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Communication abilities of children with ASD and ADHD

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Discussion



The aim of this dissertation was twofold. First, the similarities and differences in language problems of children with ASD and children with ADHD were investigated. Different aspects of linguistic abilities, ranging from syntactic abilities to semantic and pragmatic abilities, were examined in three linguistic studies: 1) in a relatively natural (and therefore less structured) situation of narrative production, and in controlled language tasks that examined 2) the production of referring expressions and 3) the comprehension of referring expressions. Second, the role of three cognitive mechanisms (Theory of Mind, working memory, and inhibition) in narrative production and in the production and comprehension of referring expressions was investigated.

Language abilities of children with ASD

In this dissertation a broad language profile of the language problems and strengths was presented for children with ASD. Their language production was examined on different linguistic measures including: a) verbal productivity; b) speech fluency; c) syntactic complexity; d) lexical semantics; and e) discourse pragmatics. Several deficits in spontaneous language production were found (Chapter 3). These deficits were not only present on pragmatic measures such as the inability to produce a narrative in a cohesive and coherent way. Children with ASD also showed deficits on syntactic measures and speech fluency measures. They seemed to have most problems with syntactic complexity, and they produced many repetitions and frequently interrupted their stories. Also in their daily life, as reported by their parents, children with ASD showed problems in language use and sentence and discourse structure.

Furthermore, we examined their ability to take into account the grammatical perspective of their conversational partner in a controlled task (Chapters 4 and 5). Two studies were performed to investigate two linguistic phenomena for which it is hypothesized that speakers or listeners have to take the other person's grammatical perspective into account: the production of subject pronouns (*he/she*) (Chapter 4) and the interpretation of object pronouns (*him*) (Chapter 5). Despite the language impairments found in narrative production and parental questionnaires, and contrary to our hypothesis, grammatical perspective taking was found not to be impaired in ASD. We conclude that children with ASD take into account the opposite conversational perspective in both the production and the comprehension of referring expressions.

Language abilities of children with ADHD

Children with ADHD also showed several language impairments. In spontaneous narrative production, they have most problems in speech fluency and syntactic complexity. Also in daily life, as reported by their parents, children with ADHD showed deficits in language structure (comparable to the deficits reported in children with ASD), and language use (although less profound as in children with ASD) (Chapter 3). In the context of a controlled language task, children with ADHD did not have more problems with the interpretation of referring expressions, compared to TD children (Chapter 5). However, they showed some problems with the choice of referring expressions, in that they were less specific than the TD children both in the controlled language task (Chapter 4) and in the more natural situation of producing a narrative (Chapter 3). Since this underspecification was only found in contexts with more than one referent, this finding may reflect problems with keeping track of the referents in a more complex discourse, rather than problems with taking into account the other person's perspective.

Grammatical perspective taking in children with ASD and ADHD

Two linguistic phenomena for which it is hypothesized that speakers take into account the grammatical perspective of the listener or vice versa (Hendriks, Englert, Wubs & Hoeks, 2008; Hendriks & Spenader, 2006) were investigated in this dissertation: the production of and the interpretation of referring expressions. Children with ASD and children with ADHD were equally capable of grammatical perspective taking in the production and comprehension of referring expressions, compared to their TD peers (Chapters 4 and 5).

The finding that children with ASD or ADHD are capable of grammatical perspective taking does not imply that they take into account the perspective of their *actual* conversational partner in communication. As discussed in Chapter 4 and 5, grammatical perspective taking can be modeled as taking the perspective of a *hypothetical* speaker/listener, which can be understood as the child itself in the other role. This may be less demanding than taking the perspective of an actual conversational partner, who may have other knowledge than the child itself (e.g., other world knowledge, explicit knowledge of the situation, and knowledge of the specific discourse). Indeed, other studies found that children with ASD and children ADHD had problems with taking into account an actual speaker or listener (Dahlgren & Dahlgren Sandberg, 2008; Nilsen, Mangal, & Macdonald, 2013).

The findings of this dissertation have three implications. First, they indicate that problems with referring expressions in children with ASD or ADHD are caused by

deficits outside the grammar. In a controlled task, these children are capable of correctly interpreting and producing referring expressions. Therefore, observed problems in the choice of referring expressions are probably due to other factors, such as difficulty to keep track of a complex discourse due to working memory problems. As discussed in Chapter 4, for children with ADHD working memory was related to pronoun use when more than one character was present in the discourse. This indicates that children with ADHD may have difficulties with keeping track of referents in the discourse, even in a relatively simple and structured language task. A more complex discourse (such as in narrative production or in daily life communication) may place a greater burden on working memory and consequently cause problems in the language production of children with ASD and ADHD. Indeed, children with ASD and ADHD showed problems in verbal productivity, syntactic complexity and discourse pragmatics, which were all related to working memory performance. Hence, this suggests that these children's language problems are caused by deficits outside the grammar, such as working memory problems.

