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Context Blindness in Autism Spectrum Disorder: Not Using the Forest to See the Trees as Trees

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Abstract

Because of the importance of contextual sensitivity in several cognitive processes that are affected in autism spectrum disorder (ASD), such as social cognition, understanding of language, or cognitive shifting, we argue that a lack of contextual sensitivity or "context blindness" should be given more attention in a neurocognitive account of ASD. Context blindness emphasizes an aspect of the central coherence hypothesis developed by Uta Frith that has been largely overlooked in both literature and scientific research, namely, the ability to use context in sense making. In this article, we will define context blindness, describe how it can explain some of the cognitive and behavioral characteristics of ASD, and explore its relationship with the other neurocognitive theories of ASD (theory of mind, empathizing–systemizing, and executive function).

Keywords

autism, autism spectrum disorder, cognition, context

Introduction

According to research in both human and computer information processing, context seems to play a vital role in a number of cognitive processes, such as attention, perception, language interpretation, social cognition, problem solving, reasoning, memory, and generalization of acquired knowledge and skills (Bradley & Dunlop, 2005). Although everyone has an intuitive idea of what context is, it is hard to find an unambiguous and widely accepted definition of context. Definitions vary across different science areas (philosophy, psychology, linguistics, artificial intelligence). In the context of psychology, where aspects such as perception, cognitive style, and sense making are essential, we could, as a very basic definition, say context refers to "everything in a given situation that reveals and influences the meaning of a target stimulus (which could be an object, a behavior, a word . . .)." Context has been categorized into external or objective context and internal or subjective context (Kokinov, 1997). The external context refers to the situation outside the person (the environmental surroundings), whereas the internal context refers to states within the person (what is stored in short- and long-term memory, such as concepts, previous experiences, and knowledge, but also expectations, emotions, arousal). In line with the definition given by Albright and Stoner (2002), context can therefore be seen as "the sensory/behavioural/cognitive milieu that influences the way each sensory feature is perceived" (p. 340).

The idea of context blindness in autism spectrum disorder (ASD) has a double background. First of all, it is a specification of the weak central coherence hypothesis (Frith, 1989) but stresses an aspect of this hypothesis that, although frequently mentioned, has received little attention in research and literature, namely, the *use* of context in the creation of meaning. Second, research on the role of context in human cognition and artificial intelligence reveals an influence of context on many of the cognitive abilities that are affected in ASD. Contextual sensitivity plays a role in seeing relevance and guiding attention ("contextual cueing," see, for example, Chun, 2000); face processing (e.g., de Gelder et al., 2006); disambiguation of meaning in language and communication (e.g., Connolly, 2001); understanding human behavior and actions (e.g., Zibetti & Tijus, 2005); and flexibility in problem solving and generalization of knowledge and skills (e.g., Kokinov & Grinberg, 2001). Finally, recent research on schizophrenia and bipolar

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disorder showed equally that context plays a very important role in social cognitions and theory of mind (e.g., Baez et al., 2013; Green, Uhlhaas, & Coltheart, 2005). As several of the autistic cognitive deficits involve processes that seem to be highly dependent on contextual sensitivity, it seems plausible to incorporate contextual insensitivity into a neurocognitive account of ASD.

We will describe context blindness in ASD, starting from the weak central coherence hypothesis, presenting evidence from research studies and illustrating its role in the autistic cognitive style. We will then argue how context blindness can account for some of the core behavioral characteristics of ASD. Finally, we will discuss the relationship between context blindness and the other prevailing psychological theories about ASD (theory of mind, empathizing–systemizing, and executive functioning).

Context Blindness in ASD

From Central Coherence to Context Blindness

When Frith (1989) introduced the term central coherence, she referred to "the natural human tendency to draw together several pieces of information to construct higher-level meaning in context" (Frith & Happé, 1994, p. 121). Based on this definition, two different aspects seem to be involved: One refers to drawing together information and forming global meaning, the other one to constructing meaning at a higher level in the light of context. Central coherence seems to include both global perception/meaning and contextual sensitivity. The concepts global and context are often used as synonyms or are interchangeable, whereas—according to us—they refer to two different aspects. Global processing, as opposed to detail focus, refers to the ability "to see the forest for the trees." Contextual processing, however, refers to the ability "to use the forest in order to quickly recognize the trees as trees" (and not as something else), in other words, to take context into account when giving meaning.

