Measuring communicative style in parents of infants with suspected neurodevelopmental delays: reliability test and adaptation of the RAACS instrument

Keywords: Responsive communication, Communicative style, Instrument reliability, Augmentative and alternative communication, Neurodevelopmental disorders, Neurodevelopmental delays

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Abstract

Background: The Responsive Augmentative and Alternative Communication Style Scale (RAACS) has been used when assessing communicative style in parents of children with communicative disabilities between 12 and 60 months of age and proved valid and reliable. It has not been tested assessing the communicative style of parents of infants up to 12 months old, a potentially valuable area of use.

Aims: The aim of this study was to investigate the reliability of RAACS 3 when applied to ratings from audio-video recordings of parents' communication with their infants (aged four to 12 months) with suspected neurodevelopmental disorders. Another aim was to suggest possible changes to suit this target group, and to pilot test this new version.

Methods and Procedures: Four speech and language pathologists rated parental communicative style in 26 audio-video recordings of interactions between parents and infants. In phase I the original instrument RAACS 3 was used, on 20 recordings. In phase II the instrument was adapted to better suit the target group (parents of infants). In phase III the adapted RAACS 4 was pilot tested on six new audio-video recordings. This phase also included two joint ratings and a short consensus discussion between the raters.

Outcomes and Results: RAACS 3 was not reliable for assessment of communicative style in parents of infants. Higher reliability was indicated in the adapted version, RAACS 4.

Conclusions and Implications: RAACS 4 might be useful when assessing communicative style of parents of infants with neurodevelopmental delays. However, further investigation is needed to validate RAACS 4.

Introduction

Typical development of communication relies on interaction between motor, cognitive, sensory and linguistic skills (Nip et al., 2011), all of which may be affected by brain injury occurring early in life, or by a congenital disorder or illness. Cerebral palsy (CP) and other neurodevelopmental disorders are not only associated with impairments in movement, but also in sensation, cognition and communication (Rosenbaum et al., 2006). Prevalence of communication impairments is high in children with cerebral palsy. Nordberg et al. (2013) reported that 53% either had speech problems or were nonverbal. Communication impairments are also common in children with congenital or early onset disorders, e.g. Down Syndrome, autism spectrum disorders (ASD), intellectual delays, residual symptoms after prematurity and epilepsy (Horovitz and Matson, 2011). Co-morbidity often increase the child's difficulties; e.g. cognitive impairment and epilepsy have been found to be strongly associated with poor communication development in children with CP (Pennington and McConachie, 2001).

Signs of communication impairments can be observed during the child's first year of life. Lack of interactional behaviors such as eye contact, turning of the head at the sound of a voice, smiling at faces or responding to changes in tone of voice can be early signs (ASHA, 2019). Later signs can be no production of cooing and single-syllable babbling when the baby

is around four months old, or delayed or absent canonical babbling when the child is between six and ten months of age (Oller et al., 1999). If the child does not use pointing or other gestures communicatively (e.g. pointing at objects or persons, reaching to be lifted or shaking head for "no") at an age of 12 months a communication impairment might be suspected (ASHA, 2019).

Depending on the underlying disorder, the symptoms of communication disorders vary. Children with CP may have difficulties mostly relating to motor control, whereas children with ASD may use fewer communicative gestures and have more problems understanding spoken language in their first year, compared to typically developing infants (Mitchell et al., 2006). Regardless of the cause, deviant or absent early communication from the infant often result in less social communication directed towards the infant (Lieberman et al., 2019, Chen et al., 2007; Warren et al., 2010; Branson and Demchak, 2009). The parent may become discouraged and communicates less (Chen et al., 2007). As a result, the child may in turn communicate less and communication dwindles. This negatively affects parent-child interaction (Pennington and McConachie, 2001; Patten et al., 2014). Ello and Donovan (2005) found a relationship between parental stress and the child's ability to communicate. Helping the parent interpret the child's communicative behaviors and adapt his/her own behavior to facilitate and help the child in developing functional communication is therefore an important goal in early communication intervention (Lieberman et al., 2019; Warren et al., 2010; Branson and Demchak, 2009).

