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Augmented feedback in autistic disorder

Authors:
Salome Geertsema[1]
Michelle McDonald[1]
Aletta Van der Merwe[1]
Margaretha Swanepoel[1]
Esedra Strasheim[1]

Affiliations:
[1]Department of Speech-Language Pathology and Audiology, University of Pretoria, South Africa

Corresponding author:
Salome Geertsema,
salome.geertsema@gmail.com

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Children with autistic disorder (AD) display atypical eye contact and struggle with the social imitation of eye contact. Impaired social imitation may be indicative of disruptions in motor learning processes. The application of specific motor learning principles, such as external feedback, may suggest which variables will result in positive change in eye contact. The study aimed to determine the effects of knowledge of performance (KP) and knowledge of results (KR) as types of feedback on the frequency and duration of elicited and spontaneous eye contact in children with AD. A two-phase multiple-probe, multi-treatment (cross-over), single-participant design with a withdrawal component was used. Mixed treatment effects were obtained. Overall effects suggest that KR results in the greatest positive change over a short period of time regarding frequency and duration for both elicited and spontaneous eye contact. This type of feedback seems to be the most effective for spontaneous eye contact. The provision of KP, after elicited and spontaneous eye contact, produced positive effects for duration only. The current Phase 1 evidence suggests that KR (which is goal-directed with fewer additional instructions) may be more beneficial to children with AD. These findings are in accordance with the limb motor learning literature and may therefore support preliminary evidence for disrupted motor learning during eye contact imitation in children with AD.

Introduction

Atypical eye contact in autistic disorder

Children with autistic disorder (AD) experience difficulty in using eye contact to initiate and sustain social interaction (Daou, Vener & Poulson 2014). These children avoid eye contact and seem to look past others (Daou et al. 2014). These deficits in eye contact may contribute to difficulties in language acquisition and social responsiveness because of diminished object and person engagement and social interaction regulation (Arnold et al. 2000; Carbone et al. 2013; Kékes Szabó & Szokolszky 2013; Senju et al. 2008). Various factors, including sensory modulation, contribute to atypical eye contact in children with AD (Arnold et al. 2000; Carbone et al. 2013; Bhat, Landa & Galloway 2011; Senju et al. 2008). Evidence for and details regarding these possible factors are scarce (Arnold et al. 2000; Bhat et al. 2011; Carbone et al. 2013; Senju et al. 2008), but there are indications that children with AD present with atypical processing of eye contact in the occipital lobe, in most instances (Senju et al. 2008). The gaze-avoidance theory states that children with AD become negatively over-aroused by direct gaze during sensory modulation and consequently avoid it (Kylliäinen et al. 2012). However, these authors found that the approach and avoidance mechanisms of children with AD were lacking (Kylliäinen et al. 2012). These mechanisms typically motivate a person to initiate social eye contact and social engagement. The researchers proposed that an avoidance of the direction or approach of the affective-motivational brain response to direct gaze, more than the intensity of the arousal, may account for a lack in motivation to make eye contact. The lack of eye contact may therefore indicate passive omission rather than deliberate avoidance (Kylliäinen et al. 2012). Rondan and Deruelle (2007) described a processing style in children with AD, which involves focusing on facial features to determine direct gaze. This processing style suggests a cognitive style that prefers featured processing (local perceptual processing style) (Senju et al. 2008). The preferred processing style reflects typical dysfunctional central cognitive processing traits in persons with AD, such as the reduced ability to process global context. Regardless of the reasons behind atypical eye contact in children with AD, the practical implication is that it reduces early face-to-face interactions with caregivers from infancy (Kékes Szabó & Szokolszky 2013). These reduced interactions imply reduced opportunities for social learning through imitation (Ingersoll, Schreibman & Tran 2003) and thus atypical early communication development during caregiver–child interaction. This atypical early development may ultimately have a possible impact on attachment with the primary caregiver.

Note: The Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM-V) changed the diagnostic characteristics of ASD by grouping the PDD subtypes into a single category (McPartland, Reichow, & Volkmar, 2012). For the purpose of this study, the researchers used the term 'autistic disorder' to describe the respective diagnosis of the participant according to the DSM-IV (American Psychiatric Association 2000).

