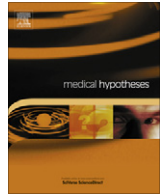


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Sensory connection, interest/attention and gamma synchrony in autism or autism, brain connections and preoccupation

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ABSTRACT

Does motivational interest increase gamma synchrony across neuronal networking to enable computation of related sensory inputs that might lead to greater social understanding in autism spectrum conditions (ASC)? Meaning, is it possible/likely that in autism because individuals process one aspect of sensory input at any one time (therefore missing the wider picture in general) when they are motivated/interested or attending to particular stimuli their attention window is widened due to increased gamma synchrony and they might be enabled to connect in ways that do not occur when they are not motivated? This is my current research question. If gamma synchrony is helping with the binding of information from collective sensory inputs, in ASC, when and only if the individual is motivated, then this has huge potential for how learning might be encouraged for individuals with an ASC.

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Introduction

If motivational interest' increase gamma synchrony across neuronal networking it will enable computation of related sensory inputs that make possible better access to greater social understanding in autism spectrum conditions (ASC). Meaning, it is possible for individuals with an ASC who process one aspect of sensory input at any one time [e.g. 1–4] thus missing the wider picture born from the input of multi-sensory connections, if motivated, to widen the attention window. This window of opportunity is made available by increased gamma synchrony and could enable connection in ways that do not occur outside of motivational present [5].

Gamma, (brain wave activity between 30 and 90 Hz), are associated with bursts of insight and high-level information processing and are well documented for their binding qualities. Gamma activity has been explored within the context of major schizophrenia research, [e.g. 5] and research in ASC [e.g. 6]. In both of these fields the research connects gamma synchrony (or lack of) to increased or decreased awareness. In schizophrenia artificially induced Gamma has been shown to widen the attention window [5] and in ASC reduced Gamma has been named as key to the behaviors clinically present [5].

It is interesting that Schizophrenia is one of the disorders that has known affiliation with ASC [e.g. 7]. So, if we know that Gamma synchrony can be artificially stimulated to support individuals living with schizophrenia, therefore, why not apply the same under-

standing, via appropriate means (motivation), to ASC? We know in ASC individuals are often governed by one interest at any one time. So much so that ritualistic, repetitive behavior often expressed as 'special interests' are part of the diagnostic criteria for an ASC [8]. If Gamma synchrony can be stimulated by using motivational attention this has huge potential for how learning might be encouraged for individuals with an ASC.

The literature

'... a full understanding of the processes of connectivity requires not only measures of networks per se, but also the context within which their activity occurs' Rippon et al. [9, p. 167].

It has been shown that Gamma activity in neurotypically developing individuals appears to operate differently during certain visual, visual illusory and motor tasks than it does for individuals with schizophrenia or/and ASC [e.g. 4–6,9–11]. In typical development the brain appears generally more symmetrical than it does in ASC where a right sided dominance has been shown by some and definite issues with connectivity when compared to controls who are neurotypically developing [e.g. 12].

In general the literature supports the idea of either over connectivity in ASC or under connectivity [12]. In either viewpoint uni-sensory activity will lead to problems with joint attention in ASC [e.g. 13].

Although the idea of using single attention in ASC has been challenged [14] only argued that there were no divided attention costs seen in ASC within the same sensory modality and not across

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modalities. This difference in power attributes also appears to influence the ability to jointly attend to a shared context, as demonstrated by joint attention tasks [11] where neurotypical respondents outperformed individuals with an ASC.

'We interpret the abnormal gamma activity to reflect decreased "signal to noise" due to decreased inhibitory processing' [9, p. 364].

Even though other studies have shown that intramodal shifts of attention are compromised if the stimulus is of sufficient complexity [15]:

"...This hypothesis predicts that even low-level visual information necessitating complex neurointegrative resources should be affected in autism. Therefore, a similar explanation, for decreased perceptual integration, may account for local bias in static stimuli, and for defective perception for dynamic, second-order information." (15, p. 2431)

This study fails to consider 'interest' as key to bridging the gap between learning, complexity and further learning. I suggest that context is of paramount importance and may override complexity issues as long as the individual is able, according to their ability.

Therefore, it is suggested that 'motivational interest' stimulates local networks by using Gamma to assist with binding the various sensory and motor responses within the brain and this could have a flow on affect to further functional ability.

'Gamma activity is related to selective attention and motor responses, and is modulated by interest' (2) p. 62.