Early intervention is also supported by research showing that the effectiveness of remaining neural networks and pathways can be strengthened in young children with brain injuries. Bates (1999) describes the infant brain as plastic enough to permit alternative 'plans' for language to emerge if the standard situation 'does not hold'. She describes children with unilateral injuries achieving language abilities within the range of that of children with typical development, but with delays. Branson and Demchak (2009) shows that early intervention is important for the development of the child's communicative abilities. Evidence shows that communication interventions for young children (aged 0 – 5) should promote a responsive communication style in the communication partners of the child, support the use of environmental milieu teaching strategies and be integrated in play and every-day activities, and provide augmentative and alternative communication (AAC) strategies (Eberhart et al., 2017).

Responsivity is when a communication partner adapts and responds to the child's cues, follows the child's lead and provides input (Warren and Brady, 2007). Landry et al. (2006) describe four areas of responsivity: contingent responding, emotional support, joint attention and language input matched to the child's receptive language level. Responsive communication also involves imitation of the child's facial expression, vocalizations and verbal responses, being physically close and showing warmth and engagement (Brouwer et al., 2011). Interaction between a typically developing child and its parent/s is often

characterized by a responsive communicative style. A change in the interaction occurs when the child's communication becomes more intentional at approximately nine months, triggering an adjustment in the partner, such as increased linguistic input (Warren et al., 2010). This facilitates further development in the child and subsequently further changes by the partner. This reciprocity can be described as a 'dance' showing that responsivity does not function independently of the child's behavior (Warren et al., 2010). Maintaining a highly responsive interaction style with a child with a communicative disability is challenging, but crucial for a positive communicative development (Warren et al., 2010; Branson and Demchak, 2009), and can be associated with a variety of positive outcomes (e.g. Milgrom et al., 2013). Warren et al. (2010) concluded that responsivity influenced the development of important skills in children with lifelong disabilities.

Use of *enhanced milieu teaching strategies in an adapted environment* is also important, when stimulating the child's communication. Arranging situations to make them surprising, pausing in well-known activities or placing objects at a distance are adaptations that may stimulate initiatives and elicit communication. Kasari et al. (2010) showed that adaptations of play routines encouraged longer communicative interactions, and Lieberman and Yoder (2012) showed that knowledge of play routines helped children develop functional communication. Adapting play and every-day activities is used in several early intervention programs, e.g. the Early Start Denver Model (EDSM), Prelinguistic Milieu Teaching, Environmental Milieu Teaching and Naturalistic Teaching and the PLAI curriculum (Promoting Learning Through Active Interaction (programs described and evaluated in e.g. Dawson et al., 2010; Warren et al., 2008 and Chen, 2007).

Early introduction of *augmentative and alternative communication (AAC)* is also of vital importance, enabling children with communication impairments to develop and maintain cognitive and communicative abilities (Branson and Demchak, 2009). AAC interventions can include communication aids or methods (e.g. manual signs, pictures, speech-generating devices) or the use of augmenting strategies. Light et al. (2019) point out that strong research demonstrates the positive effects of AAC for individuals with complex communication needs, irrespective of the reason for the difficulties, and across a wide range of ages.

Traditionally AAC was introduced when the child proved to master the aid or method. Today, we know that it is important to start AAC interventions as early as possible, and that the AAC has to be available to the child, used and modelled in daily interactions, before the child can be expected to understand and use it (Branson and Demchak, 2009; Romski and Sevcik, 2018; McNaughton et al., 2019; Light et al., 2019). McNaughton et al. (2019) stress that the child's communication partners are vital in helping the child learn the AAC.

AKKtiv is a Swedish acronym for Augmentative and Alternative Communication – Early Intervention. AKKtiv is a program focusing on education of parents and other important partners of persons with communicative disabilities (Thunberg et. al., 2011; Ferm et al.,

2011). All courses within the AKKtiv-program have been developed with the three above-mentioned objectives as key elements; strengthening the parent's responsivity and introducing milieu teaching and multimodal AAC strategies. There are AKKtiv courses for different target groups, for example ComAlong targeting parents of pre-school aged children, ComAlong Toddler for parents of children aged 1-3, and ComPal targeting preschool and school staff. AKKtiv Baby, which is of interest in this study, was developed to support parents included in the Small Step study intervention provided to parents of infants with suspected neurodevelopmental disorders.

