

The Affective World of Autism : A Review of Contemporary Evidence

Mandal, Manas K.
Defence Institute of Psychological Research, India

Harizuka, Susumu
Kyushu University

Zamami, Airi
Kyushu University

Kumar, Surender
Chikushi Jogakuen University

<https://doi.org/10.15017/1448910>

出版情報 : 九州大学総合臨床心理研究. 4, pp.131-141, 2013-03-29. 九州大学大学院人間環境学府附属
総合臨床心理センター
バージョン :
権利関係 :

The Affective World of Autism: A Review of Contemporary Evidence

Manas K. Mandal Defence Institute of Psychological Research, India

Susumu HARIZUKA Kyushu University, Japan / Airi ZAMAMI Kyushu University, Japan

Surender Kumar Chikushi Jogakuen University, Japan

Abstract

The article reviews the contemporary studies done on the affective/emotional abilities of autistics. Two kinds of evidence are reviewed: first, studies that examined the ability of autistics to understand or read emotion in others' face, and second, that examined the affect processing capability of autistics as reflected in their ocular behavior or brain activation. Though the findings are not very comprehensive, it appears that affect processing deficit is fundamental to autism. A roadmap of future research is created based on the available evidence.

Autism is considered to be one of the most important domains of research in the field of developmental clinical psychology. Thousands of research were conducted and reported by now in the literature with no conclusive evidence about the etiology and the therapeutic efficacy in autism. The field of research therefore remains fertile for future endeavor in this direction.

In this article, we made an attempt to review the contemporary evidence on autism. This was done primarily to curtail information overflow and overlap that may overwhelm the future researchers and to create a fresh baseline for undertaking research in this domain. In addition, there has been a concern about the flooding of research in this field from a host of disciplines involving genetics, pharmacology, environmental biology, developmental neuropathology to interpersonal science, giving rise the possibility of a pseudoscientific theory about the genesis of autism and exaggerated claim about the therapeutic efficacy in autism (see Herbert et al., 2002). Herbert et al. (2002) indicates that the popular etiological theories of autism are presented despite evidence contrary to their

claim; the efficacy of therapeutic interventions is shown despite the fact that these are of little use and at times harmful. Further, substantial and tall claims about autism are rarely integrated with multidisciplinary perspectives. Every science dealing with autism would make their claim independently.

Keeping these criticalities in mind, the present review is conceived to isolate substantial information from the contemporary studies that were carried out in recent times in the field of bio-behavioral sciences, with a primary aim to examine the affective world in autism. Most researches in autism are carried out to examine the cognitive domain with the presumption that there is a 'temporal priority of cognition over emotion' (Leventhal & Scherer, 1987). It is presumed that affective world is broken due to impairment in the cognitive domain.

In this review, we do not want a theoretical debate on the cognitive – affective impairments in autism; our principal inspiration is derived from the evidence that the affective world in autism is impaired despite a structurally normal amygdale (Corbett et al., 2009), an intact mirror neuron system to execute motor commands

(Press et al., 2010) and a functional neural circuitry (though a somewhat altered activation) for emotion recognition with little attention bias for non-emotional objects as compared to typically developing controls (Monk, 2010).

There is also evidence that the affective world is covertly intact though it is overtly impaired. The covert affective world is understood by the individual's ability to deal with survival emotions and to experience emotion despite the difficulty in expression or recognition of emotion. For example, autistics were found to be equally competent to detect threat in face as compared to controls (Krysko & Rutherford, 2009), thus signifying the ability to recognize basic emotions involving the fight-flight mechanism. We would therefore like to examine the affective / emotional world of autism because the input will be relevant for designing the intervention program and subsequently, to examine the outcome. In doing so, we would restrict ourselves to examining the ability to recognize and process emotion in autistics with supportive evidence drawn from neuroimaging and electrophysiological studies. The neuroimaging and electrophysiological studies would help us supplement our understanding about the affective world of an individual, not overtly visible by others.

With this backdrop, we would like (a) to ascertain the contemporary view of the researchers, (b) to examine the missing link in the understanding of affective world of autistics, and (c) to create a baseline from where future research programs can be drawn. The overall aim is to integrate the current state of knowledge for a better application-oriented research in terms of designing intervention strategies. In doing so, the data-base of researches on autism were taken care of, the researches relevant to affective domain were isolated, and the ones that deal with nonverbal indicators of the affective state of autistics were primarily focused. The verbal domain

is ignored as this is well documented.