Imitation deficits in autistic disorder

Imitation in infants and young children serves as a basis for learning and social functions when establishing appropriate social functions within communication interactions (Ingersoll et al. 2003). Imitation deficits found in children with AD were previously thought to be caused by mirror neuron deficits. Mirror neurons are found in areas of the brain that are active during imitation of another person's actions; however, imitation deficits may in fact be indicative of motor deficits, which involve motor planning, motor sequencing and disruptions in motor learning (Bhat et al. 2011; Clifford & Dissanyake 2009; Uljarevic & Hamilton 2013; Ingersoll et al. 2003). Dziuk et al. (2007) attribute these disruptions to possible deficits in the connections between the frontal, parietal, subcortical, and cerebellar regions of the brain. Motor learning supports the way in which a child explores and understands the world. This exploration and understanding affects social interaction and a negative influence may be exercised by, for example, limited head movement. Uncoordinated head movement may lead to joint attention deficits and limited social participation (Bhat et al. 2011). Another distinctive aspect of social imitation is its incentive-driven nature, in the sense that there is typically a significant motivation to imitate (Bhat et al. 2011).

Children with AD do not understand the significance of eye contact from a social communication perspective (Bayram & Esgin 2013). They do, however, exhibit intact goal-directed imitation (Wild et al. 2012). Providing feedback to highlight the task goal may result in improved imitation of the observed eye contact behaviour. Ingersoll et al. (2013) found that the provision of external feedback draws attention to the skill and creates a motor goal, which makes the behaviour that children with AD have to imitate easier to interpret. Augmented feedback may therefore benefit children with AD on a motor level, even though they have a low social motivation to make eye contact (Bhat et al. 2011; Ingersoll et al. 2013).

Motor learning and motor learning principles

Motor learning is a set of internal procedures resulting in permanent alterations in movement and response skills through practice (Kim, LaPointe & Stierwalt 2012; Maas et al. 2008). A motor skill reflects a task that has a specific purpose or goal to achieve (Magill & Anderson 2013). Augmented feedback is a motor learning principle that provides an individual with information that he is unable to detect through his own sensory system (Magill & Anderson 2013). This feedback is provided irrespective of the accuracy of the attempt and serves two main purposes (Maas et al. 2008; Magill & Anderson 2013). The first is, to facilitate the achievement of a movement skill at a faster rate by helping the child to determine what he is doing that helps or hinders task performance (Magill & Anderson 2013). Secondly, it motivates the child to reach the movement goal (Magill & Anderson 2013). The first category of external augmented feedback, Knowledge of results (KR), is the feedback that is provided after task conclusion. This type of feedback indicates how close the attempt was to achieving the intended goal (Kim et al. 2012; Maas et al. 2008; Magill & Anderson 2013). KR provides information about the outcomes of the performed task (Magill & Anderson 2013). The second category of feedback, Knowledge of Performance (KP), provides detailed information specific to task performance. Task performance reflects the characteristics of the movement that led to the performance outcomes (Kim et al. 2012; Magill & Anderson 2013). Information from past experiences and task performance outcomes, as gained through feedback, creates schemas that are essential in the learning process (Maas et al. 2008).

Managing eye contact in children with autistic disorder

Motor learning and operant conditioning underlie Applied Behaviour Analysis (ABA)–motivated interventions (Bhat et al. 2011). ABA is the analysis and improvement of socially significant behaviour. These intervention strategies include the management of poor eye contact as a prerequisite skill for more complex behaviours (Bhat et al. 2011). The management of poor eye contact may improve other affected developmental areas such as language and pragmatics. The unique characteristics of children with AD warrant an eclectic approach to behavioural aspects of social interaction treatment (Bhat et al. 2011).The investigation of isolated aspects of motor learning in this population may overcome certain methodological limitations imposed by specific variables of motor learning theory and the various approaches to teaching motor skills such as eye contact in children with AD. Unfortunately, there is a dearth of research regarding the efficacy of targeting these isolated aspects of motor learning in eclectic intervention approaches (Oostyen 2011). The management of eye contact in children with AD is advocated in ABA, but literature lacks detailed investigation regarding effective eye contact interventions (Ospina et al. 2008). A few authors such as Carbone et al. (2013) suggested that eye contact interventions should include verbal and physical prompts in combination with reinforcement. These researchers found that prompts need fading and are time consuming, but will reduce maladaptive behaviours such as avoidance of eye contact. Their suggested social interactive behavioural strategies included extrinsic reinforcement such as praise, edible items and other tangible objects, although these could preclude generalisation of skills (Carbone et al. 2013).