Observing and measuring the communicative style of a parent is vital when evaluating communication interventions (Romski and Sevcik, 2018). In earlier studies of communicative style in parents (Warren et al., 2010; Landry et al., 2006) assessment of parents using AAC has not been made. The need for an instrument also focusing on AAC was clear when the AKKtiv developers wanted to investigate the efficacy of the AKKtiv courses (Broberg et al., 2012). Therefore, they developed The Responsive Augmentative and Alternative Communication Style Scale (RAACS), focusing on interactions, also when using AAC, especially modeling in interaction with their children (Romski et al., 2010; Jonsson et al., 2011). The instrument needed to meet seven criteria: (a) interactions should be valid and motivating for the child and the parent, (b) interaction should be short, (c) responsive communication style in the parent should be assessed, (d) parental strategies for using and facilitating AAC should be assessed, (e) the affective tone in the interaction should be assessed, (f) the scale should have good psychometric qualities, and (g) the coding should be easy to understand and not require extensive training (Broberg et al., 2012). The first three versions of RAACS were developed over a period of seven years (2005—2012). Version 2 of the instrument was tested for reliability and sensitivity to change with parents of children aged 12-60 months participating in AKKtiv ComAlong courses (Almsenius and Karlsson, 2008; Lennartson and Sörensson, 2010; Broberg et al., 2012), and showed acceptable reliability. Three items were removed to ascertain internal consistency, resulting in RAACS 3 (Broberg et al., 2012). The items removed were rarely occurring in these assessments. It was suggested that the instrument should be investigated assessing parents to children in other age ranges. RAACS 3 was hypothesized to be valid and reliable, but was never tested (Broberg et al., 2012).

The Small Step Study is a randomized study focusing on early intervention (Eliasson et al., 2016). The infants in the study exhibited delayed psychomotor development or clinical signs of abnormal neurology. Inclusion criteria were based on a combination of assessments, including the Alberta Motor Infants Scale (Darrah et al., 1998), together with other findings from clinical neurological examinations. The inclusion age varied between four and eight months depending on the type and severity of the neurological signs and time of referral. The Small Step intervention consists of three training modules: hand use, mobility and communication. These three programs were carried out in the child's home by the infant's parents, coached by different specialists, one for each module (occupational therapist, physiotherapist and speech and language pathologist). The communication intervention,

AKKtiv Baby, was specifically developed for the Small Step Study by researchers and clinicians responsible for the AKKtiv program. The key elements in the AKKtiv program formed the basis: responsivity, environmental teaching strategies and introduction of multimodal AAC. The format was adapted to support parents of infants in their homes using evidence from recent literature (Kasari et al., 2010). The speech and language pathologist visiting the parent focused on modeling strategies also using video feedback to the parent, and the AAC was based on the use of activity charts, simple speech-generating devices and/or apps. The intervention included four home visits (weekly or spread out depending on the situation) by a speech and language pathologist. The parents were encouraged to use the strategies that had been modeled between the visits and a follow-up was made at the next visit. As part of the research in the Small Step Study all parents were instructed to make recordings of interaction with their child at different time points (Eliasson et al., 2016).

Early communication intervention is strongly supported by research (Bates, 1999; Branson and Demchak, 2009; Eberhart et al., 2017; Light et al., 2019; McNaughton et al., 2019) and in the Small Step Study it was hypothesized that the AKKtiv Baby program would have a positive impact on the communication style of the parents, increasing their use of responsive communication, environmental strategies and use of AAC. To evaluate this, RAACS 3 was chosen, but with the expectation that adaptations were needed when used with this new target group: parents of infants with a suspected neurodevelopmental disorder.

Aims

The aim of this study was to investigate the reliability of RAACS 3 when applied to ratings from audio-video recordings of parents' communication with their infants (aged four to 12 months) with suspected neurodevelopmental disorders. Another aim was to suggest possible changes to suit this target group, and to pilot test this new version.

The following research questions were used:

1. Is the Responsive Augmentative and Alternative Communication Style Scale (RAACS), version 3, reliable when used to rate recordings of parents' communication with their infants up to 12 months of age?
2. If the answer to question no 1 is no: Which adaptations are needed with regard to items and instructions to adapt the instrument to rating parents of infants?
3. Do these adaptations seem to improve reliability, when tested in a pilot study?

Method

The study was carried out in three phases. In phase I the original instrument RAACS 3 was used, based on 20 audio-video recordings, in phase II the instrument was adapted, and in phase III the new version with these adaptations was pilot tested with six new recordings.

Participants

The participating coders were four speech and language pathologists, A, B, C and D, described in table 1.

