Title

EEG hyper-connectivity in high-risk infants is associated with later autism

Authors

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ADDITIONAL INTORMATION:

Summary of the previous EEG and MEG studies of brain functional connectivity in ASD.

Abbreviation: ; ***ACC*** *– anterior cingulate cortex;* ***AVE*** *– average reference;* ***CMS-DRL*** *- Common Mode Sense-Driven Right Leg reference;* ***IFG –*** *inferior frontal gyrus;* ***MI*** *- mutual information;* ***nvIQ*** – non-verbal IQ; ***PDC*** *- Partial directed coherence;* ***PLI*** *- phase lag index;* ***REF*** *– reference;* ***RIM*** *- robust interdependence measure;* ***SL -*** *Synchronization Likelihood.*

Authors/ Year	**Age, Number of participants IQ**	**Method of connectivity analysis, EEG reference**	**Condition**	**Spectral power results**	**Connectivity results**
Boersma et al. 2013 (1)	***3.5 yrs*** 12 ASD, IQ =108(12); 19 TD, IQ =85(17)	EEG: ***PLI;*** REF: CMS-DRL	Passively watched pictures of cars and faces; trials of 1 s length (including 100 ms pre-stimulus)	Not analyzed	***No differences*** in connectivity strength in 4–10 Hz band; ***decreased connectivity*** in ASD in 10-25 Hz band. *Graph analysis:* decreased 'small-worldness' in ASD at 4–10 Hz; Decreased clustering and increased path length at 10-25 Hz.

Kikuchi et al. 2014 (2)	***3.2-7.7 yrs*** 50 ASD 50 TD	MEG: ***Coherence*** between sensors located ~20 cm apart from one another	Watched a video program (with sound)	No differences	***Decreased*** theta coherence (with maximal effect at 6 Hz) between left frontal and right posterior sensors.
Isler et al, 2010 (3)	***5.5–8.5 yrs*** 6 ASD, IQ=67(27) 8 TD, IQ=117(10)	EEG: ***Coherence, Phase synchrony,*** REF: AVE	Stroboscopic flashes; ISI 1 sec; trials of 1 s length (100 ms pre-stimulus)	Power was increased in ASD	***Decreased*** inter-hemispheric occipital connectivity in ASD in wide frequency range (2-40 Hz)
Coben et al., 2008 (4)	***6-11 yrs*** 20 ASD, IQ=107(27.4); 20TD, IQ=110 (14.7)	EEG: ***Coherence;*** REF: Linked ears	Resting with eyes closed	ASD: Decreased absolute delta (1.5–3.5 Hz), and beta (12.5–25 Hz); enhanced relative theta (3.5–7.5 Hz); no differences in alpha (7.5–12.5 Hz)	***Decreased*** coherencies in delta, theta, alpha and beta bands.
Peters, et al., 2013 (5)	***0.08-25.6 yrs*** Tuberous Sclerosis patients with (14) and without ASD	EEG: ***Coherence,*** REF: AVE	?	Not analyzed	***No coherence differences*** in 4 - 8Hz, 8-10Hz and 10-12Hz bands; decreased long over short range coherence ratio in ASD. *Graph analysis*: No differences in network topography; increased

	(29), non-syndromic ASD (16), and controls (46). IQ?				resilience in ASD
Duffy et al., 2012 (6)	***2-12 years*** 430 ASD 554 TD IQ?	EEG: ***Coherence,*** REF: Laplacian	?	Not analyzed	1-32 Hz range in 2-Hz bands: ***decreased short-distance*** and ***decreased, as well as increased, long-distance*** coherences in ASD in various bands.
Lazarev et al., 2009 (7)	***6–16 yrs*** 14ASD IQ=91(22), 19TD IQ?	EEG: ***Coherence*;** REF: unilateral references to the corresponding earlobe	Photic stimulation at 12 frequencies between 3–27 Hz and resting state	Decreased power in the right hemisphere at all driving frequencies	***Coherence increased*** in the left hemisphere in ASD at the EEG frequencies corresponding to stimulation frequencies (6–27 Hz). No connectivity differences under rest.
Velazquez et al., 2009 (8)	***7 -16 yrs***, 15 ASD, IQ=111.2(15); 16 TD, IQ=123(8)	MEG: ***Phase synchrony*** at 10, 18, 26 and 32 Hz	Stroop colour word task	Not analyzed	*Lack of task-related increase of coherence* in ASD;
Han et al., 2013 (9)	***8–17 yrs*** 17 HF-ASD IQ= 106 (20); 17 LF-ASD IQ= 56 (12) No TD control	EEG: ***Coherence*** REF: Linked ears	Resting with eyes open	Not analyzed	***Increased coherence*** in 4-8 Hz band ***in low-functioning ASD compared to high-functioning ASD***. Other bands were not analyzed