Rationale for the current study

Children with AD display atypical eye contact (Daou et al. 2014) and struggle with the social imitation aspect of developing appropriate eye contact (Bhat et al. 2011). Impaired social imitation may be indicative of disruptions in motor learning processes (Bhat et al. 2011; Clifford & Dissanyake 2009; Ingersoll et al. 2003). The application of specific motor learning principles may suggest ways to manage and improve these motor learning processes and determine which detailed variables will result in positive change in eye contact interventions.

Augmented external feedback is an example of such a motor learning principle (Magill & Anderson 2013). Previous studies have found increased eye contact in response to augmented external feedback (Oostyen 2011). Detailed evidence of the effectiveness of isolated aspects (such as the type of extrinsic verbal reinforcement) is lacking (Bhat et al. 2011). Because children with AD exhibit intact goal-directed imitation (Wild et al. 2012), providing feedback to highlight the task goal may not only benefit the motivation to imitate but also improve the motor learning which takes place during eye contact imitation. This hypothesis led to the following research question: What is the effect of two types of augmented feedback when establishing eye contact in a child with AD?

Objectives of the study

The main objective of the study was to determine the effect of different types of feedback when establishing eye contact in a child with AD. A secondary objective was to compare the effect of KP to KR feedback as a motor learning principle, when establishing eye contact in a child with AD.

Research design

Setting and materials

Treatment was conducted in rooms at the speech-language pathology clinic of a South African university. A clinician was assigned to each of the three participants. Digital video cameras were set up in the corner of each room to record the probes. Equipment used to elicit eye contact included a ball, an iPad, balloons, and soft toys. (The complete elicitation and treatment protocol is available in Appendixes 1 and 2). The Draw-a-Person Test (Goodenough 1926) was probed as control behaviour.

The choice of this test as control behaviour was based on its relative stability in cognitive maturation for the duration of the treatment phases (Goodenough 1926). Any improvement in the scores of this test was unlikely during the time frame of the present research, and any changes in behaviour could therefore be attributed to the treatment alone.

Participant

An English male participant aged 5 years 5 months was included in the study. He had previously been diagnosed with AD according to the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (American Psychiatric Association 2000) by paediatric neurologists. The communication profile of the participant (adapted from Pepper & Weitzman 2004) is described as a first word user and unintelligible.

The participant was recruited via convenience sampling from a speech-language pathology clinic. Hearing screening at the clinic indicated that the participant has normal hearing. He had not received any previous treatment for social or communication difficulties. Individual levels of communication functioning for the participant were not regarded as specific inclusion or exclusion criteria as the objective was to investigate eye contact alone.

Ethical considerations

The study was approved by a departmental research ethics committee at a South African university. No adverse techniques were applied during intervention and participants were given the option of discontinuing a session or the trial at any time. Participant assent was obtained by means of a child assent form. Parents gave written informed consent for the child to participate. All identifying information of the participant was kept confidential.

Design

A two-phase, multiple-probe, multi-treatment, single-participant design with a withdrawal component was used. Treatments were counterbalanced across phases to control the order effect (Hegde 2003). Treatment performance effects were determined. Treatment refers to the elicitation of eye contact and the augmented feedback provided once eye contact had been established and also to spontaneous eye contact moments when augmented feedback was provided. The participant received feedback (KR and KP) during alternating treatment phases. The first week of data collection was allocated to baseline probing. Phase 1 of treatment was conducted during weeks 2–4. A withdrawal period of 1 week followed during which an extended baseline probe was conducted. Phase 2 of treatment followed during weeks 6–9. A third extended baseline probe was conducted a week after the final week of treatment.

Method

Pre-treatment procedures

The speech-language abilities of the participant were assessed and recorded for the purpose of monitoring general progress. These results were not the focus of the present study and are therefore not included here. No treatment was conducted prior to the treatment phases.