Studies on central coherence have focused mainly on the first aspect, that of global integration of information. The results of these studies are inconsistent, a consequence of the use of different test materials and groups of subjects, but also due to the fact that the term central coherence has been operationalized in quite different ways (for a good overview, see Peeters, Verbeke, Bijttebier, Steyaert, & Wagemans, 2007). In their own review of more than 50 studies, Happé and Frith (2006) concluded that there is robust evidence for a local bias, but that regarding a deficit in global processing, the findings are mixed. According to Happé and Booth (2008), it is impossible to draw clear conclusions because most paradigms used in studies on weak central coherence conflate global and local processing.

Frith (1989) made a distinction between coherence at a low level (the level of the peripheral input processes in perception) and coherence at a higher level, that of the central thought processes (the level of meaning and (re-)interpretation). Frith further suggests that in autism "only the central processes are affected, but not the mere peripheral input processes" (p. 97). In these central processes, context plays a crucial role: "The need to slot information into a larger and larger context is another way to look at the effect of high-level central cohesion" (Frith, 1989, p. 101). According to Frith (2003), "a drive for coherence and the ability to make use of context are one and the same thing" (p. 158). Frith's writings indicate that when she introduced the term central coherence, she did not only refer to the ability to perceive globally and to *see* the whole or the context but also referred to the ability to *use* context in perception and sense making. Although the former is a prerequisite for the latter, seeing context does not necessarily mean that one also uses it in interpreting what is perceived. A very illustrative example of this has been presented by Happé (1994a) with the clinical anecdote of a boy with ASD who named the pillow on a bed "a piece of ravioli" (p. 118). He did so even after he correctly had named the bed, mattress, and quilt, proof that he had "seen" the context of the pillow. Disregarding the context of the bed, the purely perceptual information (the shape of the pillow) could indeed be linked to the meaning of "ravioli" (and many other meanings, such as a cookie, a frame, a stamp). However, the bed context should disambiguate these different meanings in favor of the meaning of "pillow." Most of the things we perceive in the real world are open to multiple interpretations. The world is intrinsically ambiguous. Stimuli do not have a fixed meaning but obtain their "correct" meaning from the context. This is strikingly illustrated by the well-known scene in the movie Rain Man in which Raymond Babbit (played by Dustin Hoffman) crosses the street and stops walking when the traffic light changes to "Don't walk." Raymond does not take into account the context (i.e., the fact that he is already halfway across the street) in his interpretation of the stimulus of the traffic light. The concept of context blindness in ASD (or more accurately, a lack of contextual sensitivity) refers primarily to the difficulties people with ASD have in *using* context when constructing meaning rather than to their detail focused style of perception.

Context Blindness and the Neurocognitive Characteristics in ASD

The examples above clearly demonstrate the role of context in sense making, particularly in disambiguating meaning. Both the ravioli and the traffic light examples involve the use of the external context, the surroundings. In ASD, the difficulties in using context also include the internal context. Ropar and Mitchell (2002) found that the perception of

shapes in participants with ASD was less influenced by prior knowledge than in a control group. Soulières, Mottron, Saumier, and Larochelle (2007) found a similar lack of effect of categorical knowledge on perceptual discrimination in a group of adolescents and adults with ASD and normal intelligence.

A lack of contextual sensitivity and feeling for the different contextually induced meanings can account for the difficulties people with ASD have in distinguishing the important from the incidental (Frith, 2004) and their difficulties in attending to the salient stimuli in a given situation (Loth, Gómez, & Happé, 2011). Issues of context and relevance are frequently cited in literature. For example, Ekbia and Maguitman (2001) argued that context and relevance are inextricably linked. A reduced contextual sensitivity results in a lack of selective bias toward the relevant aspects of the perceptual input and all details stay equally important and, hence, the brain is being bogged down in minute details or irrelevancies. A lack of selective attention to significant aspects of the environment and giving too much weight to details are frequently seen in people with ASD. Reduced contextual sensitivity results in all stimuli being equally (un)important or having the same meaning. Attention is paid to stimuli that should normally be ignored because they are extraneous in a given context, and/or contextually significant stimuli are being overlooked. So-called "autistic ideas" or misunderstandings often reveal fixed or rigid connections between stimulus and meaning (e.g., do not walk = stop). Reduced contextual sensitivity can explain the rigid or straightforward thinking typically seen in ASD and can be regarded as the source of the lack of flexibility in ASD.