Indicators of affective state

Literature suggests difficulty in expressing emotion interpersonally by children with developmental disorder, especially with autism. Attempts have been made to examine their ability to express, experience and understand emotion through different techniques involving psychometric testing, dyadic interaction patterns, facial expressions, spontaneous reactions, speeches, brain activation pattern, electrophysiological reactivity in natural, simulated or experimental situations. The outcome of these researches has been nearly similar suggesting paucity of emotional sensitivity in children with developmental disorder, in general, and with autism, in particular.

Studies have also been done to assess the efficacy of therapeutic methods in enhancing the emotional sensitivity of these children. The comparative evaluation of therapeutic methods has been inconclusive, suggesting that the efficacy of a therapeutic intervention is dependent on the mode of response elicitation rather than on the treatment mechanism per se. These studies were conducted with a variety of conventional response mechanism, primarily through verbal channel.

It has been found that examining therapeutic efficacy of emotional sensitivity through subjective responses that are invariant to all forms of intervention is difficult to undertake in research designs, especially with children with developmental disorders. Because verbal responses are not considered reliable to examine the efficacy of a treatment plan, it is argued that nonverbal responses may be a reliable indicator to this effect. Research has suggested that some forms of nonverbal communication, for example, facial expressions, are universally expressed and recognized. Other forms of nonverbal communication, for example, eye contact, gaze direction, gesture, proximal

behavior and para-linguistic characteristics of speech, are also found to be highly reliable, especially in the expression and experience of emotion. One of the major difficulties of this form of response mechanism is that these are subtle and transient, and therefore are difficult to capture. Since technologies are now available to capture, isolate and analyze these expressions, nonverbal behaviors may be considered as the most reliable form of response mechanism to examine the efficacy of a treatment plan. It has also been found by numerous researchers that while verbal expressions are more often used to convey the logical aspect (or content), nonverbal expressions are used to portray the affective aspect (or context) of a behavior.

It is with this understanding the present article has

reviewed studies that examined nonverbal indicators of emotion, especially with facial expressions of emotion in autistic spectrum disorders (ASD). We have taken into cognizance the studies conducted in recent years. These studies were divided into two sections: those that examined recognition or understanding of emotion and that examined ocular behaviour or in brain activation during affect processing in ASD.

Understanding of emotion in autism

Over a dozen of studies were reported (Table 1) in the last three years that deal with recognition of emotion in autistics. In these studies, attempts were made to examine the affective world of autism through

Table 1: Recognition of facial emotion in autism

Year	Author	Sample	Method	Finding
2010	Blampied et al.	ASD, normal control (5-15yr.)	Differentiation between enjoyment – non-enjoyment smiles	ASD children were impaired than normal children
2010	Law Smith et al.	ASD, TD adolescents	Recognition of facial emotion with varying intensities	ASD adolescents were impaired most in disgust followed by anger & surprise
2010	Bal et al.	ASD, TD children	Recognition of facial emotion varying from neutral to expressions	Accuracy of emotion recognition was dependent on severity of autism
2009	Rump et al.	ASD, TD children, adults	Recognition of facial emotion in video display	ASD subjects were impaired irrespective age compared to matched controls
2009	Embregts & van Nieuwenhuijzen	ASD, ID, TD Children	Social problem solving, information processing	ASD, ID focus more on negative emotional information & inadequate solution to social situation
2009	Lacroix et al.	ASD, WS children	Emotional & non-emotional face recognition	WS children were more impaired than ASD in emotion recognition
2009	Kuusikko et al.	ASD, TD, matched controls	Facial emotion recognition	ASD subjects had lower score than controls & perceived ambiguous stimuli as negative
2009	Krysko & Rutherford	ASD, matched controls	Threat detection ability	ASD subjects had threat detection advantage over happy face but were inferior to controls in overall ability
2008	Wright et al.	ASD, matched controls	Recognition of pictures of facial affect	ASD did not perform poorly than normal except for angry & happy faces
2008	Clark et al.	ASD, RD, normal	Briefly presented facial emotions	ASD subjects performed worst compared to others in emotion identification
2008	Homer & Rutherford	ASD, normal controls	Face matching, identification	ASD can categorize facial expressions of some emotions
2008	Wolf et al.	ASD, TD children	Face & object processing ability	ASD children were impaired in detecting features & changes in face
2008	Riby et al.	ASD, WS subjects	Structural encoding of face	WS were better than autistics in eye-gaze, expression processing of face