The idea of gamma synchrony being enhanced by attention/interest is not new [e.g. 16–18,2]. This type of Gamma synchrony can be thought of as directed attention via top-down processing (or bottom up in some individuals) that induces gamma activity prompting the binding of sensory (e.g. visual and motor) information enabling event related potentials (ERP). In other words, focused attention can cause a variety of neuronal networks to talk to each other, and we can monitor this with the appropriate technology (e.g. EEG).

Since the 1980s studies have been conducted to explore the hypothesis of gamma frequency as a binding frequency that impacts upon the firing of ERP [e.g. 19,9,20,18] noted that increased perceptive awareness seemed to follow gamma synchrony. To date there is evidence with regard to schizophrenia (for example), that increased gamma synchrony can lower the incidence of illusory behavior and allow more connectivity to the 'reality' of daily life as experienced by typical others [5].

In this paper I propose the idea that increased gamma synchrony will open doors to learning in ASC and build connection to the wider understanding of the social world that otherwise might be limited. When we consider gamma as the binding frequency or band wave that draws and connects other band waves it is reasonable to suggest that if gamma is increased via motivation then connectivity to understanding will be too.

Autism spectrum conditions

The ideas expressed above challenge previous concepts that suggest ASC behaviors are connected to individuals being systemisers; lacking in ability to empathize and only interested in serving their own ego [21]. Instead, it suggests ASC will mean individuals use single sense and do not automatically integrate multi-sense making multi-tasking difficult [e.g. 13]. Sharing another's interest, being able to 'put oneself in another's shoes,' being able to accommodate change and forward think are all the natural outcome of dividing one's attention and being able to multi-task (accommodate interests of Self and Other). These abilities are associated with typical development and not with autistic develop-

ment, but, I suggest the reasoning why this is so and what it might mean is quite different to that traditionally believed (i.e. lacking empathic ability). I also suggest that individuals with an ASC can learn to do the above but via different means to that associated with typical development.

Over the past 20 years ASC's have been viewed as neurological conditions impacting negatively upon social interaction, social imagination and social communication [22]. Some have suggested the reason for the difficulties experienced in ASC are more to do with chromosomes [e.g. 23,12,24] than they are other factors (e.g. the environment; brain configuration and so on).

However, there is also a positive move afoot [4] to explore ASC from the point of view that being 'wired up' differently can have some potential for good and may lead to qualities that typically developing individuals miss out on (e.g. in ASC, individuals are often detail focused (upon things that interest them) and such details occupy one's interest whilst in typical development the details might be missed due to taking in the wider viewpoint (one's own interests and those outside of self). Therefore, this paper seeks to question traditional thinking about ASC. I suggest that if social learning could be assisted via widening the attention window of social awareness using motivational interest these interests would be viewed as qualities rather than draw backs. Such thinking would also contribute to ASC being valued more highly in a society that doesn't easily accept 'difference and diversity.'

With the question of causes and outcomes in ASC, Knickmeyer et al. [23] propose that individuals with ASC have the extreme form of the male brain and will have more systemizing characteristics (as in more male dispositions) and less empathizing characteristics (usually associated with being female, than in the typical population). This in itself is not a bad thing but other researchers have found support for the opposite view, meaning their studies on girls with ASC seem to contradict this. They show female toddlers being less sociable than their male counterparts and better at non-verbal problem-solving than the boys. For example, Carter et al. [25] noted in their study of 22 girls and 68 boys, all diagnosed with ASC, and aged between 18 and 33 months that consistent to expectation the boys were more advanced in verbal and motor skills than the girls were. However, when language was controlled for, girls showed stronger visual reception skills and non-verbal problem solving skills. The boys, however, showed more social skills than the girls.

This outcome, albeit with a small sample group, suggests that being ASC does not automatically mean you will be wired up to love systems and be disconnected to the more feminine qualities associated with empathizing.

Brock et al. [6] argue that although Frith and Happé [26] describe issues of 'weak central coherence' in autism and name this disposition for being responsible for problems with social attendance, and poor executive functioning, they fail to show the causes. Brock et al [6] however suggest:

'that weak central coherence is the result of a failure to integrate different specialized local networks in the brain and argue that this will become increasingly important as the developing brain becomes more specialized' p. 209.

They also argue that, in autism, these local networks are reduced due to a deficit in temporal binding when compared to controls. This implies that in neurotypical development Gamma activity is more extensive and balanced across local networks than it might be in ASC.