Context also seems to play a role in memory. For instance, episodic memories rely on context for evaluation and validation; semantic memories do not require this contextual validation. There is evidence for a personal episodic memory deficit in ASD in the absence of a personal semantic memory deficit (Crane & Goddard, 2008). Bowler, Gardiner, and Grice (2000) had shown that individuals with Asperger syndrome have a better memory for items without context than for items with context and that their episodic memory is affected. Furthermore, recall (but not recognition) seems to be less contextually enhanced in autistic people than in non-autistic people (Bowler, Gaigg, & Gardiner, 2008).

Finally, as a specification of the weak central coherence hypothesis, the idea of context blindness is in accordance with the suggestion that in ASD, there is an overgrowth of local connections in the brain and a lack of long-range connectivity, probably due to a failure of pruning in early brain development and resulting in too much bottom-up and a lack of top-down modulation and feedback from frontal and prefrontal cortex (Courchesne & Pierce, 2005). Context seems to be involved in this top-down influence because context provides, through recurrent feedback connections, information that influences earlier levels of information processing (Albright & Stoner, 2002).

Evidence for Context Blindness

Although the results of the majority of studies about central coherence, those concerning the global–local issues, are quite inconsistent, the findings of studies that examined the abilities of people with ASD to *use* context are less equivocal. Deficits in contextual sensitivity have been demonstrated in the following:

- The quick and spontaneous identification of contextually incongruent objects (e.g., Au-Yeung, Benson, Castelhano, & Rayner, 2011; Jolliffe & Baron-Cohen, 2001);
- The ability to detect contextually relevant changes (Fletcher-Watson, Leekam, Turner, & Moxon, 2006; Loth, Gómez, & Happé, 2008; Nakahachi et al., 2008);
- The ability to attend to and remember context-relevant aspects of scenes (Loth et al., 2011);
- The ability to match objects or pictures to a context (Noens & van Berckelaer-Onnes, 2008);
- The use of contextual information in face processing (Teunisse & de Gelder, 2003);
- The use of contextual information, such as body movements, in emotion recognition (Atkinson, 2009; Da Fonseca et al., 2009; Fein, Lucci, Braverman, & Waterhouse, 1992; Koning & Magill-Evans, 2001; Serra et al., 1995);
- The recognition of context-dependent emotions (Tudusciuc & Adolphs, 2011);
- The recall from memory of specific contextual details (e.g., Bennetto, Pennington, & Rogers, 1996);
- Contextually induced false memories (Beversdorf et al., 2000);
- The ability to take advantage of the semantic or syntactic context for the recall of words (Hermelin & O'Connor, 1970);
- The use of context in disambiguating the pronunciation or meaning of homographs (e.g. Happé, 1997; Lopez & Leekam, 2003);
- The ability to resolve lexical ambiguity (Diehl, Bennetto, Watson, Gunlogson, & McDonough, 2008; Norbury, 2005);
- The ability to complete sentences with words that are congruent with the whole sentence context (Booth & Happé, 2010);
- The contextual activation of semantic networks (Beversdorf, Narayanan, Hillier, & Hughes, 2007; Braeutigam, Swithenby, & Bailey, 2008; Ring, Sharma, Wheelwright, & Barrett, 2007);

- The ability to make context-appropriate inferences in short stories (e.g., Jolliffe & Baron-Cohen, 2000; Kaland, Smith, & Mortensen, 2007; Nuske & Bavin, 2011; Saldaña & Frith, 2007);
- The ability to use context when answering contextually demanding questions (Loukusa et al., 2007);
- The use of context in reasoning and decision making (De Martino, Harrison, Knafo, Bird, & Dolan, 2008; McKenzie, Evans, & Handley, 2010; Morsanyi, Handley, & Evans, 2010; Pijnacker et al., 2009);
- Based on their study, Morsanyi et al. (2010) described the autistic mind as "*decontextualized minds*."

The study of Jolliffe and Baron-Cohen (2001) on identification of contextually incongruent objects is interesting with regard to the difference between detail focus and context blindness. Jolliffe and Baron-Cohen used the Scenic Test, a test presenting black line drawings of scenes containing a contextually inappropriate item (e.g., a kitchen knife in a child's bedroom). The clinical group (adults of normal intelligence with ASD) showed a deficit in both their ability to spontaneously notice and identify incongruent objects, as well as to identify the scenes, and they were not faster at locating a named incongruent object than the control group. This is in contrast with what is commonly assumed, namely, that people with ASD have a good eye for detail. On the contrary, the results seem to indicate that there is a specific problem extracting the gist of a scene and *using* this context in the detection, interpretation, and qualification of details embedded in this context.