*ASD=Autistic Spectrum Disorder, TD=Typically developing controls, ID=Intellectual disability, WS=Williams syndrome, RD=Reading disability

the capability to understand or recognize emotions. Since emotions are displayed more authentically via face, most studies have considered facial expressions of emotion as the vehicle to examine the affective world. The research questions were varied but generally include the following:

- (a) Can autistics recognize basic emotions in facial expressions like happy, sad, fear, anger, surprise, disgust; if so, at what level of accuracy?
- (b) Are autistics deficient in recognizing certain categories of emotion?
- (c) Can autistics discriminate varying degrees of intensity in facial expressions of emotion?
- (d) Whether autistics are capable of distinguishing between smiles that reflect enjoyment or non-enjoyment?
- (e) How far autistics are competent in isolating socially relevant emotional input?
- (f) Whether the impairment in autistics is linked to recognizing emotion in face or detecting facial features that cue for an emotion?

A variety of methodologies was adopted to examine the affective world of autistics. Subjects with ASD were shown either in static or video displays of facial expressions of emotion, facial expressions were administered either in free-viewing condition or in micro-expressions (brief presentations), and responses were elicited either in an open-ended or matching alternative formats. Participants with ASD were compared with typically developing subjects across age groups, and at times subjects with other forms of developmental disorders like intellectual disability, Williams syndrome, fragile X syndrome were also considered for comparable purposes.

Findings of these studies suggest impairment in the ability to understand or recognize emotion displayed in face, in general. The basic emotions like happy, sad,

fear, anger, surprise, and disgust were used as categories. Most studies have suggested impairment in the understanding of these emotional categories. Although some studies have indicated that autistics can categorize these emotions without difficulty (for example, Homer & Rutherford, 2008), such evidence has not been supplemented by their ability to understand the emotion in that category.

It is also generally presumed that happiness is the easiest emotion to recognize (Mandal et al., 1996) and is understandable even in case the affective world is somewhat distorted. While Wright et al. (2008) have demonstrated little impairment in ASD in recognizing happiness when compared with matched controls; Blampied et al. (2010) have found that children with ASD had less-than-normal sensitivity to differences between enjoyment and non-enjoyment smiles.

The ability to recognize anger in face has been found to be contradictory. While some studies have suggested that threat detection (such as, the ability to detect anger better than happy expressions in a visual search paradigm) as a natural ability is not impaired (Krysko & Rutherford, 2009; see also Wright et al., 2008), others have suggested impairment in the recognition of anger expressions in autistics (see Law Smith et al., 2010). Law Smith et al. (2010) have also indicated impairment in the recognition of disgustful and surprise expressions. Others have suggested that impairment in the recognition of facial emotion depends on the degree of severity of autism (Bal et al., 2010), and that the ability to decipher ambiguous social situation is poor in autistics (Embregts & van Nieuwenhuijzen, 2009) which results in inappropriate (negative) attribution (Kuusikko et al., 2009).

These findings hint upon more fundamental issues: that is whether autistics are impaired at discriminating emotional from non-emotional expressions in face, or whether autistics are impaired at detecting expressional

cues (feature detection) in face. While the second issue may be answered in the following section by the way examining ocular behavior and brain activation during affect processing, the first question has been addressed recently by Lacroix et al. (2009). They compared autistics with children afflicted to Williams syndrome. Though the ability to discriminate emotional from non-emotional faces was inferior to normal subjects, autistics performed better than Williams syndrome. This evidence therefore suggests that autistics are impaired in the ability to recognize emotion in face but not deficient to detect emotional cues altogether. Possibly the pathology hinders with their ability to integrate emotional information depicted in face. This assertion is supplemented by the fact that a large number of autistics (nearly 75%, see, Herbert et al., 2002) are mentally retarded. It may be presumed therefore that given the training to integrate emotional cues from social situation, autistics may become sensitive to emotional expressions.