Treatment and probing

Treatment procedures

The participant received 12 treatment sessions, 6 sessions for each of the 2 phases. Treatment sessions were conducted twice weekly. The first treatment session of each week lasted an hour. Eye contact was addressed throughout this session of play-based communication treatment, through random repetitive elicitation via the elicitation protocol (Appendixes 1 and 2). Augmented feedback was provided for each successfully elicited moment of eye contact (Appendixes 1 and 2) and for moments of spontaneous eye contact. The second treatment session of each week consisted of 15 min eye contact treatment conducted in the same way as the first session. Augmented feedback was also provided in the same way as the first session. These initial 15 min of treatment were followed by 30 min of probing as described under probing procedures. The second weekly session then concluded with another 15 min of treatment conducted in the same manner as the initial 15 min, and the hour treatment of the first weekly session. The speech-language therapist adhered to a treatment hierarchy protocol to ensure treatment fidelity and reliability (Appendix 1).

Probing procedures The Draw-a-Person Test (Goodenough) was probed as control behaviour prior to and post-treatment as individual control behaviour. The probing protocol was designed according to considerations suggested by the What Works Clearinghouse (Kratochwill et al. 2010).

Because of the restricted time frame of the study and the variability in behaviour of children with AD, only two pre-treatment baseline probes for eye contact frequency and duration were obtained prior to the onset of the study during play-based language stimulation sessions. The same eye contact elicitation protocol as for treatment was followed during these pre-treatment probes (Appendixes 1 and 2). No feedback regarding eye contact was given during the probing sessions (Appendix 2). Digital recordings of the treatment probes were made during the mid-treatment 30 min of every second weekly treatment session and during withdrawal periods. The use of mid-treatment time for probing minimised the effect of settling in to the session at the start and possible fatigue at the end of the session. Attempts at elicited eye contact were carried out by briefly placing an object in front of the face of the speech-language therapist to draw attention to the eyes. This procedure was carried out every 3 min for the first 15 min of the probe.

Spontaneous eye contact was measured throughout the 30-min probe.

The digital recordings of both phases of treatment were used for visual analysis and scored by a panel of three independent and untrained viewers. The number and duration of both spontaneous and successfully elicited eye contact occurrences were scored for each participant for each probe session. These eye contact occurrences were scored for KR and KR feedback conditions, respectively. The panel was guided by specific guidelines for scoring (Appendix 3). Inter-rater reliability was calculated after scoring by calculating the percentage of disagreements for a randomised probe (mean percentage of disagreement 6.53%; range: 5.56% – 8.40%).

High inter-rater reliability, with a set criteria of 80% or higher, was therefore established. The results on the recording sheets were analysed in Microsoft Excel (2010). The frequency and duration counts were analysed to determine the treatment effects for KP and KR. Two sets of data were analysed for each treatment condition (KR and KP) in order to determine the treatment effect sizes for the acquisition of eye contact skills. These data sets were analysed according to Cohen's formula (1988, as cited in Beeson & Robey 2006). He defined a *d*-value of 0.00–0.19 as an insignificant effect, a *d*-value of 0.20–0.49 as a small effect, a *d*-value of 0.50–0.79 as a medium effect and a *d*-value of 0.8 or larger as a large effect (Beeson & Robey 2006).

Results and discussion

Data for the participant are presented in Table 1 and Figure 1. Square markers indicate spontaneous eye contact probes, and diamond markers successfully elicited eye contact probes. The control probes consisting of pre-test and post-test values for the Goodenough Draw-A-Person test are not indicated on the graphs. The vertical lines across the graphs separate the phases.

The participant showed no improvement in his ability to draw a person. His age-equivalent scores remained stable at <3y3m, <3y3m and <3y3m. Experimental control was maintained.

Maturation, history of event, or the repeated assessment can therefore be ruled out as contributing to possible treatment effects. The participant always required a family member in the room, which was distracting at times. The data for KR probe session 1 and KP probe session 1 were normalised as these two sessions were ended earlier than planned, upon request of the mother. However, as these two probes were not included in the calculation of the two data sets, it did not influence the calculation of effect sizes.

Elicited eye contact

During Phase 1 the participant was provided with KR. The value was 3.67 for successfully elicited eye contact frequency (SD = 1.53), compared to the value of 3.33 (SD = 1.89). The d-index of 0.20 reflects a small effect. Elicited eye contact duration had a value of 1.62 s (SD = 0.62) and a value of 1.19 s (SD = 0.03), resulting in a d-index of 1.12 (large positive effect). KP was provided during Phase 2. The elicited eye contact frequency value of 3.33 was measured against the value of 2.00 (SD_{pooled} = 1.41).