Table 1. Participating coders; professional experience and earlier use of RAACS

Person	*Professional experience*	*Earlier use of RAACS*
A	20 years; ten years at a regional communication center	None
B	27 years; specialized in developmental language disorders (DLD)	None
C	15 years; child habilitation services	Some use (in research project) Brief instructions from developers
D	35 years; since 1988 at a regional communication center, now mainly working with education, research and development	Developer of the instrument Limited use for research purposes

Material

A total of 26 audio-video recordings of fourteen children (aged six to ten months) and 19 parents (11 mothers and eight fathers) were used in this study. Each recording lasted between six and ten minutes, and featured different interactional situations, play being the most frequent. In table 2 the recordings, and their use in the study (phase I using RAACS 3 or phase III using the adapted version) are described. All parents were engaged in the Small Step Study (Eliasson et al., 2016). The setting of the recordings was mostly the home of the family, with a few recordings being made in a clinical setting (table 2). All of the recordings were filmed using a video camera placed on a tripod. The recordings were done either by the parent him-/herself, or by a research assistant. The recordings selected was a convenience sample based on Small Step audio-video recordings available at the start of phase I, and at the start of phase III of this study.

Table 2. Description of the audio-video recordings in the study: Length of video, Situation recorded, study Phase and Coders

Infant		*Parent*	*Length of video (min:sec)*	*Situation*	*Phase*	*Coders*
1.	Girl	Mother	09:10	Meal	I	A, B
		Father	10:00	Play	I	A, B
		Father	10:00	Play	I	A, B, C
		Father	06:00	Meal	I	A, B
2.	Boy	Mother	08:41	Play	I	A, B
		Mother	08:24	Diaper change	I	A, B
		Father	06:05	Play	I	A, B
3.	Boy	Mother	10:00	Play	I	A, B, C
		Mother	10:00	Play	I	A, B, C
		Mother	10:00	Play	I	A, B
		Father	10:00	Play and training	I	A, B
4.	Girl	Father	10:00	Meal	I	A, B, C
5.	Boy	Father	09:20	Play	I	A, B
6.	Girl	Father	10:00	Play	I	A, B, C
		Mother	07:45	Play	I	A, B, C
7.	Boy	Mother	10:00	Play	I	A, B, C
		Mother	10:00	Play	I	A, B
		Father	10:00	Play	I	A, B
		Father	10:00	Meal	I	A, B, C
8.	Boy	Mother	08:30	Play (clinical setting)	I	A, B
9.	Boy	Mother	10:00	Training hand function	III	A, C, D
10.	Boy	Father	06:33	Play	III	A, C, D
11.	Boy	Mother	06:00	Play (clinical setting)	III	A, C, D
12.	Boy	Mother	10:00	Play	III	A, C, D
13.	Boy	Mother	09:34	Play	III	A, C, D
14.	Boy	Mother	10:00	Play	III	A, C, D

The coders had no information about when the recordings were done: before, during or after the interventions in the Small Step study, or if the parents and children belonged to the control group.

Procedure

Phase I

The coders in phase I were A, B and C. The manual of RAACS 3 was followed and each audio-video recording was rated according to the items in RAACS 3 (table 3). Parental behaviors in the first seven items were assessed using a three-graded scale, the rates 0, 1 or 2 being used to describe how well the parent performed according to the descriptions in the manual. This was rated minute-by-minute, a value rated for each of the recorded minutes. These rates were summed up, the sum then being divided by the length of the video in minutes, creating a mean for each item. Two global items were used to rate the overall impression of the parent's communicative style according to '1 – never', '2 – sometimes' or '3 – often'. These were filled out at the end of the assessment. All results from the first seven items were then added to the global scores, making up a total (RAACS) score. All items are described in table 3.

Table 3. Parental behaviors rated in RAACS 3

1	The parent attends to and confirms the child's communication
2	The parent adjusts physically to the child
3	The parent gives the child space to communicate
4	The parent clarifies his or her own communication
5	The parent communicates according to the child's focus of interest or conversational topic
6	The parent expands on the child's communication
7	The parent uses AAC (e.g. objects, manual signs, pictures, communication boards or speech-generating devices)
8	Global assessment: the parent adapts and is engaged
9	Global assessment: the parent adjusts to the communicative level of the child

Twenty recordings were rated by coders A and B. To make the assessments better, another coder, C, was asked to rate as many recordings as was possible, and that was eight of the 20. Ten video recordings were selected for a second rating by coder A. It was the first ten that were selected in order to make the time elapsed from the first rating as long as possible.