The distribution of autistic population is also highly heterogeneous. Most studies on autistics find higher 'dispersions than average' on any outcome measure, suggesting heterogeneity within the population. This prevents us from making generalizations about autistics. The issue of heterogeneity becomes more complex in case of judgment about emotion expressions. This is because there is heterogeneity within the emotion categories that are considered 'basic'. Emotions like disgust and surprise are misperceived in many cross-section of population. Some of the basic emotions, for example, anger expressions, are less often experienced in collective cultures (like Japan, India, see Mandal et al., 2001). Future studies therefore should be directed to assess emotional sensitivity of autistics towards the dimensions of emotion (for example, pleasant – unpleasant, aroused – nonaroused, approach –

avoidance) rather than categories of emotion (for example, happy, sad, fear, anger, surprise, disgust). Given such variability within the experimental conditions, we suggest to make limited generalizations, based on sample and stimulus characteristics, about the ability to recognize emotion in autism.

Further, the research evidence in recent times, though substantial, lacks a comprehensive understanding about the ability of autistics to recognize emotion in face. A meta-analysis of available data may provide a bit more input in this direction. Alternatively, emotion recognition in autism can be tested with a very large population with data-base from several countries. Most research on autism is based on the Western population with very little input from the Eastern world. The impacts of gene, environment and cultural predisposition are important considerations in the manifestations and outcome of autism. In a large scale study, these variances may be taken care of systematically.

Processing of emotion in autism

Some studies (Table 2) were conducted to examine the emotion processing ability of autistics in recent years. These were largely bio-behavioral studies and may be stratified into two types. In the first, studies were conducted to examine the ocular behavior of autistics while they attend to emotional cues in face or their ability to produce a facial expression through mimicry. To conduct these studies, eye tracking instruments were used to determine the direction of gaze, and electromyographic tools were used to record the activation during mimicry. In the second, studies are conducted to examine the pattern of brain activation during processing of emotion in autistics. Either magnetic resonance or electrophysiological instruments were used to record cerebral blood flow or electrical activation in the brain during perception of

Table 2: Processing of emotion in autism

Year	Author	Sample	Method	Finding
2010	Press et al.	ASD, normal control	Automatic imitation of facial emotion	Groups did not differ in automatic imitation of facial actions
2010	Akechi et al.	ASD, TD children	Gaze direction, ERP during facial expression processing	TD children recognized emotion better with direct & averted gaze
2010	Monk et al.	ASD, normal controls	fMRI during processing of facial emotion	ASD had more right amygdale activation than normals
2009	Uono et al.	AD, matched controls	Target detection with dynamic emotional gaze	Both groups showed gaze-triggered attention orienting but AD were poor in integration of emotion & gaze direction
2009	Corbett et al.	ASD, TD children	Volumetric analysis & functional activation during emotion processing	No difference in amygdale volume but reduced activation in ASD during emotion processing
2009	Akechi et al.	ASD, TD children	Gaze direction during facial emotion processing	ASD children do not encode or integrate multiple communicative signals
2009	Hernandez et al.	ASD, control adults	Ocular behaviour during processing of neutral & emotional face	Autistics spent less time in eye region compared to normal adults & had poorer strategy in face exploration
2009	Hermans et al.	Normals with levels of autistic traits	Facial mimicry, activation recorded with EMG	Women with autistic traits had reduced spontaneous facial mimicry
2009	Wilbarger et al.	ASD, typical controls	Eye-blink, facial EMG during emotion processing	ASD had startle reaction for both positive & negative emotions; controls had a normal pattern of startle during negative emotions
2008	Wicker et al.	AD, matched controls	Structural equation modeling of functional cerebral network during emotion processing	Data analysis of mathematical modeling indicated prefrontal cortex as the key site of dysfunction in autism
2008	Beall et al.	ASD, TD children	Rapid facial reactions to emotional expressions	ASD had undifferentiated rapid facial reaction to emotional expressions compared to normals
2008	De Jong et al.	ASD, matched controls	Gaze shifts during neutral & emotional faces	ASD had normal gaze shift for neutral expressions but had impairment in modulating for emotion expressions
2008	Dalton et al.	ASD, FXS, controls	Brain activation & gaze fixation during facial emotion perception	ASD and FXS had divergent impairment at neural level during face processing
2008	Loveland et al.	ASD, normal controls	Brain activation during emotion congruence task	Autistics had reduced prefrontal activation suggestive of poor integration of visual-verbal emotional input

*ASD=Autistic Spectrum Disorder, TD=Typically developing controls, AD=Asperger's disorder, FXS=Fragile X syndrome

facial expressions of emotion.

Nearly six studies were of significance that dealt with ocular behavior. These studies had some general objectives which include the following:

- (a) How autistics perceive core facial features?
- (b) Does dynamic gaze enhance attention orienting in individuals with Asperger's disorder?
- (c) How far the congruence of gaze direction and facial expression influence emotion recognition accuracy in autistics?
- (d) Does gaze direction modulate facial expression

processing in ASD?

