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Can monitoring in language comprehension in Autism Spectrum Disorder be modulated? Evidence from event-related potentials

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ABSTRACT

The present study examined language comprehension in Autism Spectrum Disorder (ASD) in light of monitoring. It was studied whether individuals with ASD monitor their language perception, and whether monitoring during language perception could be modulated with instructions. We presented higher-level (semantic) linguistic violations and lower-level (orthographic) linguistic violations in a free reading condition and in an instructed condition, recording event-related potentials. For control participants, a monitoring response as tapped by the P600 effect was found to semantically and orthographically incorrect input in both conditions. For participants with ASD, however, a monitoring response to semantically implausible input, tapped by the P600, was found only in the instructed condition. For orthographic errors monitoring was observed both in the free reading and in the instructed condition. This suggests that people with ASD are less inclined than typical individuals to monitor their perception of higher-level linguistic input, but that this can be enhanced with instructions.

Autism Spectrum Disorders (ASD) are characterized by a range of language and communication deficits (DSM-IV-TR, American Psychiatric Association, 2000). Although individuals with ASD vary greatly in their language abilities, some being completely mute and others being verbally fluent, even the most verbal individuals on the spectrum experience difficulties with more complex aspects of language (e.g., Huemer & Mann, 2010; O'Connor & Klein, 2004; Tager-Flusberg, 2001). The present study focuses on language comprehension in high-functioning adults with ASD. In this subgroup, basic language abilities such as phonological and lexical processing are shown to be relatively intact. However, the processing of linguistic aspects that require integration of verbal information for comprehension, such as complex semantics and pragmatics, is often found to be impaired (for an overview see Kelley, 2011). Although a lot of research has been conducted on language comprehension impairments in ASD, their cognitive correlates are still poorly understood. Researchers have proposed some form of cognitive control to be involved in the impairments, but the exact mechanism has not yet been specified and warrants further examination.

Evidence from recent psycholinguistic research suggests that the quality of our understanding of language depends largely upon cognitive control processes (for a review see Ye & Zhou, 2009). Cognitive control refers to the control over attention, thoughts and behaviors in order to ensure goal-directed behavior (e.g., Botvinick, Braver, Barch, Carter, & Cohen, 2001). An aspect of cognitive control that has been found to be of specific relevance for the optimization of language comprehension is monitoring (for an overview see Van de Meerendonk, Kolk, Chwilla, & Vissers, 2009). Monitoring entails the evaluation of the demands for control, a process that can vary as a function of for instance context and individual abilities (Stuss & Knight, 2002). The role of cognitive control processes in language comprehension indicates that language (and problems associated with it) should not be studied in isolation, but in light of its interaction with monitoring. As such, the present study used the monitoring perspective on language as a starting point to study language comprehension in individuals with ASD. Below we will provide a brief overview of the literature on monitoring and language, where after we will describe how we studied language comprehension in ASD from this perspective.

1. Monitoring in language comprehension

Monitoring is an aspect of cognitive control that ensures the quality of perception and behavior (Stuss & Knight, 2002). In the domain of language, people monitor to optimize their

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comprehension of linguistic input. According to monitoring theory of language perception, this occurs by checking for conflicts that arise in case of discrepant linguistic representations, and by adjusting attentional control accordingly (Kolk, Chwilla, Van Herten, & Oor, 2003). A representational conflict occurs when an observed linguistic element does not match the element expected based on context or world knowledge. In case of such conflicts, additional attention is needed for reanalysis of the input, to prevent erroneous information from being integrated in the interpretation and hence to optimize language comprehension.

Monitoring can be mapped using event-related potentials, and is said to be reflected by the P600 effect. The P600 is a late, positive-voltage effect with a centroposterior scalp distribution, starting approximately 600 ms after occurrence of a representational conflict (Van de Meerendonk et al., 2009). Although the P600 has previously been related specifically to syntactic processes (e.g., Friederici, 1995; Hagoort, Brown, & Groothusen, 1993; Kaan, Harris, Gibson, & Holcomb, 2000), more recent research shows that violations of expectancy in general also elicit a P600 effect. That is, the P600 has been found to be elicited by several linguistic (e.g., orthographic, syntactic, semantic) as well as nonlinguistic (e.g., conceptual) violations of expectancy (e.g., Kim & Osterhout, 2005; Kolk et al., 2003; Kuperberg, Sitnikova, Caplan, & Holcomb, 2003; Vissers, Chwilla, & Kolk, 2006; Vissers, Kolk, Van de Meerendonk, & Chwilla, 2008). As such, the P600 has been proposed to reflect a neurophysiological marker of general monitoring processes, and hence, of the optimization of language comprehension.