Lazar et al., 2010 (10)	***7.5–21.5 yrs*** 18 ASD 14 TD, matched on nvIQ (Raven)	EEG: ***Coherence***, REF: Linked mastoids	Non-REM sleep	Increased power in delta (0.5–4 Hz) and decreased in alpha (8–10.75 Hz), sigma (11-15 Hz), beta (15.25–25 Hz), gamma 1 (25.25–35 Hz) and gamma 2 (35.25–45 Hz) bands.	***Decreased coherences*** in delta, theta, alpha and sigma bands.
Khan et al., 2013 (11)	***13-21 yrs*** 17 ASD, nvIQ=112(18) 20 TD nvIQ=112(16)	MEG: ***Event-related coherence*** *in source space*	Pictures of houses and faces presented for 1 s with 1 s ISI	No power differences	***Decreased long-range coherence*** between fusiform face area and precuneus, IFG, and ACC in ASD, confined to the alpha band. Decrease alpha-gamma phase-amplitude coupling, pointing to ***decreased local coherence***. Correlations with ADOS social score
Tsiaras et al., 2012 (12)	**17–21 yrs** 8 ASD, IQ=107(14)	MEG: ***RIM, PDC, MI***	Supine, rest with eyes closed	Not analyzed	***Decreased short-range connections*** in ASD within bilateral temporal, frontal and left

	8 TD IQ=123(6);				parietal sector. ***Decreased long-range connectivity*** of temporal and frontal regions with all other regions. Group differences were greatest for RIM and restricted to the alpha band.
Barttfeld et al., 2011 (13)	***Adults*** 10 ASD IQ=107(15) 10 TD IQ?	EEG: ***SL*** REF: AVE	Rest, eyes-closed	Not analyzed	***Decreased long-range connectivity*** *in ASD*, most prominent for fronto-occipital connections. ***Increased short-range connectivity*** in lateral–frontal electrodes. Only delta range (0.5-3Hz) was analyzed. *Graph analysis*: decreased 'small-worldness' in ASD.
Barttfeld et al., 2013 (14)	***Adults*** 74 neuro-typical subjects	EEG: ***SL;*** REF: AVE	Rest, eyes-closed	Not analyzed	***Decreased connectivity*** was associated with an increasing number of autistic traits. The effect was greatest for in delta (0.5-4 Hz) and theta (4 Hz to 8 Hz) bands, was present for beta (15-25 Hz) and gamma (25-35 Hz) and was absent for alpha (8-12 Hz) and sigma (12 -15 Hz), bands . *Graph analysis*: 'small-worldness' in the delta band was negatively related to amount of autistic

					traits.
Catarino et al., 2013 (15)	***Adults*** 15 ASD, IQ=119(14) 15 TD, IQ=119(13)	EEG: ***Wavelet coherence,*** REF: tip of the nose	Presentation of faces and chairs; matching tasks; 0-400 ms interval after stimulus onset	No differences	***Decreased inter-hemispheric coherence*** in ASD for all electrode pairs studied. Group differences were observed after 150 ms and at frequencies lower than 13 Hz
Kenet et al., 2012 (16)	***Adults*** 11 ASD IQ=116(8) 11TD IQ=113(9)	MEG: ***Coherence,*** *in source space*	Baseline, as well as periods of preparation for pro- or anti-saccades	No difference	***Decreased*** alpha band ***coherence*** in ocular motor control network in ASD. Absence of task-related increase in coherence in ASD.
Leveille et al., 2010 (17)	***Adults*** 9 ASD, IQ= 101.3, 11 TD, IQ=115.7	EEG: ***Coherence*** REF: Linked ears	REM sleep	Not analyzed	***Increased*** left intra-hemispheric ***coherence*** with 'O1' in ASD; ***decreased coherence*** between F6-F4. The differences were significant in delta (0.75–3.75 Hz), and theta (4.00–7.75 Hz), but not in alpha (8.00–12.75 Hz), sigma (12.00–14.00 Hz), or beta (13.00–20.25 Hz) bands. No differences for inter-hemispheric coherence
Mathewson et al., 2012 (18)	***Adults*** 15 ASD, IQ=107(12); 16 TD,	EEG, ***Coherence,*** REF: Cz	eyes-closed and eyes-open	No differences	Only alpha band (8–13 Hz) analyzed. ***No group differences in coherence.***

	101 (19)				
Murias et al., 2007 (19)	***Adults,*** 18 ASD, IQ>80; 18 TD, IQ?	EEG, ***Coherence,*** REF: AVE	Rest, eyes-closed	Theta (3-6 Hz) power was increased; alpha (8-10 Hz) power was decreased in ASD	***Coherence increased*** in theta and ***decreased*** in alpha band in ASD.

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