- (e) Can autistics imitate facial expressions of others?

These objectives were tested by examining the ocular behavior, like gaze direction, gaze shift, eye blink, of individuals with ASD. Findings were somewhat similar suggesting some form deviation from the ocular behavior of normal controls. For example, autistics were found to have spent less time to eye region of the face which is considered to be the

core area for identification of emotion. Normal controls were found to have spent more time to the eye region of the perceived face. The normal pattern of eye dominance had also been found to be different in autistics suggesting that the natural strategy to perceive a face is somewhat impaired (Hernandez et al., 2009).

While normal subjects were found to have judged facial expressions of emotion more accurately that are congruent with gaze direction (direct gaze for anger, averted gaze for fearful expressions), subjects with ASD were not affected (Akechi et al., 2009). In another study, Akechi et al. (2010) had also found that motivationally incongruent facial stimuli do not elicit normal pattern of electrodermal response potential in autistics. These studies by Akechi et al. indicate that the processing of emotion is somewhat impaired in autistics. Uono et al. (2009) used a target detection paradigm with dynamic emotional gaze cues. They found that individuals with Asperger's disorder and normal controls have usual gaze-triggered attention orienting towards neutral vs. fearful facial expressions but such behavior is less optimized in case of Asperger's disorder.

De Jong et al. (2008) attempted to answer an important question about the autistics' ability to understand emotion. They found that autistics have normal gaze shifts while performing any task other than that involves emotion judgment. Autistics show normal gaze shift while perceiving neutral face. However, unlike normal controls, they fail to modulate their gaze shift during perception of facial emotions. Studies were also done to examine startle modulation in autism. Wilberger et al. (2009) examined affective eye blink startle modulation as an indicator of brain's response to emotional stimuli. In normal subjects, startle response increases with the exposure to negative stimuli while such response decreases with the exposure to positive stimuli. Adults with ASD showed

atypical startle potentiation irrespective of the valence (positive or negative) of emotional stimuli.

Some studies were also conducted on autistics' ability to imitate facial expressions of others. These studies were undertaken to examine whether individuals with ASD can follow motor commands that are required to derive advantage of social sensitivity training. Press et al. (2010) found that ASD and normal controls can imitate the facial actions equally well with no group difference. The study did not conclude that the emotion expression ability in ASD is intact. It was instead suggested that the impairment of motor neuron system in ASD, as indicated by other researchers, is driven by a lack of visual attention to stimuli rather than their inability to follow motor command. The study pointed out the possibility of acquiring socio-cognitive functioning in autistics through training. Beall et al. (2008) tried to examine rapid facial reactions to emotional expressions with the hypothesis that normal controls would mimic facial expressions faster than the adults with ASD. Using electromyography, they found that adults with ASD had undifferentiated rapid facial reactions in response to emotional expressions like anger, fearful and happy expressions. Hermans et al. (2009) conducted a study on normal subjects who were high or low on traits on autism. They assessed the spontaneous and instructed mimicry of facial actions by men and women volunteers and found spontaneous mimicry varies as functions of gender and autistic trait.

More direct evidence on autistics' affective world was made available by researchers by the way of examining brain activation pattern using functional magnetic resonance (fMRI). In these studies, the brain activation was captured while the autistics perceive emotionally loaded films or pictures. The primary research objective was to examine the difference in the

brain activation between individuals with autism and matched controls. Loveland et al. (2008), for example, administered a task requiring judgment of auditory-visual affective congruence to adolescents with or without autism. While the normal adolescents had significantly greater prefrontal activation during affective congruence task, autistic subjects did not have so. These investigators have identified deficits in the fronto-limbic areas and in the superior-temporal region for autistics. Wicker et al. (2008) developed a model of functional cerebral network of autistics and analysed secondary data with structural equation model to examine the deficit. This study substantiates the findings of Loveland et al. (2008) indicating that the prefrontal cortex is the key site of dysfunction in autistics. The prefrontal cortex helps integrate cues for emotional understanding in normal individuals.