Whether the control process during language perception is elicited, depends on the strength of the linguistic conflict. Only strong representational conflicts result in reprocessing of language, whereas mild conflicts do lead to integration difficulties but do not require reprocessing to be resolved (Van de Meerendonk, Kolk, Vissers, & Chwilla, 2010). Moreover, whereas under certain circumstances a particular linguistic element will result in a conflict and trigger a monitoring response, in other situations it will not. For instance, sentence context can modulate the expectancy for a certain linguistic event, and thus influence whether we need to reprocess certain information or whether the information can be integrated into the ongoing representation without extra attention (Van de Meerendonk, Indefrey, Chwilla, & Kolk, 2011). Furthermore, the process of reanalysis is sensitive to various task variables. For example, the probability of encountering linguistic violations within a given block of sentences influences whether a control process is triggered. Less probable linguistic violations appear to result in increased P600 amplitudes relative to their probable counterparts, supposedly because the violation is more unexpected and a strong conflict arises between the expected and the perceived input (Coulson, King, & Kutas, 1998; Gunter, Stowe, & Mulder, 1999; Hahne & Friederici, 1999). Other evidence for the sensitivity of monitoring to task demands comes from studies using a levels of processing approach, in which participants are either stimulated to shallow processing by judging the physical characteristics of a word in a sentence (i.e., judge whether a word was printed in upper case letters), or to deep processing by judging the grammatical correctness of a word in a sentence (Gunter & Friederici, 1999). Compared with the deep processing task, P600 amplitudes elicited by grammatical errors encountered during the shallow processing task appear largely reduced. Hence, task instructions appear to affect the control process triggered in case of linguistic violations. In line with this instruction effect, in a study by Vissers et al. (2007) participants were informed about the presence of certain semantic violations and were told not to be deceived by those, but to focus on the syntactic structure of the sentences instead. This instructed adjustment in processing strategy appeared to strongly attenuate the monitoring tendency, probably because of reduced conflict strength in case of semantic violations. Above all, processing strategies and linguistic competences can vary across individuals, making some individuals more sensitive to linguistic violations than others (Osterhout, 1997). Given that there are individual differences in sensitivity to linguistic violations, one could assume that, consequently, there are differences in the inclination to monitor. Findings from behavioral studies on comprehension monitoring, in which poor comprehenders and good comprehenders (i.e., individuals with similar decoding skill but different comprehension skill) are compared, seem supportive of this idea. It has been proposed that poor comprehenders tend to attend to the decoding of individual words, are less likely to notice anomalies in text (Yuill & Joscelyne, 1988; Yuill & Oakhill, 1988), and would not notice inconsistencies in information in relation to discourse or world knowledge (Garner, 1981). This suggests that there are individual differences in monitoring tendency, some individuals being more likely to monitor their understanding than others (Nation & Angell, 2006).

Altogether, the abovementioned findings clearly suggest that language comprehension is not an autonomous, algorithmic process. The quality of our understanding of language depends upon cognitive control processes such as monitoring. Moreover, the interaction between monitoring and language entails a dynamic process. Several variables appear to influence expectancy and conflict strength (such as linguistic context, task demands and individual strategies) and hence the cognitive control exerted for comprehension.

1.1. Monitoring in language comprehension in ASD

Given that ASD is associated with impairments in the understanding of language, the question arises as to whether these impairments might be related to differences in the inclination to monitor during language comprehension. The idea that cognitive control processes are involved in the language difficulties in ASD is consistent with findings from several previous studies. For instance, although people with ASD seem to have difficulties in deriving the correct pronunciation of a homograph (e.g., the word 'tear') from sentence context, they are able to do so when attention is explicitly directed towards sentence meaning with instructions (Snowling & Frith, 1986; Jolliffe & Baron-Cohen, 1999). Moreover, when provided with task instructions, adults with ASD appear to detect errors at global (syntactic) linguistic level with accuracy similar to that of a matched control group (Koolen, Vissers, Hendriks, Egger, & Verhoeven, 2012), but in individuals with ASD this error detection is associated with higher attentional costs, as shown by longer reaction times (Koolen et al., 2012) and broader distributed P600 effects (Koolen, Vissers, Egger, & Verhoeven, 2013). The finding that (higher-level) processing is sensitive to instructions suggests that language comprehension difficulties in ASD are related to differences in the process of cognitive control. Moreover, several researchers have reported relatively intact semantic or contextual priming at an early, implicit level of processing in individuals with ASD, but impaired processing of linguistic elements at later processing stages where linguistic input needs to be integrated to form a coherent representation of the input (Henderson, Clarke, & Snowling, 2011; Saldana & Frith, 2007; Tesink et al., 2011). Above, researchers have pointed out similarities in reading comprehension profiles of individuals with ASD and that of 'poor comprehenders'. As mentioned before, the poor comprehension profile in less skilled readers has been associated with superficial reading and a reduced tendency to monitor comprehension in order to detect comprehension failure (Nation & Angell, 2006). Reading comprehension in ASD is often characterized by a similar profile of intact word decoding skill and impaired comprehension skill (Nation, Clarke, Wright, & Williams, 2006). Several factors have been identified to play a