Second, this dissertation underlines the need to combine controlled language tasks with more natural (and hence less structured) situations, such as narratives. Investigating specific linguistic structures in a controlled task contributes to our knowledge of whether children with (or without) developmental disorders have difficulties with the linguistic structure per se. It aids in dissecting the specific problems children with ADHD and children with ASD have, and the problems they do not have, thus contributing to our overall understanding of these disorders. Additionally, to gain insights in the problems children may encounter in daily life, measures of linguistic performance in more natural situations (such as narrative production) as well as parental reports are useful. As found in this dissertation, although children with ASD and ADHD do not show language problems in controlled tasks, they clearly show language problems in less structured tasks and in daily life.

Third, this dissertation emphasizes the need to focus on language problems not only in ASD, but in ADHD as well. Clear deficits in their language use were reported by their parents and also found in their narrative production. At present, language and communication problems are part of the diagnostic criteria of ASD, and are often part of diagnostic assessments. This does not hold for ADHD. The difficulties in language and communication of children with ADHD may have consequences for their social functioning, since language plays a large role in social interaction. Therefore, it is important to screen for possible language problems during diagnosis and treatment in children with ADHD as well.

Theory of Mind in children with ASD and children with ADHD

In addition to language problems in children with ASD and ADHD, we investigated children's Theory of Mind performance. In Chapter 2 we showed that children with ASD and children with ADHD reveal comparable problems in Theory of Mind performance, consistent with findings of Buitelaar, Van der Wees, Swaab-Barneveld, and Van der Gaag (1999) and Caillies, Bertot, Motte, and Raynaud (2014), but contrasting with others (Charman, Carroll, & Sturge, 2001; Dyck, Ferguson, & Shochet, 2001). We found that the deficits in Theory of Mind performance of children with ADHD are associated with their problems with processing and actively maintaining a large amount of verbal information (i.e., working memory), while in the ASD group there seems to be a genuine Theory of Mind problem. This would suggest that social difficulties of children with ADHD may be caused by difficulties in working memory, rather than by difficulties to understand the rules of social communication and interaction. In contrast, children with ASD seem to have difficulties with the understanding of the rules of social interaction.

The studies that reported Theory of Mind problems in ADHD (including ours) all used False Belief tasks, while the other studies that found intact Theory of Mind in ADHD (Charman et al., 2001; Dyck et al., 2001) used the Strange Stories task (Happé, 1994). The Strange Stories task is shorter and contains less complex syntactic structures than False Belief tasks (cf. De Villiers, 2005). Therefore, it might be that Happé's Strange Stories task does not rely on working memory and verbal ability as heavily as False Belief tasks do. Hence, since we found an association of Theory of Mind performance with working memory and verbal ability in children with ADHD, we may expect that the ADHD group in our study would not show problems in the Strange Stories task. Following this suggestion, their expected performance would contrast with that of children with ASD: children with ASD who performed well on False Belief tasks, failed on the Strange Stories task (Happé, 1994). Happé claimed that the Strange Stories task is a more naturalistic test of Theory of Mind than False Belief tasks, because the stories are embedded in realistic contexts of everyday social situations. This would suggest that children with ADHD have fewer problems with Theory of Mind in daily life. However, real life social interaction involves the integration of information, for which sufficient working memory capacity is needed. Our results suggest that in situations in which their working memory is taxed, children with ADHD do have problems with taking the other person's perspective into account. Therefore, on the basis of our results, we would expect that children with ADHD show Theory of Mind like deficits in social interaction, manifest in, for example, difficulties to maintain reciprocal friendships (see also Nijmeijer et al., 2008).

Cognitive mechanisms in language production and comprehension

The second aim of this dissertation was to investigate the cognitive mechanisms underlying language production and comprehension. We examined whether the following mechanisms are involved in grammatical perspective taking: Theory of Mind, working memory, and inhibition. Two controlled tasks were performed to investigate two linguistic phenomena for which it is hypothesized that speakers and listeners have to take into account the other person's grammatical perspective: the production of subject pronouns (e.g., *he*) (Chapter 4) and the interpretation of object pronouns (e.g., *him*) (Chapter 5). It was found that Theory of Mind and inhibition were associated with grammatical perspective taking, while working memory was involved in keeping track of the referents in the discourse. Furthermore, Theory of Mind and working memory were associated with various linguistic skills in a more natural setting (i.e., the production of a narrative) as well (Chapter 3).