Of late, studies were conducted to examine the role of the amygdale in autistics. Structural or volumetric studies did not yield any significant difference in the size of the amygdale between individuals with autism and control subjects (Corbett et al., 2009). Functional analysis of the brain by this group of investigators (Corbett et al., 2009) also indicated intact emotion matching performance by autistics, though with diminished activation of the fusiform gyrus (which helps in face processing) and the amygdale (which helps in emotion processing). Monk et al. (2010) also conducted a functional resonance study on individuals with ASD during an attention cueing task with emotional (happy, sad, angry) and neutral faces. Compared to matched controls, ASD group had greater right amygdale activation. The study groups did not differ on any of the behavioural measure that assessed attention bias.

In sum, the major aim of these studies was to examine the bio-behavioral indicators that reflect the capability of autistics to process emotion. Ocular

behavior during the perception of facial emotion was considered an important marker. The findings suggested undifferentiated gaze shift, inappropriate startle potentiation, and less optimized attention orientation in autistics during perception of facial emotion. The ability to imitate facial action was also tested. These studies reflect that the capability to mimic face is intact though rapid facial reactions are somewhat impaired in autistics. Finally, the brain activation studies suggested that the regions of interest are either over-or-under activated, indicating some form of aberration at the functional level of emotion processing. Two areas are found to have important bearings in this context, amygdale and pre-frontal cortex.

Comments

Though the overall picture is not very comprehensive, recent studies on bio-behavioral indicators of emotion processing in autistics suggest impairment. The important question arises therefore (a) whether emotion processing deficit is secondary to autism or (b) emotion processing deficit lead to autism. To answer this question, developmental models are used to examine emotion processing deficit in autism. Earlier studies on this issue suggested that autistic behavior may be detected as early as 2 years with their inability to communicate on verbal command, lack of social reciprocity, and restricted, repetitive behavior (Lord, 1995). Systematic observational studies in infancy indicated impairment in nonverbal expression, imitation, responsiveness to others, and social play (Stone et al., 1994). Accumulated evidence on parental reports about infants, later diagnosed as autistics, suggested interpersonal disengagements at a very early age (see Hobson, 2005). Herbert et al. (2002) concluded after reviewing etiological (biological, environmental, pharmacological, interpersonal) factors that genetic

predispositions and early cerebral insult are most likely cause of autism. Given this research evidence, it may be presumed that emotion processing deficit is fundamental to autism and, therefore future research should be directed towards enriching the emotional quality of life of autistics.

Towards this objective, it is also important to address the question whether cognitive impairment has a temporal priority over emotion deficit in autistics. As of now, there is no substantive evidence to conclude on this issue; however efforts may be made to examine this issue to design better intervention plan. It is also important to understand how the affective world of autistics, though impaired, is constructed. Is this a unified world with symbolic representation and not known to us, or a disjointed entity, or this world simply lacks 'natural aboutness' (Hobson, 2005) in the affective world? Current evidence only suggests that autistics are less connected with other people and their ability to relate 'context with content' at interpersonal level is impaired. To gain more insight into their affective world, future studies may be directed to examine the 'perception-expression-experience' link of emotion in autistics, instead of examining these facets independently. In case these facets are integrated at some level with some form, the affective world of individuals with autism may be revisited with a fresh approach.

Footnote

1. Manas K. Mandal thankfully acknowledges the help of the faculty and student members of the Center for Clinical Psychology & Human Development, Kyushu University, for providing support to undertake this research
2. Manas K. Mandal has been a visiting professor at the Center for Clinical Psychology & Human Development, Kyushu University, Japan, during this research

References

- Akechi, H., Senju, A., Kikuchi, Y., Tojo, Y., Osanai, H., & Hasegawa, T. (2009). Does gaze direction modulate facial expression processing in children with autism spectrum disorder? *Child Development, 80*, 1134-1146.
- Akechi, H., Senju, A., Kikuchi, Y., Tojo, Y., Osanai, H., & Hasegawa, T. (2010). The effect of gaze direction on the processing of facial expressions in children with autism spectrum disorder: an ERP study. *Neuropsychologia, 48*, 2841-2851.
- Ashwin, C., Chapman, E., Colle, L., Baron-Cohen, S. (2006). Impaired recognition of negative basic emotions in autism: a test of the amygdala theory. *Social Neuroscience, 1*, 349-363.
- Bal E, Harden E, Lamb D, Van Hecke A.V, Denver J.W, Porges S.W. (2010). Emotion recognition in children with autism spectrum disorders: relations to eye gaze and autonomic state. *Journal of Autism Developmental Disorders, 40*, 358-370.
- Beall, P.M., Moody, E.J., McIntosh, D.N., Hepburn, S.L., & Reed, C.L. (2008). Rapid facial reactions to emotional facial expressions in typically developing children and children with autism spectrum disorder. *Journal of Experimental Child Psychology, 101*, 206-223.
- Blampied, M., Johnston, L., Miles, L., & Liberty, K. (2010). Sensitivity to differences between enjoyment and non-enjoyment smiles in children with autism spectrum disorder. *The British Journal of Developmental Psychology, 28*, 483-489.
- Clark, T.F., Winkielman, P., & McIntosh, D.N. (2008). Autism and the extraction of emotion from briefly presented facial expressions: stumbling at the first step of empathy. *Emotion, 8*, 803-809.
- Corbett, B.A., Carmean, V., Ravizza, S., Wendelken, C., Henry, M.L., Carter, C., & Rivera, S.M. (2009). A functional and structural study of emotion and