The results found by Jolliffe and Baron-Cohen (2001) are in contrast to the study of Lopez and Leekam (2003) who found no difference between a group of children with ASD and the control group in identifying contextually incongruent objects in a visually presented scene. Lopez and Leekam found a contextual facilitation effect in both the control and the clinical groups. Similar results were found with verbally presented contextual information: Words related to a previously presented contextually related word were identified more rapidly and correctly than words preceded by a neutral word. These results seem to indicate that people with ASD are capable of using context. An important difference between the two studies can account for the contrasting results. As Lopez and Leekam acknowledge, in their study, the subjects did not have to evaluate the contextual appropriateness of an object or word, they only had to name it. Contextual sensitivity is not confined to object identification; it refers mainly to the use of context in giving meaning to target stimuli: Evaluating, disambiguating, and changing between several possible meanings in the light of context. Context blindness therefore refers primarily to difficulties in finding *contextually appropriate* meanings (as illustrated in the "ravioli" anecdote). This is for instance the case in reading homographs. In the same study, Lopez and Leekam also presented a homograph test, and in this test, where context had to be actively used to evaluate and disambiguate meanings, children with ASD were outperformed by the control group. Additional evidence for an autistic deficit in using context to disambiguate comes from a recent study by Allen and Chambers (2011). Although the adolescents with ASD in that study were able to successfully perceive the dual meanings of an ambiguous drawing (such as the well-known duck/rabbit), experiencing and labeling the reversal did not bias their copy of the figure. The same study did not find evidence for a local drawing style, but instead evidence for a dominant global style, adding some further support for disentangling local focus and a deficit in using context.

It seems plausible then to define context blindness as a deficit in the spontaneous identification of context and the use of context in giving, evaluating, and disambiguating meaning.

Context Blindness and the Behavioral Characteristics of ASD

In what follows, we will describe how the main behavioral characteristics of ASD (difficulties with social interaction, social communication, and reduced flexibility) could be linked to a lack of contextual sensitivity. In addition, we will also try to relate context blindness to the sensory difficulties in ASD, now included in the diagnostic criteria for ASD (American Psychiatric Association [APA], 2013).

Context and the Impairment in Social Interaction

Taking context into account is crucial to understanding other people's behavior and reacting appropriately. Effective social engagement requires integration of context (Klin, Jones, Schultz, & Volkmar, 2003). For example, the meaning of a raised hand depends on the context: People raise their hand to ask a question, greet someone, ask permission to speak, stop a taxi, say goodbye, and so on. The meaning or intention behind the concrete gesture cannot be found in the gesture itself but in the context of that gesture.

Context is equally important in guiding one's own social behavior. Social misjudgment might occur when an individual does not use the (social) context to guide his or her own behavior in social situations. No single behavior is in itself socially appropriate. Concepts such as "politeness" or "socially appropriate" are contextually defined. What is polite in one context is inappropriate in another. Studies have shown that even more able adolescents with ASD have difficulties in judging the appropriateness of social behavior (Loveland, Pearson, Tunali-Kotoski, Ortgeon, & Gibbs, 2001). In a test of social problem solving (the Predicaments test), adolescents with Asperger syndrome could generate

as many solutions as the control group, but their solutions were less socially appropriate because they took contextual factors insufficiently into account (Channon, Charman, Heap, Crawford, & Rios, 2001). As we will argue further in the text, the cognitive skills required for success in social interaction (theory of mind, empathizing) demand a lot of contextual sensitivity.

Context and the Impairment in Communication

Both semantic and pragmatic difficulties in ASD can be linked to context blindness. On a semantic level, words have, just like human behavior, no fixed meaning: Their meaning has to be derived from the context. This does not only apply to words with multiple meanings (e.g., bat, lead, bank) but for almost every word, even words that we consider to have only one meaning, for example, work. Work could mean many different things: Driving a bus, feeding animals, teaching children, analyzing computer programs, writing an article on ASD, and so on. It is often said that individuals with ASD have difficulties understanding abstract words, but it might well be the case that these difficulties refer especially to making the abstract *concrete in a certain context*: What does "work" mean within this particular context? People with ASD are less efficient in using the context to resolve lexical (Norbury, 2005) or syntactic (Jolliffe & Baron-Cohen, 2000) ambiguity.