Our findings that Theory of Mind and inhibition are related to the production of subject pronouns and the comprehension of object pronouns support the theoretical analysis of these two phenomena in terms of grammatical perspective taking (Hendriks, 2014). We found effects of Theory of Mind and inhibition in both the production and the comprehension of referring expressions. This strengthens Hendriks' view (2014) that both speakers and listeners must take into account the other person's grammatical perspective. Working memory was not involved in grammatical perspective taking, but may be needed to maintain an up-to-date representation of the referents in the discourse (Chapters 4 and 5).

Our findings that grammatical perspective taking involves Theory of Mind-like processes as well as inhibition of one's own perspective may not only apply to referring expressions, but also to other linguistic phenomena that are thought to require listeners to take into account the perspective of the speaker, such as the interpretation of indefinite subjects and objects (De Hoop & Kramer, 2006), scalar reasoning (Noveck, 2001), and the interpretation of contrastive stress (Hendriks, De Hoop, Krämer, De Swart, & Zwarts, 2010). Future research investigating the relation of Theory of Mind and inhibition with these aspects of language may provide further support for the need of perspective taking in language comprehension and production.

We hypothesized that children with ASD and children with ADHD, who show problems with Theory of Mind and executive functioning, also have difficulties with (grammatical) perspective taking. However we did not find group differences in grammatical perspective taking (Chapter 4 and 5). Hence, the reported language problems in ASD and ADHD may not be caused by problems with grammatical perspective taking per se. It may be that these children have problems in integrating

all linguistic information at several levels (syntactic cues, lexical cues, discourse information) and that there is large variability in how children with ASD and ADHD resolve this potential overload of information. For example, one child may be able to take the other person's perspective into account but fail to consider the discourse while another child may use the discourse information but lack additional processing capacity to also take into account the other person's perspective. Whether children with ASD and ADHD indeed use different strategies in their production and comprehension of language in complex discourses is left for future research.

Furthermore, we did not find group differences in working memory or response inhibition between children with ASD or ADHD and TD children (cf. Happé & Frith, 2006; Ozonoff & Strayer, 2001; Ozonoff, Strayer, McMahon, & Filloux, 1994; Pennington & Ozonoff, 1996; Williams, Goldstein, Carpenter, & Minshew, 2005). Nonetheless, Theory of Mind performance was mediated by working memory in the ADHD group (Chapter 2). This illustrates the heterogeneity of ASD and ADHD (e.g., Sonuga-Barke, 2002). That is, deficits in working memory are found in some, but not all children with ASD and ADHD. Likewise, there is variation in working memory capacity in TD children. This overall heterogeneity illustrates the relevance of examining cognitive mechanisms underlying language production and comprehension (i.e., regardless of group differences).

Future directions

This dissertation focused on the production and comprehension of referring expressions. Further research is needed to unravel other language deficits of children with ASD and children with ADHD. Both narrative production and parental questionnaires revealed various linguistic areas in which these children show problems (such as problems with complex syntax and speech fluency). We suggest investigating these linguistic areas in controlled tasks (as we did for referring expressions) in order to further our understanding of how these language problems come about.

Furthermore, in this dissertation, Theory of Mind, response inhibition and working memory were examined as mechanisms underlying language abilities. However, these cognitive functions can be operationalized in multiple ways and many different tasks to measure these three functions have been developed. Future research may therefore include other linguistic as well as cognitive tasks to understand the observed variation in language abilities, including language deficits.

First, to capture Theory of Mind performance we chose to use a False Belief understanding task, because in our view this is the Theory of Mind ability that is most closely related to perspective taking in language. In perspective taking, a speaker or

listener needs to take into account the (grammatical) perspective of the other person, which may differ from his or her own perspective. This resembles the concept of False Belief, which is the understanding that a person has his or her own beliefs and that these can be different from reality or from someone else's beliefs. Still, as mentioned above, the Strange Stories task may yield different results regarding the role of Theory of Mind in the linguistic performance of children with ASD and ADHD. Particularly, because there seems to be an opposite pattern of performance on False Belief tasks versus performance on the Strange Stories task between the two groups: Children with ASD have more difficulties with the Strange Stories task than with a False Belief task (Happé, 1994), while children with ADHD seem to perform well at the Strange Stories task (e.g., Charman et al., 2001) but fail at False Belief tasks (Chapter 2). The difference between these two Theory of Mind tasks may also be reflected in their relation with linguistic measures. For example, the Strange Stories task (which includes items about non-literal interpretation of language) may only relate to pragmatic measures, while Theory of Mind performance on the False Belief task is associated with linguistic abilities on different levels, from grammatical perspective taking (Chapters 4 and 5) to semantic and pragmatic levels (Chapter 3).