The d-index of 0.94 signifies a large effect. Elicited eye contact duration produced a value of 1.09 s and a value of 1.33 s (SD_{pooled} = 0.14). The d-index of -1.73 signifies a large negative effect.

Spontaneous eye contact

In Phase 1 (KR) spontaneous eye contact frequency had a value of 75.33 (SD = 12.66) and a value of 27.83 (SD = 10.61).

TABLE 1: Effect sizes for participant.

	Condition	Elicited		Spontaneous	
		Frequency	Duration	Frequency	Duration
Phase 1	KR	Small +	Large +	Large +	Small -
Phase 2	KP	Large +	Large -	Small +	Large -

KP, knowledge of performance; KR, knowledge of results.

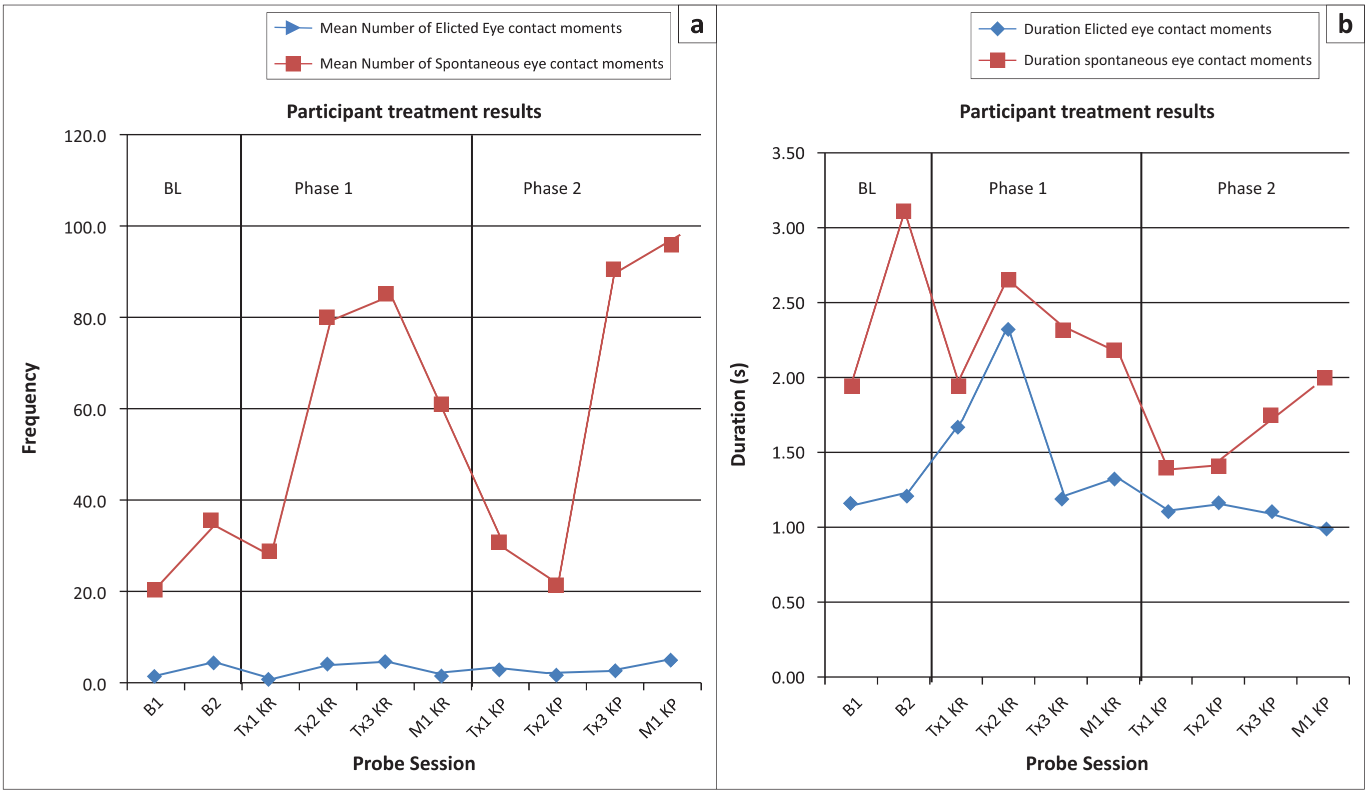

FIGURE 1: Mean number (a) and duration (b) of elicited and spontaneous eye contact moments.

