behseta, S. Swedo, and C. Pierpaoli. 2012. Diffusion tensor imaging in young children with autism: biological effects and potential confounds. *Biol Psychiatry* 72 (12):1043-51.

Walker, S. J., J. Segal, and M. Aschner. 2006. Cultured lymphocytes from autistic children and non-autistic siblings up-regulate heat shock protein RNA in response to thimerosal challenge. *Neurotoxicology* 27 (5):685-92.

Wallace, K. B., and A. A. Starkov. 2000. Mitochondrial targets of drug toxicity. *Annu Rev Pharmacol Toxicol* 40:353-88.

Waly, M. I., M. Hornig, M. Trivedi, N. Hodgson, R. Kini, A. Ohta, and R. Deth. 2012. Prenatal and Postnatal Epigenetic Programming: Implications for GI, Immune, and Neuronal Function in Autism. *Autism Res Treat* 2012:190930.

Wang, C., J. Cong, H. Xian, X. Cao, C. Sun, and K. Wu. 2002. [The effects of electromagnetic pulse on fluidity and lipid peroxidation of mitochondrial membrane]. *Zhonghua Lao Dong Wei Sheng Zhi Ye Bing Za Zhi* 20 (4):266-8.

Wass, S. 2011. Distortions and disconnections: disrupted brain connectivity in autism. *Brain Cogn* 75 (1):18-28.

Wayman, G. A., D. D. Bose, D. Yang, A. Lesiak, D. Bruun, S. Impey, V. Ledoux, I. N. Pessah, and P. J. Lein. 2012. PCB-95 modulates the calcium-dependent signaling pathway responsible for activity-dependent dendritic growth. *Environ Health Perspect* 120 (7):1003-9.

Wayman, G. A., D. Yang, D. D. Bose, A. Lesiak, V. Ledoux, D. Bruun, I. N. Pessah, and P. J. Lein. 2012. PCB-95 promotes dendritic growth via ryanodine receptor-dependent mechanisms. *Environ Health Perspect* 120 (7):997-1002.

Wdowiak, A., L. Wdowiak, and H. Wiktor. 2007. Evaluation of the effect of using mobile phones on male fertility. *Ann Agric Environ Med* 14 (1):169-72.

Wei, H., K. K. Chadman, D. P. McCloskey, A. M. Sheikh, M. Malik, W. T. Brown, and X. Li. 2012. Brain IL-6 elevation causes neuronal circuitry imbalances and mediates autism-like behaviors. *Biochim Biophys Acta* 1822 (6):831-42.

Weisbrot, D., H. Lin, L. Ye, M. Blank, and R. Goodman. 2003. Effects of mobile phone radiation on reproduction and development in Drosophila melanogaster. *J Cell Biochem* 89 (1):48-55.

Welsh, J. P., E. S. Ahn, and D. G. Placantonakis. 2005. Is autism due to brain desynchronization? *Int J Dev Neurosci* 23 (2-3):253-63.

White, J. F. 2003. Intestinal pathophysiology in autism. *Exp Biol Med (Maywood)* 228 (6):639-49.

Whitehouse, A. J., B. J. Holt, M. Serralha, P. G. Holt, P. H. Hart, and M. M. Kusel. 2012. Maternal Vitamin D Levels and the Autism Phenotype Among Offspring. *J Autism Dev Disord.*

Whitney, E. R., T. L. Kemper, M. L. Bauman, D. L. Rosene, and G. J. Blatt. 2008. Cerebellar Purkinje cells are reduced in a subpopulation of autistic brains: a stereological experiment using calbindin-D28k. *Cerebellum* 7 (3):406-16.

Whitney, E. R., T. L. Kemper, D. L. Rosene, M. L. Bauman, and G. J. Blatt. 2009. Density of cerebellar basket and stellate cells in autism: evidence for a late developmental loss of Purkinje cells. *J Neurosci Res* 87 (10):2245-54.

Wilcox, J. , M. T. Tsuang, E. Ledger, J. Algeo, and T. Schnurr. 2002. Brain perfusion in autism varies with age. *Neuropsychobiology* 46 (1):13-6.

Wills, S., M. Cabanlit, J. Bennett, P. Ashwood, D. G. Amaral, and J. Van de Water. 2009. Detection of autoantibodies to neural cells of the cerebellum in the plasma of subjects with autism spectrum disorders. *Brain Behav Immun* 23 (1):64-74.

Wills, S., C. C. Rossi, J. Bennett, V. Martinez Cerdeno, P. Ashwood, D. G. Amaral, and J. Van de Water. 2011. Further characterization of autoantibodies to GABAergic neurons in the central nervous system produced by a subset of children with autism. *Mol Autism* 2:5.

Witter, F. R., A. W. Zimmerman, J. P. Reichmann, and S. L. Connors. 2009. In utero beta 2 adrenergic agonist exposure and adverse neurophysiologic and behavioral outcomes. *Am J Obstet Gynecol* 201 (6):553-9.

Wolff, J. J., H. Gu, G. Gerig, J. T. Elison, M. Styner, S. Gouttard, K. N. Botteron, S. R. Dager, G. Dawson, A. M. Estes, A. C. Evans, H. C. Hazlett, P. Kostopoulos, R. C. McKinstry, S. J. Paterson, R. T. Schultz, L. Zwaigenbaum, and J. Piven. 2012. Differences in white matter fiber tract development present from 6 to 24 months in infants with autism. *Am J Psychiatry* 169 (6):589-600.