- face processing in children with autism. *Psychiatry Research*, 173, 196-205.
- Dalton, K.M., Holsen, L., Abbeduto, L., & Davidson, R.J. (2008). Brain function and gaze fixation during facial-emotion processing in fragile X and autism. *Autism research: official journal of the International Society for Autism Research*, 1, 231-239.
- de Jong, M.C., van Engeland, H., & Kemner, C. (2008). Attentional effects of gaze shifts are influenced by emotion and spatial frequency, but not in autism. *Journal of the American Academy of Child and Adolescent Psychiatry*, 47, 443-454.
- Embregts, P., & van Nieuwenhuijzen, M. (2009). Social information processing in boys with autistic spectrum disorder and mild to borderline intellectual disabilities. *Journal of intellectual disability research*, 53, 922-931.
- Golan, O., Ashwin, E., Granader, Y., McClintock, S., Day, K., Leggett, V., & Baron-Cohen, S. (2009). Enhancing emotion recognition in children with autism spectrum conditions: an intervention using animated vehicles with real emotional faces. *Journal of Autism Developmental Disorders*, 40, 269-279.
- Herbert, J.D., Sharp, I.R., & Gaudiano, B.A. (2002). Separating fact from fiction in the etiology and treatment of autism. *The Scientific Review of Mental Health Practice*, 1, 23-43.
- Hermans, E.J., van Wingen, G., Bos, P.A., Putman, P., van Honk, J. (2009). Reduced spontaneous facial mimicry in women with autistic traits. *Biological psychology*, 80, 348-353.
- Hernandez, N., Metzger, A., Magné, R., Bonnet-Brilhault, F., Roux, S., Barthelemy, C., & Martineau, J. (2009). Exploration of core features of a human face by healthy and autistic adults analyzed by visual scanning. *Neuropsychologia*, 47, 1004-1012.
- Hobson, P. (2005). Autism and emotion. In F.R. Volkmar, R. Paul, A. Klin, & D. Cohen (Eds.). *Handbook of autism and pervasive developmental disorders*, vol-I, (pp.406-422). Hoboken, New Jersey: John Wiley & Sons.
- Homer, M., & Rutherford, MD. (2008). Individuals with autism can categorize facial expressions. *Child Neuropsychology*, 14, 419-437.
- Hubert, BE., Wicker, B., Monfardini, E., Deruelle, C. (2009). Electrodermal reactivity to emotion processing in adults with autistic spectrum disorders. *Autism: the international journal of research and practice*, 13, 9-19.
- Khetrpal, N. (2008). The framework for disturbed affective consciousness in autism. *Neuropsychiatric Disease Treatment*, 4, 531-533.
- Krysko, KM., & Rutherford, MD. (2009). A threat-detection advantage in those with autism spectrum disorders. *Brain and Cognition*, 69, 472-480.
- Kuusikko, S., Haapsamo, H., Jansson-Verkasalo, E., Hurtig, T., Mattila, ML., Ebeling, H., Jussila, K., Bölte, S., & Moilanen, I. (2009). Emotion recognition in children and adolescents with autism spectrum disorders. *Journal of autism and developmental disorders*, 39, 938-945.
- Lacroix, A., Guidetti, M., Rogé, B., & Reilly, J. (2009). Recognition of emotional and nonemotional facial expressions: a comparison between Williams syndrome and autism. *Research in Developmental Disabilities*, 30, 976-985.
- Law Smith, M.J., Montagne, B., Perrett, DI., Gill, M., & Gallagher, L. (2010). Detecting subtle facial emotion recognition deficits in high-functioning Autism using dynamic stimuli of varying intensities. *Neuropsychologia*, 48, 2777-2781.
- Leventhal, H. & Scherer, K.R. (1987). The relationship of emotion to cognition: A functional approach to semantic controversy. *Cognition & Emotion*, 1, 3-28.
- Lord, C. (1995). Follow-up of two-year olds referred