Thus, just like the rest of humankind there are many issues seen in individuals with ASC; some are viewed as negative whilst others are more positive. Some of the usually considered 'bad' qualities include obsessions. However, obsessive dispositions where

individuals are only focussed upon things that interest them potentially could lead to a successful career. What would happen if we change the term obsession and think of it as ‘passion’ instead? I believe we might think more positively about autism in general if we see single focussed interests in this light. After all, in 2012, the year of the London Olympics there were athletes practising to be the top athlete in their field by spending up to 5 h a day on their chosen sport. Is this a bit obsessive? I think we might consider their behavior to be that of dedicated, committed individuals, driven to be the best they can be, rather than obsessed and compulsive negative behaviors.

In ASC, as well as having problems with multi-tasking and, therefore, multiple interests, there are areas of sensory discord where the system of sensing is either under connecting or over connecting [e.g. 27–30]. Seeing this as issues of attention and brain configuration differences have been noted by several researchers [e.g. 2,18,31–33]:

‘In autism, a model of local hyperconnectivity and long-range hypoconnectivity explains many of the behavioral and cognitive deficits present in the condition...’ [31,p. 12].

Therefore, I suggest whatever is occupying one’s conscious attention in ASC is taking over the interest/attention circuits in the brain and keeps the individual thinking and ruminating about those things. This would mean if individuals with ASC are not equipped with appropriate connectors that allow them to side-track the issue (put it on hold) whilst they deal with other things, they can only obsess (or become passionate) about what’s ‘filling’ their attention.

Some have suggested for those with ASC, it’s the multi-sense connections that are diminished and the uni-sense connections that are in control [34,4,6,9,31]. Therefore, telling the individual concerned to ‘stop thinking about that’ or ‘put that issue to one side for now and focus on this,’ is like telling them to fly to the moon!

Brain plasticity

This being the case an individual with an ASC would find it very difficult to change their focussed ability upon details of interest to them and connect to the wider picture. Yet, because the brain has plasticity and is both malleable and constantly reforming neuro-connections enabling it to learn new things, learning can happen via major top down processing or by differing, less known, systems. This is one reason why humans can form new habits, have new ideas and unlearn things they once held as ‘gospel’ even though the learning appears entrenched. It is proposed that in ASC this access to learning can be made by using the less available connections, which is often exhausting, or is made more accessible by gamma synchrony triggered by motivation/interest.

Deco and Theile [15] point out that in typical development the brain’s emphasis is upon biasing of existing competitive interaction between multiple stimuli and it filters out non-interesting stuff or irrelevant stimuli. But, in autism where uni-sensory connections are prominent and multi-sensing systems are less connecting, individuals may not be good at filtering out unwelcome or unwanted stimuli nor at placing the appropriate pieces together to solve social puzzles. However, their disposition towards obsessive (passionate) ritualistic activities could be termed as ‘attention and interest deeply connected’ and could be a useful dynamic [35].

When individuals with ASC are involved in something of interest to them it appears that they lose the above bias (not able to filter out unwanted information is swapped for the ability to let it go) and it’s almost as if being interested enables them in ways that wouldn’t happen otherwise. For example, whilst very loud noises

made by others can cause an individual with ASC to cover their ears as if in pain, if they make the loud noise themselves it doesn’t impact upon them in the same way as it might when made by others; indeed it may be experienced as pleasurable [36].

Neurological wiring

In ASC the brain is wired differently to that of those in the neurologically typical (generic) population. This means learning is accessed in different ways to that of the typical population. It’s as if in ASC the multi-sense connectors are often ‘off line’. However ‘motivation/interest’ in ASC serves to awaken attention and create a neuro-pathway to learning, in effect bringing it back ‘on-line’. So, if interest can be triggered it allows gamma activity to spark ERP forming links to transfer information. For some, however, this process may still be slower than in the generic population and may need to involve one sense over another.

‘The problem with autistic brains may be that the language skill is not learned and localized early on. Inefficient synapses and circuitry cause a critical delay in the formation of the language processing machinery, so that using and understanding speech remains dependent upon the complicated and complete transmission of multiple inputs’ [1].

Therefore, when information is incomplete, interrupted or obsessively dominating an individual’s thinking they will need support and time to process that information. This means needing ‘time out,’ reduced sensory demand and expectation... rather than simply being redirected or told to get over it.