The resulting d-index of 4.01 indicates a large positive effect. Spontaneous eye contact duration produced a value of 2.38 (SD = 0.24), and the value it was measured against was 2.52 s (SD = 0.83). The d-index was -0.29 (small negative effect). For Phase 2 (KP) spontaneous eye contact frequency produced a value of 69.33 and a value of 61.00 (SD_{pooled} = 0.14). The d-index of 0.24 reflects a small positive effect. The duration of spontaneous eye contact had a value of 1.72 s and a value of 2.19 s (SD_{pooled} = 0.33).

These values resulted in a d-index of -1.40 (large negative effect).

The KR phase reflected small negative (elicited frequency) and large positive (elicited duration and spontaneous frequency) effect sizes. A small decline from baseline conditions was calculated for the duration of the spontaneous eye contact moments. KR was effective in increasing successfully elicited eye contact behaviour. The small decline in spontaneous eye contact duration is challenging to interpret. As there was a large increase in spontaneous eye contact frequency, it is possible that the measures chosen precluded accurate measurements of therapeutic effects.

The participant may have displayed more frequent eye gaze responses for shorter periods, which could have led to increased overall looking time per session. This measure was not within the scope of the current study. If accurate, the current findings would support the longstanding reporting of Kendon and Cook (1969) that eye contact frequency and duration are negatively correlated. The KP phase reflected large and small positive effects sizes for the number of successfully elicited and spontaneous eye contact moments, respectively. The duration of elicited and spontaneous eye contact showed a noticeable decline from baseline conditions for KP. Clifford and Dissanyake (2009) suggest that the frequency of eye contact is of less importance than the quality of eye contact for later social competence. The increase in eye contact frequency may not necessarily predict better social-communicative outcomes (Clifford & Dissanyake 2009). It is interesting to note that the KP protocol prompted for longer looking. The fact that frequency increased and not duration, may therefore also reflect the goal-directed theory, rather than providing support for the theory that the children would avoid additional instructional steps (Carbone et al. 2013). The same argument for measurement parameters and negative correlation, as described for KR, may be applicable here.

Conclusions

The study aimed to determine and compare the effect of KP and KR on spontaneous and elicited eye contact frequency and duration. Mixed treatment effects were obtained for the different phases. Overall effects suggest that KR feedback results in the greatest positive change over a short period of time regarding frequency (elicited and spontaneous) and duration (elicited) of eye contact. Furthermore, providing this type of feedback seems to be the most effective when eye contact has been established spontaneously. This is positive, because spontaneous eye contact is more important for social competence (Clifford & Dissanyake 2009).

The current Phase 1 evidence (Beeson & Robey 2006) supports the finding that children with AD do not understand the significance of eye contact from a purely social-communication perspective and may not benefit from inherent social rewards associated with eye contact (Bayram & Esgin 2013). They do, however, benefit from external feedback (Ingersoll et al. 2003) and are goal-directed (Wild et al. 2012). KR may therefore be more beneficial to children with AD as it is goal-directed (Wild et al. 2012) but involves fewer additional instructional steps (Carbone et al. 2013). Moreover, these additional instructional steps, included in KP, contain verbal prompts to which children with AD do not always respond positively because of the social-communicative nature of the prompts. Several studies suggest that providing external feedback to children with AD may provide them with both the motor goal for a skill and the social motivation to perform such an action. Few of these studies investigated eye contact as skill (Bhat et al. 2011; Ingersoll et al. 2003) or the specific type of feedback provided by the clinician. The current study concluded that the provision of a specific type of feedback – KR – may benefit children with AD the most by providing them with a specific goal, although participants possibly still lacked the social motivation to make eye contact. KR-augmented feedback may therefore be considered more useful to clinical practice because it yielded the greatest positive change in a relatively short time period. As such, it may also be used in treatment of children with AD as an external antecedent technique.

Limitations and suggestions for further research

A number of factors that may influence results of controlled single-participant designs are encountered when working with children with AD: eye gaze, individual levels of arousal, attention and emotions. Most of these factors could be related to methodological constraints. A criticism for using verbal reinforcement for children with AD is that there are many paralinguistic variables that have to be processed and fixating on a specific part of the message may result in failure to receive the intended message (Oostyen 2011). A final note of causation towards generalisation of results is the small sample size in this multiple single-subject study. The proposed design included most of the levels of evidence and design considerations suggested by Kratochwill et al. (2010), but evidence should still be recognised within-subject rather than generalised to the entire paediatric population with AD. As such, each of the participants should be viewed as providing individual levels of evidence.