- for possible autism. *Journal of Child Psychology & Psychiatry*, *36*, 1365-1382.
- Loveland, K.A., Steinberg, J.L., Pearson, D.A., Mansour, R., & Reddoch, S. (2008). Judgments of auditory-visual affective congruence in adolescents with and without autism: a pilot study of a new task using fMRI. *Perceptual & Motor Skills*, *107*, 557-575.
- Mandal, M.K., Bryden, M.P., & Bulman-Fleming, B. (1996). Similarities and variations in facial expressions of emotions: Cross-cultural evidence. *International Journal of Psychology*, *31*, 41-58.
- Mandal, M.K., Harizuka, S., Bhushan, B., & Misra, R.C. (2001). Cultural variation in hemifacial asymmetry of emotion expressions. *The British Journal of Social Psychology*, *40*, 385-398.
- Monk, C.S., Weng, S.J., Wiggins, J.L., Kurapati, N., Louro, H.M., Carrasco, M., Maslowsky, J., Risi, S., & Lord, C. (2010). Neural circuitry of emotional face processing in autism spectrum disorders. *Journal of Psychiatry and Neuroscience :JPN*, *35*, 105-114.
- Picard, R.W. (2009). Future affective technology for autism and emotion communication. *Philosophical transactions of the Royal Society of London. Series B, Biological sciences*, *364*, 3575-3584.
- Press, C., Richardson, D., & Bird, G. (2010). Intact imitation of emotional facial actions in autism spectrum conditions. *Neuropsychologia*, *48*, 3291-3297.
- Riby, D.M., Doherty-Sneddon, G., & Bruce, V. (2008). Exploring face perception in disorders of development: evidence from Williams syndrome and autism. *Journal of neuropsychology*, *2*, 47-64.
- Rump, K.M., Giovannelli, J.L., Minshew, N.J., & Strauss, M.S. (2009). The development of emotion recognition in individuals with autism. *Child Development*, *80*, 1434-1447.
- Stichter, J.P., Herzog, M.J., Visovsky, K., Schmidt, C., Randolph, J., Schultz, T., & Gage, N. (2010). Social competence intervention for youth with Asperger Syndrome and high-functioning autism: an initial investigation. *Journal of Autism Developmental Disorders*, *40*, 1067-1079.
- Stone, W.L., Hoffman, E.L., Lewis, S.E., Ousley, O.Y. (1994). Early recognition of autism: Parental reports vs. clinical observation. *Archives of Pediatrics and Adolescent Medicine*, *148*, 174-179.
- Uono, S., Sato, W., & Toichi, M. (2009). Dynamic fearful gaze does not enhance attention orienting in individuals with Asperger's disorder. *Brain and Cognition*, *71*, 229-233.
- Wicker, B., Fonlupt, P., Hubert, B., Tardif, C., Gepner, B., & Deruelle, C. (2008). Abnormal cerebral effective connectivity during explicit emotional processing in adults with autism spectrum disorder. *Social Cognitive and Affective Neuroscience*, *3*, 135-143.
- Wilbarger, J.L., McIntosh, D.N., & Winkielman, P. (2009). Startle modulation in autism: positive affective stimuli enhance startle response. *Neuropsychologia*, *47*, 1323-1331.
- Wolf, J.M., Tanaka, J.W., Klaiman, C., Cockburn, J., Herlihy, L., Brown, C., South, M., McPartland, J., Kaiser, M.D., Phillips, R., & Schultz, R.T. (2008). Specific impairment of face-processing abilities in children with autism spectrum disorder using the Let's Face It! skills battery. *Autism research: official journal of the International Society for Autism Research*, *1*, 329-340.
- Wright, B., Clarke, N., Jordan, J., Young, A.W., Clarke, P., Miles, J., Nation, K., Clarke, L., & Williams, C. (2008). Emotion recognition in faces and the use of visual context in young people with high-functioning autism spectrum disorders. *Autism: The International Journal of Research and Practice*, *12*, 607-626.