Second, to capture response inhibition, we used the Stop Task, which has been found to be a reliable and valid measure of response inhibition (Kindlon, Mezzacappa, & Earls, 1995; Tannock, Schachar, Carr, Chajczyk, & Logan, 1989). Yet, it may be worthwhile to investigate the relation with other inhibition skills, particularly between interference control (cognitive inhibition) and linguistic abilities. Even though we showed the relevance of motor response inhibition (Chapters 4 and 5), the inhibition of competing words and structures during sentence production may more resemble performance on an interference control task than on a motor response inhibition task. In support of this idea, a relation between interference control and verbal fluency has previously been found, but not between response inhibition and verbal fluency (Engelhardt, Nigg, & Ferreira, 2013; Shao, Janse, Visser, & Meyer, 2014).

Third, working memory can also be operationalized in different ways. Here, we used an n-back task to capture working memory. Yet, working memory as measured by a reading or listening span task (Daneman & Carpenter, 1980) may resemble the memory processes needed for communication more than performance on an n-back task. However, reading and listening span tasks are highly dependent on language abilities, such as language comprehension (Daneman & Merikle, 1996). Therefore, it may be hard to disentangle the working memory component from general language comprehension in listening span tasks.

In this dissertation we examined the relation between language and three cognitive functions: Theory of Mind, working memory and inhibition. However, other cognitive functions are likely to be involved in communication as well, such as cognitive flexibility, planning and sustained attention. For example, it is likely that

cognitive flexibility plays a role in grammatical perspective taking, since speakers and listeners must switch from their own perspective to the other person's perspective. These cognitive functions have been found to be impaired in ASD and/or ADHD (e.g., Hill, 2004; De Vries & Geurts, 2012; Willcutt et al., 2005). The role of these other cognitive functions in communication of children with and without developmental disorders is left for further study.

While it is clear that language and Theory of Mind are associated, the direction of this association is debated. It may be that the association between language and Theory of Mind merely reflects the fact that most False Belief tasks are verbal tasks. However, we showed that lexical-verbal ability mediates performance on the Theory of Mind tasks in children with ADHD, but not in children with ASD. This finding suggests that the association between language abilities and performance on Theory of Mind tasks thus entails more than merely the fact that the tasks are verbal. Some researchers argue that language plays a causal role in the development of Theory of Mind: either because conversations with adults bring the concept of mental states to the attention of the child (e.g., Nelson, 1996) or because the syntax provides the representational format that is needed for False Belief understanding (e.g., De Villiers, 2005). The design of our study did not enable us to determine the direction of the associations between linguistic abilities, on the one hand, and Theory of Mind and executive functioning, on the other hand. Clearly, a longitudinal design provides more insight in the direction of the relation between language, Theory of Mind and executive functioning. Based on this dissertation, we recommend including controlled linguistic tasks as well as more natural language measures, in order to further unravel these associations.

Finally, as discussed above, there was large heterogeneity in Theory of Mind, executive functioning and language measures. That is, although we found group differences in Theory of Mind and linguistic measures at the narrative task, there were children with ASD or ADHD who performed well at Theory of Mind tasks and narrative production. Similarly, although we did not find group differences in the comprehension of referring expressions, working memory performance or inhibition performance, some children showed problems on these tasks. Whether more homogeneous subgroups in ASD or ADHD can be identified who have specific linguistic and cognitive deficits (cf. Fair et al., 2012; Munson et al., 2008) is left for further research.

Conclusion

This dissertation shows that not only children with ASD, but also children with ADHD have clear deficits in language production and comprehension and in Theory of Mind performance. Both groups show problems in narrative production and in language use in daily life, although the deficits in ASD are in general more profound than in ADHD. Additionally, both children with ASD and children with ADHD show deficits in Theory of Mind performance. Nevertheless, both children with ASD and children with ADHD are capable of taking the other person's grammatical perspective into account in their production and comprehension of referring expressions.

In addition to similarities in language and Theory of Mind problems between the two groups, there are also differences. Children with ASD show most deficits in syntax and pragmatics, while children with ADHD have most problems in their choice of referring expressions and their fluency of speech. Furthermore, different mechanisms seem to underlie children's performance in the ADHD group compared to the ASD group. Working memory is involved in Theory of Mind performance and in the production of referring expressions of children with ADHD, but not of children with ASD.

This dissertation showed further that individual differences in Theory of Mind and response inhibition are associated with performance on the production and comprehension of referring expressions. This supports the view that speakers and listeners must take the other person's grammatical perspective into account in their production and comprehension of referring expressions. In addition, working memory is not needed for grammatical perspective taking, but appeared to be involved in keeping track of the different referents in the discourse.