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Competing interests

The authors declare that they have no financial or personal relationships which may have inappropriately influenced them in writing this article.

Authors' contributions

S.G. designed the study, set up the treatment protocol and compiled the article. M.M., A.V.d.M. and M.S. contributed to the data collection and interpretation of the results. E.S. assisted in the writing of the article.

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Appendix 1

APPENDIX 1: Treatment design with different phases and probes.

Treatment Phase 1		Treatment Phase 2	
Treatment type/ condition	**Description**	**Treatment type/condition**	**Description**
Knowledge of Results	'Hey! Good looking at my eyes! Thank you!'	Knowledge of Performance	'Try looking at my eyes for longer'.
Treatment Stimuli	*KR with ball* • *Method:* Place the ball in front of the clinician's face briefly and contingently provide KR. • *Interval:* Once every 3 min throughout the treatment. *KR without ball* A continuous schedule will be followed by providing KR every time after the participant makes spontaneous eye contact with the clinician.	*Treatment Stimuli*	*KP with ball* • *Method:* Place the ball in front of the clinician's face briefly and contingently provide KP. • *Interval:* Once every 3 min throughout the treatment. *KP without ball* A continuous schedule will be followed by providing KP every time after the participant makes spontaneous eye contact with the clinician.
Probe Stimuli	*Treated Probe: KR with ball* • *Method:* Place the ball in front of the clinician's face briefly and contingently provide KR. • *Interval:* Once every 3 min throughout the first 12 min of the total probe. • *Number of probes:* Five treated probes will be obtained. *Transfer Probe: KR without ball* • *Method:* Provide KR when the participant makes spontaneous eye contact. • *Interval:* Every time the participant makes spontaneous eye contact. • *Number of probes:* Specific to the amount of spontaneous eye contact made by the participant.	*Probe Stimuli*	*Treated Probe: KP with ball* • *Method:* Place the ball in front of the clinician's face briefly and contingently provide KP. • *Interval:* Once every 3 min throughout the first 12 min of the total probe. • *Number of probes:* Five treated probes will be obtained. *Transfer Probe: KP without ball* • *Method:* Provide KP when the participant makes spontaneous eye contact. • *Interval:* Every time the participant makes spontaneous eye contact. • *Number of probes:* Specific to the amount of spontaneous eye contact made by the participant.
Control Stimuli	*Good Enough Draw-a-Person Test.* • Once during pre-treatment. • Once during Phase 1.	*Control Stimuli*	*Good Enough Draw-a-Person Test.* • Once during Phase 2.

KP, knowledge of performance; KR, knowledge of results.

Appendix 2

APPENDIX 2: Treatment protocol for knowledge of results and knowledge of performance conditions.