Literal understanding of language is said to be typical of ASD. Usually, difficulties in understanding figurative speech are mentioned to illustrate this literal understanding, but the problem with taking utterances literally goes beyond figurative speech. As such, acontextual understanding might be a more accurate term, because the real problem lies in grasping the contextually appropriate meaning rather than relying on the most typical, common meaning of words and sentences. People with ASD experience problems adapting and changing the meaning of a word or sentence according to the context. When asked to open the door because the bell rang, a boy with ASD opened the kitchen door instead of the front door. This acontextual understanding is not limited to the understanding of spoken and written language but can be seen in the processing of every form of communication, even non-linguistic forms such as drawings, photographs, or pictograms. A picture of a cup, which is often used to indicate "drinking" for people with ASD and additional learning difficulties, can have quite different meanings depending on the context: coffee or tea but also juice or a soft drink or plain water, drinking alone or in group, and so on.

Pragmatic problems are well known in ASD and can be linked to contextual sensitivity as well. Non-autistic people use context to retrieve the communicative intentions of their interlocutors. For instance, they understand the question "Nice weather, isn't it?" as an ironic statement when it has been raining for days in a row. According to Wang, Lee, Sigman, and Dapretto (2006), one of the reasons why people with ASD have difficulties understanding irony is their lack of use of context.

Context and Lack of Flexibility

A lack of contextual sensitivity results in rigid and absolute links between stimuli and meanings and, hence, a lack of flexibility in behavior. People with ASD often adhere to fixed meanings, scenarios, and rules and find it difficult to make contextual changes to them. During a summer camp, a boy with ASD did not recognize the toilets on the campsite because they all had a black seats instead of the white seats he knew from the toilets at home and at school, in spite of all the other stimuli in the context indicating the concept of toilet (such as toilet paper, the flush, a washbasin). People with ASD have problems coping with exceptions (Van Lambalgen & Smid, 2004). Difficulties in changing plans when this is necessary due to changed context have been well documented in ASD and are part of what is known as the executive dysfunction in ASD (see below). If the meaning of objects, words, and people changes all the time depending on the context, the world becomes very unpredictable for individuals who are context blind. Resistance to changes, engaging in restricted interests, and stereotyped behaviors are normal and human reactions to the threats of an inconstant world with ever changing multiple meanings.

Context and Sensory Problems

Happé and Frith (2006) found a link between hypersensitivity and acontextual information processing. Context seems to be vital in modulating the sensory input and can have both facilitatory and inhibitory effects. Reduced contextual sensitivity may lead to a lack of differentiation in the stimuli present and, consequently, all stimuli or none is transmitted, or relevant stimuli are ignored and irrelevant ones transmitted for processing. Poor contextual sensitivity and the consequent lack of top-down modulation of incoming stimuli could lead to all incoming stimuli being processed as unexpected, resulting in increased sensitivity and sensory overload.

Context Blindness and the Cognitive Theories of ASD

Context and Theory of Mind

Contextual sensitivity is essential for attributing intentions and other mental states and can thus be seen as a vital factor in "theory of mind" (see above, the example with the meaning of a raised hand). Although there is ample evidence for

the difficulties of people with ASD in recognizing and understanding both their own and others' minds, there does not seem to be an outright failure in mentalizing. Some people with ASD seem to have some understanding of mental states, but they experience difficulties using this knowledge spontaneously and flexibly in real life. For instance, Begeer, Rieffe, Terwogt, and Stockmann (2006) found in a group of children with pervasive developmental disorder–not otherwise specified (PDD-NOS) that their attention for emotions is so to speak "off-line" but that they became more attentive to expressions of emotion when they were given some cues. It seems there is a lack of contextual activation of the rather "theoretical" knowledge about mental states that more able people with ASD have (contextually activated mentalizing can be regarded as spontaneous mentalizing). When this is lacking, attention to other people's mental states has to be externally activated. This need for external cueing of social cognitions can explain not only the lack of a strong positive correlation between off-line tests of theory of mind and measurements of social competence in real life (see, for example, Joseph & Tager-Flusberg, 2004; Klin et al., 2003) but also why interventions and training programs for mind reading have limited effects on real life social competence (Swettenham, 2000). We argue that the mentalizing problems seen in people with ASD do not originate from a deficit in mind reading as such (although there is possibly a delay in its development), but that they reflect difficulties in the spontaneous use of context to activate mind reading and to make contextually appropriate inferences about other people's mental states. Some studies have already shown deficits in the ability to detect mental states from contextual cues (Baron-Cohen, O'Riordan, Stone, Jones, & Plaisted, 1999; Fein et al., 1992; Happé, 1994b). Adults with ASD who succeed in static and acontextual Theory of Mind tests, such as the "Reading the mind in the eyes test" (Baron-Cohen, Wheelwright, & Jolliffe, 1997), are impaired in more contextualized tests of Theory of Mind (Roeyers, Buysse, Ponnet, & Pichal, 2001; Spek, Scholte, & van Berckelaer-Onnes, 2010). On a more basic level of social perception, individuals with ASD perform face-processing tasks as accurately as normal controls when faces are displayed in isolation but are impaired when faces are displayed in the context of a visual scene (Hanley, McPhillips, Mulhern, & Riby, 2012; Speer, Cook, McMahon, & Clark, 2007). In matching faces with emotional expressions, children with ASD, although not showing superior processing of details, tend to be less influenced by contextual factors (Evers, Noens, Steyaert, & Wagemans, 2011).