None of the coders in phase I received any instructions before coding, and there were no consensus discussions after coding, due to a desire to investigate if the instrument could be used relying on the manual in the instrument alone (Eliasson, 2016; Broberg et al., 2012). This approach was different from approaches used earlier. In Broberg et al. (2012), the coders had 15 hours of instruction before coding and post-coding consensus discussions on half of the video material.

Phase II

After phase I, the three coders A, B and C had a discussion and carried out a joint rating of sections of a recording rated in phase I (selected because it was showing significant disagreements), focusing on those items where the disagreement was large. The discussion and joint rating were audio recorded, transcribed and analyzed by the author. Suggestions of changes of the instrument were then compiled and submitted to the developers of the instrument and accepted.

This new version was then used by A, C and D in two joint assessments, one with a discussion while rating and one with a discussion afterwards. This took approximately three hours, and a certain consensus was reached. The audio-video recordings that were used during this joint rating were selected from the recordings that were used in phase I of the study (then only rated by A and B, two years earlier).

Phase III

The coders in phase III were A, C and D, rating six new video recordings (numbers 9 to 14 in table 2), also collected from the Small Step Study. The adapted version of RAACS was used. As in phase I, each rating took approximately 60 to 90 minutes, and the ratings took place in a work or a home setting.

Analyses

Inter-rater reliability

The results were compiled by the author in MS Excel spreadsheets calculating sums, means, global scores and total RAACS scores for each rating. Characteristics were also noted (situation, deleted time, comments made while rating).

In the earlier study of RAACS (Broberg et al., 2012) acceptable values on inter- and intra-rater reliability were shown when using RAACS 2 with parents of children aged 12 to 60 months. Only percentage of exact agreement was used and, as stated by Koo and Li (2016) and Hallgren (2012), analyses with this calculation does not take into consideration chance or guessing, and agreement can be overrated. Only half of the 105 assessments were coded without consensus discussions, but all assessments were treated as one group, making the conclusions even more unsure (Broberg et al., 2012). To avoid these uncertainties in this study, RAACS 3 and 4 were tested with more valid statistical tools. Intraclass Correlation

Coefficient, ICC (Koo and Li, 2016; Hallgren, 2012), Cohen's Kappa (Viera and Garrett, 2005) and Krippendorff's Alpha (Hayes and Krippendorff, 2007) were added as complements to percentage of exact agreement. ICC was chosen as it is a standardized measure of inter-/intra-rater reliability when two or more coders are present and when all subjects are rated by multiple coders (Koo and Li, 2016; Hallgren, 2012). ICC model used was two-way random effects model with average measures, since all recordings were coded by multiple coders (Hallgren, 2012). Cohen's Kappa was chosen as it is a standardized measure of inter-/intra-rater reliability when data based on subjective interpretations are present (Viera and Garrett, 2005). Finally, Krippendorff's Alpha was chosen because it can be used regardless of the number of observers, levels of measurement, sample sizes and presence or absence of missing data (Hayes and Krippendorff, 2007).

To investigate *general reliability of the instrument*, ICC (two-way random effects model, average measures) was used, as well as percentage of exact agreement, Cohen's Kappa and Krippendorff's Alpha. RAACS scores were used with ICC. Comparisons between scores minute-by-minute and between scores on global items were used with percentage of exact agreement, Cohen's Kappa and Krippendorff's Alpha. These comparisons were done in pairs and all three raters combined (when possible).

To investigate *reliability in the individual items*, the same calculations (ICC, two-way random effects model average measures, calculation of percentage of exact agreement, Cohen's Kappa and Krippendorff's Alpha) were used on all the item ratings (items 1-9 in phase I and items 1-10 in phase III), in the same manner as described above, item sums for ICC and minute-by-minute ratings for percentage of exact agreement, Cohen's Kappa and Krippendorff's Alpha.

IBM SPSS version 23 was used for all calculations.

Intra-rater reliability

Coder A's repeated ratings of ten video recordings (using RAACS 3) were used when calculating intra-rater reliability. Intra-class correlation (ICC) two-way random effects model were used on the sums of the ten videos and the sums of the different items 1—7.