‘Reactions to sensory events can be cumulative. A child may be able to tolerate a certain level of sensory discomfort from individual events; however, once a certain threshold is met, s/he may have a reaction at a later time. This is important to know and may indicate a need for sensory intervention throughout the day to prevent a meltdown later in the day’ (Texas Guide for Effective Teaching: Sensory Assessment [37, p. 17]).

Sensory issues

For reasons outlined above, it is so important that whatever demands are being made on individuals with an ASC the sensory environment is autism friendly. This means that the people factor (noisy conversation, social demand, fragrances from deodorant; perfume; hair spray and so on) must be accounted for and taken into consideration. People talking (lecturing, conversing) is very exhausting for AS individual’s to listen to and they often need time to process what is being said and time to reply. If they are not given time this impacts upon behavior and often it means they become agitated, frustrated, short tempered and overwhelmed.

Gamma synchrony and Alertness

‘Studies of arousal and attention provide a further demonstration of the role of Gamma synchrony in the active state of perception. These findings suggest that Gamma synchrony is specific to behavioral situations of perception as well as associated states of alertness’ (1) . 63.

Gamma integration is conducted on a wider scale almost intuitively for the generic population but, for those individuals with ASC, this process takes a lot of work and can be quite exhausting. I say this because gamma synchrony for the generic population is enabled as sensory information is made available to an individual via multi-sense. But, in ASC single sense is the usual path for directed gleaning of meaning (4). Thus, when lots of sensory input is directed

through one sense only, the senses become crammed full to bursting and this takes one's energy away. Simply trying to stay on top of the things life brings ones way is exhausting [13].

Bio-feed back and other studies on social skill development

If we know that bio-feedback from games, hobbies and other motivational activities increases the likelihood of gamma synchrony across neuronal networks for individuals with an ASC it makes sense that we use this concept to promote teaching and enhance learning. Social skill is redundant without social understanding. If we utilize the way the brain is 'wired up' in autism then we are working with who the person is and not against them. This has to benefit self-esteem for individuals with an ASC and potentially open up a very positive future.

Although I could not find a lot of research or studies showing evidence that 'interest' per se is the key to attention in ASC, there is some formal research and much anecdotal evidence that this is happening (see [33]). There is a promising study that looks at facilitating a variety of communications via the iPad, being facilitated by The University of Toronto in connection with The Beverley School for Autism, in Canada. In this study Prof. Rhonda McEwen and her team show how children with autism, who usually have huge problems socializing, are joining in games on the iPad with other children, sometimes without being asked to do so. For example: "I love the iPad. You should see the kids react to it". It is amazing. We got this Jackson Pollock app that you barely have to touch and you have to see their faces:). One of the kids in my room that has never really shown any interest in any object – not even the iPod Touch – was so engaged with the iPad and grinning from ear to ear". – Stacie, teacher – SK-Grade 1.

Phase 1 results from their study 'Purposeful & intentional engagement with educational material expressive incentive,' shows some of the behaviors that increased via augmented and verbal communication such as self-initiated social interaction with peers. For example: "... a student in my class initiated communication with the iPad. He scrolled through pictures and found a picture of outside and pressed it. So we went right outside!!!". Teacher, Grades 2 and 3. "one of my students has been getting through his afternoon routine super quickly with the iPad as his reward. And yesterday he shared it with another student, all by himself, and the two of them played the hockey game together. I'm a happy teacher".

A formal study by Koegel et al. [38] showed a group of young people with autism who had a keen interest in computer graphics were able to increase their social engagement with others when they used their interest and skills to facilitate a computer graphics club that allowed them to share their knowledge and skills with others. "When he was able to interact on a topic in which he was interested, he was able to demonstrate more normal social behavior," Koegel said. "He not only made friends with his fellow members, he was elected club president."

Therefore, it would appear, as one young man put it:

"... the social nature of an activity is not directly relevant to motivated attention to a task but rather may be incidental in the meeting of multiple individuals with the same interests" (Jamie McFadyen, 2012).

Conclusion

This paper serves as an introduction to the idea that motivational interest will increase Gamma synchrony and open paths to learning via an ASC individual's interest enabling the individual in ways that are not otherwise available to them. It builds upon

the concept of monotropism (deeply seated interests) clearly laid out in earlier work by Murray [38], Lawson [36,39,33] and Murray et al. [35]. It is hoped that further research in this area will be prompted by the ideas outlined above.

Conflict of interest statement

None declared.

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