Context and Empathizing–Systemizing

The empathizing–systemizing theory (Baron-Cohen, 2002) holds that ASD can be characterized as deficits in empathizing alongside intact or even superior systemizing abilities. Although systemizing and central coherence share some characteristics (for instance, both demand excellent attention to detail), Baron-Cohen sees a difference between the two, more precisely the fact that systemizing requires a wider contextual view of the entire system and the ability to draw local conclusions together into a whole (Lawson, Baron-Cohen, & Wheelwright, 2004). However, in the same article, Baron-Cohen and his colleagues mention the possibility that empathizing and systemizing might be specific abilities that are human adaptations to a crucial environmental distinction, namely, the difference between open and closed events or systems. Currently, no studies have examined the abilities of people with ASD in understanding and coping with open and closed systems, but Happé and Frith (2006) pointed out that people with ASD often excel in the mastery of certain closed systems (such as bus route numbering, calendars) and that these systems may be "fathomable through local coherence, provided that simple if-then rules operate without context dependent effects" (p. 19). The distinction between open and closed systems can largely be made on the difference in contextual influence: The closure of closed systems refers to the lack of contextual influences (if x, then always y), whereas in open systems, the outcomes of target phenomena are context dependent (if x, then only y under certain conditions). The difficulties people with ASD have in social situations and their problems with empathizing can be understood within the framework of contextually influenced open systems. According to Klin et al. (2003), the social world is an open system and as such, it "implies the need to consider a multitude of elements that are more or less important depending on the context of the situation" (p. 349). Social interaction knows no fixed, absolute rules in terms of "if x, then always y."

Context and Executive Function

Executive function is a kind of umbrella term, encompassing different cognitive functions such as planning, working memory, impulse control, inhibition, and shifting set, as well as the initiation and monitoring of action. There is evidence for an executive dysfunction in ASD; however, this is not a general deficit. Instead, there is a specific and differential profile of deficits, involving only certain areas of executive functioning, more precisely attention shifting, planning, and cognitive flexibility (Hill, 2004). Perhaps the most profound executive deficits in ASD are those connected to difficulties in set shifting and cognitive flexibility (Hill, 2004), both of which can be connected to contextual sensitivity because they require shifts in attention and plans in the light of a changing context. Given the connections between contextual sensitivity and these executive functions and, on a neurological level, top-down modulation in the brain, one could argue that context blindness is a concretization of the executive dysfunction hypothesis rather

than a specification of the weak central coherence hypothesis. Although many functions of contextual sensitivity can be understood as some form of (higher level) executive function, there seem to be at least some differences between the two concepts. For instance, poor planning and problems of inhibition can insufficiently explain local bias and decreased contextual sensitivity (Booth, Charlton, Hughes, & Happé, 2003; Booth & Happé, 2010). Moreover, the use of context is thought to be a property of both lower and higher level systems in information processing. Influences of stimulus context can already be seen in very early stages of visual perception: Response properties of neurons in primary visual context (V1) are already dependent on context (Gilbert & Sigman, 2007). Contextual modification of a neuron's responses by stimuli outside the neuron's receptive field has been shown in, for instance, perceptual pop-out, perceived brightness, and color constancy. These contextual effects are attributed to preattentive vision (Lamme & Roelfsema, 2000). In the line of what Happé and Frith (2006) wrote about the local bias in ASD, we hypothesize that context blindness is not just a side effect of executive dysfunction, but that it is part of a more general perceptual deficit in ASD. Clearly, the relationship between a lack of contextual sensitivity and executive dysfunction is in need of further explanation.