Time of session	Knowledge of results	Knowledge of performance
First 15 min of the session	1. Meet and greet: Model appropriate verbal and non-verbal greeting pragmatics and language. 2. Orientation to the session: Explanation of the temporal layout of the session using a visual time table. 3. Phonological awareness: Book reading and rhyming activities in order to provide exposure to the sound structure of English. According to the hierarchy of Bernthal, Bankson and Flipsen (2009). Treatment of eye contact will occur throughout all three activities. Every time the participant makes spontaneous eye contact, KR feedback will be provided. In addition, a ball will briefly be placed in front of the clinician's face every 3 min to elicit eye contact. Every instance of eye contact will be followed by: 'Hey! Good looking at my eyes! Thank you!' A continuous feedback schedule will be followed (Roth & Worthington 2011).	1. Meet and greet: Model-appropriate verbal and non-verbal greeting pragmatics and language. 2. Orientation to the session: Explanation of the temporal layout of the session using a visual time table. 3. Phonological awareness: Book reading and rhyming activities in order to provide exposure to the sound structure of English. According to the hierarchy of Bernthal et al. (2009). Treatment of eye contact will occur throughout all three activities. Every time the participant makes spontaneous eye contact, KP feedback will be provided. In addition, a ball will briefly be placed in front of the clinician's face every 3 min to elicit eye contact. Every instance of eye contact will be followed by: 'Try looking at my eyes for longer!' A continuous feedback schedule will be followed (Roth & Worthington 2011).
Middle 30 min of the session	Conduct treatment and maintenance probes as discussed in Appendix 1. The following activities will be completed: 1. Turn taking 2. Requesting 3. Protesting 4. Focused stimulation of target words (Roth & Worthington 2011)	Conduct treatment and maintenance probes as discussed in Appendix 1. The following activities will be completed: 1. Turn taking 2. Requesting 3. Protesting 4. Focused stimulation of target words (Roth & Worthington 2011)
Last 15 min of the session	1. Naturalistic Language Intervention: The clinicians will provide language elicitation and stimulation using a common theme with graded levels of difficulty specific to the level of each participant. *Language elicitation techniques to create opportunities for the participant to communicate:* A combination of the following techniques as described by Owens (2009): Silence, pausing, unfinished activities, unfinished sentences, mand-model, high interest activities and questions. *Language stimulation techniques focused on objects or actions of immediate interest to the child:* A combination of the following techniques as described by Owens (2009): Labelling, modelling, expansion, extension, recasting, rephrasing, commenting, imitating, repeating, self-talk, parallel talk, emphasising, build-ups and break downs and focused stimulation 2. Literacy Pre-literacy activities: • Reading: Holding book right side up, tracking from left to right page, distinguishing between pictures and print, showing sustained interest during book-reading, recognises own name. • Writing: Scribbling, correct writing posture, copying line, circle, cross, block, triangle, diamond, tracing letters, copying letters and words, writing own name. • Phoneme–grapheme coupling will be targeted by implementing the phoneme song in combination with visual stimuli and writing task, in accordance with each participant's level of literacy. These activities will be individualised to each participant. 3. Greeting Model-appropriate verbal and non-verbal greeting pragmatics and language. Treatment of eye contact will occur throughout all three activities. Every time the participant makes spontaneous eye contact, KR feedback will be provided. In addition, a ball will briefly be placed in front of the clinician's face every 3 min to elicit eye contact. Every instance of eye contact will be followed by: 'Hey! Good looking at my eyes! Thank you!' A continuous feedback schedule will be followed (Roth & Worthington 2011).	1. Naturalistic Language Intervention: The clinicians will provide language elicitation and stimulation using a common theme with graded levels of difficulty specific to the level of each participant. *Language elicitation techniques to create opportunities for the participant to communicate:* A combination of the following techniques as described by Owens (2009): Silence, pausing, unfinished activities, unfinished sentences, mand-model, high interest activities and questions. *Language stimulation techniques focused on objects or actions of immediate interest to the child:* A combination of the following techniques as described by Owens (2009): Labelling, modelling, expansion, extension, recasting, rephrasing, commenting, imitating, repeating, self-talk, parallel talk, emphasising, build-ups and break downs and focused stimulation 2. Literacy Pre-literacy activities: • Reading: Holding book right side up, tracking from left to right page, distinguishing between pictures and print, showing sustained interest during book-reading, recognises own name. • Writing: Scribbling, correct writing posture, copying line, circle, cross, block, triangle, diamond, tracing letters, copying letters and words, writing own name. • Phoneme–grapheme coupling will be targeted by implementing the phoneme song in combination with visual stimuli and writing task, in accordance with each participant's level of literacy. • These activities will be individualised to each participant. 3. Greeting Model-appropriate verbal and non-verbal greeting pragmatics and language. Treatment of eye contact will occur throughout all three activities. Every time the participant makes spontaneous eye contact, KP feedback will be provided. In addition, a ball will briefly be placed in front of the clinician's face every 3 min to elicit eye contact. Every instance of eye contact will be followed by: 'Try looking at my eyes for longer!' A continuous feedback schedule will be followed (Roth & Worthington 2011).

KP, knowledge of performance; KR, knowledge of results

Appendix 3

APPENDIX 3: Operational definitions for scoring eye contact.

SCORING SHEET FOR VIDEO ANALYSIS	
Variable	**Operational definition**
Eye contact episode duration	Time in seconds during which the child maintained eye contact with the clinician.
Eye contact frequency	Number of eye contact episodes.
Spontaneous eye contact	Eye contact initiated by the participant, in the absence of elicitation.
Elicited eye contact	Eye contact prompted by an object briefly placed at the clinician's eye level.