Xu, S., Z. Zhou, L. Zhang, Z. Yu, W. Zhang, Y. Wang, X. Wang, M. Li, Y. Chen, C. Chen, M. He, G. Zhang, and M. Zhong. 2010. Exposure to 1800 MHz radiofrequency radiation induces oxidative damage to mitochondrial DNA in primary cultured neurons. *Brain Res* 1311:189-96.

Yan, E., M. Castillo-Melendez, G. Smythe, and D. Walker. 2005. Quinolinic acid promotes albumin deposition in Purkinje cell, astrocytic activation and lipid peroxidation in fetal brain. *Neuroscience* 134 (3):867-75.

Yan, J. G., M. Agresti, T. Bruce, Y. H. Yan, A. Granlund, and H. S. Matloub. 2007. Effects of cellular phone emissions on sperm motility in rats. *Fertil Steril* 88 (4):957-64.

Yang, X., G. He, Y. Hao, C. Chen, M. Li, Y. Wang, G. Zhang, and Z. Yu. 2010. The role of the JAK2-STAT3 pathway in pro-inflammatory responses of EMF-stimulated N9 microglial cells. *J Neuroinflammation* 7:54.

Yang, Y., and C. Pan. 2012. Role of metabotropic glutamate receptor 7 in autism spectrum disorders: A pilot study. *Life Sci.*

Yao, Y. , W.J. Walsh, W. R. McGinnis, and D. Pratico. 2006. Altered vascular phenotype in autism: correlation with oxidative stress. *Arch Neurol* 63 (8):1161-1164.

Yariktas, M., F. Doner, F. Ozguner, O. Gokalp, H. Dogru, and N. Delibas. 2005. Nitric oxide level in the nasal and sinus mucosa after exposure to electromagnetic field. *Otolaryngol Head Neck Surg* 132 (5):713-6.

Yip, J., J. J. Soghomonian, and G. J. Blatt. 2007. Decreased GAD67 mRNA levels in cerebellar Purkinje cells in autism: pathophysiological implications. *Acta Neuropathol* 113 (5):559-68.

Yip, J., J. J. Soghomonian, and G. J. Blatt. 2008. Increased GAD67 mRNA expression in cerebellar interneurons in autism: implications for Purkinje cell dysfunction. *J Neurosci Res* 86 (3):525-30.

Yip, J., J. J. Soghomonian, and G. J. Blatt. 2009. Decreased GAD65 mRNA levels in select subpopulations of neurons in the cerebellar dentate nuclei in autism: an in situ hybridization study. *Autism Res* 2 (1):50-9.

Young, A. M., E. Campbell, S. Lynch, J. Suckling, and S. J. Powis. 2011. Aberrant NF-kappaB expression in autism spectrum condition: a mechanism for neuroinflammation. *Front Psychiatry* 2:27.

Zalata, A. A., A. B. Christophe, C. E. Depuydt, F. Schoonjans, and F. H. Comhaire. 1998. The fatty acid composition of phospholipids of spermatozoa from infertile patients. *Mol Hum Reprod* 4 (2):111-8.

Zalata, A., T. Hafez, and F. Comhaire. 1995. Evaluation of the role of reactive oxygen species in male infertility. *Hum Reprod* 10 (6):1444-51.

Zecavati, N., and S. J. Spence. 2009. Neurometabolic disorders and dysfunction in autism spectrum disorders. *Curr Neurol Neurosci Rep* 9 (2):129-36.

Zerrate, M. C., M. Pletnikov, S. L. Connors, D. L. Vargas, F. J. Seidler, A. W. Zimmerman, T. A. Slotkin, and C. A. Pardo. 2007. Neuroinflammation and behavioral

abnormalities after neonatal terbutaline treatment in rats: implications for autism. *J Pharmacol Exp Ther* 322 (1):16-22.

Zhang, B., S. Asadi, Z. Weng, N. Sismanopoulos, and T. C. Theoharides. 2012. Stimulated human mast cells secrete mitochondrial components that have autocrine and paracrine inflammatory actions. *PLoS One* 7 (12):e49767.

Zhang, Y., Y. Sun, F. Wang, Z. Wang, Y. Peng, and R. Li. 2012. Downregulating the canonical Wnt/beta-catenin signaling pathway attenuates the susceptibility to autism-like phenotypes by decreasing oxidative stress. *Neurochem Res* 37 (7):1409-19.

Zhao, T. Y., S. P. Zou, and P. E. Knapp. 2007. Exposure to cell phone radiation up-regulates apoptosis genes in primary cultures of neurons and astrocytes. *Neurosci Lett* 412 (1):34-8.

Zilbovicius, M. , N. Boddaert, P. Belin, J. B. Poline, P. Remy, J. F. Mangin, L. Thivard, C. Barthelemy, and Y. Samson. 2000. Temporal lobe dysfunction in childhood autism: a PET study. Positron emission tomography. *Am J Psychiatry* 157 (12):1988-93.

Zimmerman, A. W., S. L. Connors, K. J. Matteson, L. C. Lee, H. S. Singer, J. A. Castaneda, and D. A. Pearce. 2007. Maternal antibrain antibodies in autism. *Brain Behav Immun* 21 (3):351-7.

Zirlinger, M., and D. Anderson. 2003. Molecular dissection of the amygdala and its relevance to autism. *Genes Brain Behav* 2 (5):282-94.

Zlokovic, B. V. 2008. The blood-brain barrier in health and chronic neurodegenerative disorders. *Neuron* 57 (2):178-201.

Zoroglu, S. S., F. Armutcu, S. Ozen, A. Gurel, E. Sivasli, O. Yetkin, and I. Meram. 2004. Increased oxidative stress and altered activities of erythrocyte free radical scavenging enzymes in autism. *Eur Arch Psychiatry Clin Neurosci* 254 (3):143-7.