Discussion

With context blindness as a specification of the weak central coherence hypothesis, we refer to the impairment in the *spontaneous use of context* in information processing and sense making. For future studies about the role of context in ASD, it will be important to distinguish "seeing" context from "using" context and to differentiate tasks that involve the "cued" use of context from tasks that require the "spontaneous" use of context. The idea of context blindness further predicts that people with ASD will be outperformed by typically developing people especially in those tasks that involve *contextually based disambiguation* of meanings, such as tasks with homographs, ambiguous visual stimuli, social situations that force one to change or adapt the prototypical scenarios, or tasks that present emotional expressions with multiple meanings (such as tears of sadness and tears of happiness).

Although a lack of contextual sensitivity seems to explain several features of ASD and although there is some—albeit limited—evidence, for a reduced use of context in ASD, many questions remain open or unanswered.

The first and probably the most important question is the following: Which ASD features can be explained by a lack of contextual sensitivity and which ones cannot? Future research will need to elucidate the possible link between "context blindness" and the different behavioral symptoms of ASD.

Furthermore, is context processing a unitary construct or rather a collection of processes, only a subset of which may be (partially) impaired in ASD? Travers et al. (2013) found that individuals with ASD have difficulties with implicit contextual cueing when only stimulus–identity cues are provided but not when spatial cues are given. There is clearly no general deficit in the use of context, but future research will have to clarify the specific conditions under which people with ASD fail to use context.

Do people with ASD use context in a different way? For instance, a recent study by Kourkoulou, Leekam, and Findlay (2012) found that individuals with ASD can learn a visual context and use it as a cue to guide their visual attention, but that they follow a different learning pattern.

Are there degrees in contextual (in)sensitivity? And can these be linked to levels of severity of ASD features on a behavioral level or to developmental level? In the study by Loukusa et al. (2007), the older children with ASD performed better than the younger children when answering contextually demanding questions, suggesting that the ability to use context increases with progressing development.

How specific is context blindness? As context processing deficits have been found in schizophrenia as well, how can the assumed deficits in contextual sensitivity in ASD be differentiated from those found in schizophrenia? For example, it might be possible that not being able to activate contextually appropriate meanings is especially typical for ASD, whereas not being able to repress contextually inappropriate meanings is more characteristic of schizophrenia (Titone, Levy, & Holzman, 2000), resulting in the schizophrenia symptoms of hallucinations and formal thought disorders (Stratta, Daneluzzo, Bustini, Prosperini, & Rossi, 2000).

And finally, what are the implications for education and treatment of ASD? Can the use of context be made subject to training? How and to what extent? Context plays a pivotal role in social cognition and social skills. If people with ASD indeed have difficulties using context in their social interactions, generic social skills training will not be sufficient. We will also have to teach them to focus on the socially relevant features of the context, so they will know when to apply the learned social skills and how to adapt the learned social scripts to different contexts. There is preliminary evidence for the positive effects of this "pushing the context button." For instance, providing situational correlates facilitates emotion recognition in people with ASD (Balconi, Amenta, & Ferrari, 2012). Children with ASD who have difficulties retrieving and using display rules (social rules for how and when to express or mask emotions) spontaneously are able to reproduce these social rules when sufficient contextual information is given (Begeer et al., 2011).

Conclusion

To improve our understanding of ASD and our support of people affected by it, we need to understand the way people with ASD perceive and understand the world around them. Understanding the perceptual and cognitive style in ASD is

essential. A whole line of research has pointed to the importance of context in human perception and cognition and has given evidence for the role of context particularly in those areas that are affected in ASD, such as cognitive flexibility, focus of attention, understanding of language and communication, and—finally but not least—the processing of social and emotional information. We have tried to show how a refinement of Frith's hypothesis of weak central coherence, emphasizing the role of context in the definition of central coherence, could contribute to an explanation of some of the main features of ASD. With this article, we hope to stimulate a discussion about the problems with context that have been so often mentioned in both anecdotal and scientific reports on ASD. Despite these numerous references to context, we still lack a clear understanding of the difficulties that people with ASD have in perceiving and using context. It is time to put the autistic difficulties with context in . . . context.

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