Acceptable reliability limits

In the literature, different limits of reliability are accepted. In Table 4 accepted values are shown for the different measures. Only "strong" and "moderate" values were considered acceptable in this study.

Table 4. Limits of reliability in the different calculations used

Calculation	**Abbreviation used**	**Weak / Minimal / None**	**Moderate**	**Strong**
Intraclass Correlation Coefficient (Koo and Li, 2016)	ICC	<0.50	0.50–0.75	(excellent) >0.90 (good) 0.75–0.90
Cohen's Kappa (Viera and Garrett, 2005)	κ	(fair/minimal) 0.40–0.21 (slight/none) 0.20–0.01	0.60–0.41	(almost perfect) 0.99–0.81 (good) 0.80–0.61
Krippendorff's Alpha (Hayes and Krippendorff, 2007)	α		≥0.667 (only accepted in preliminary results)	≥0.80
Percentage of absolute agreement	percentage			≥80%

Ethical considerations

The material used in this study was provided by the Small Step Study, approved by the Stockholm Regional Ethical Review Board (no. 2013/2044-31/1). All parents in the video recordings were given oral and written information about the Small Step Study, and the possibility of rejection without being excluded from the intervention or other pediatric services, before signing an informed consent form.

Results

Inter-rater reliability of RAACS 3

Inter-rater reliability of RAACS 3 was none or very low in all comparisons, when used assessing parental behaviors in audio-video recordings of parents with their infants.

Agreement between A and B on coding of the 20 videos was *none/poor*; ICC=.330 (95% CI=-.292–.698), percentage=56.4%, κ=.368 and α=.5245 (table 5).

Coder B scored considerably higher than coder A (figure 1). A few outliers are shown, one low rating by A, and two by B. Median values for coder A were 12.5, and for coder B 15.5.

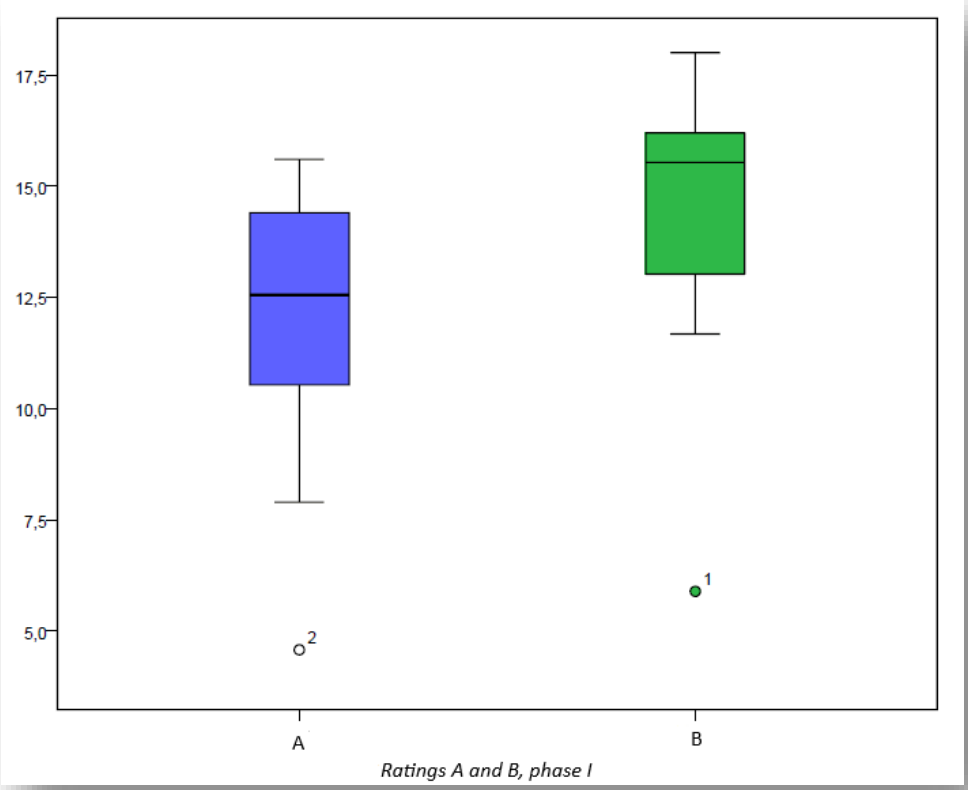

Figure 1. RAACS total scores by coders A and B, median, maximum and minimum values calculated (n=20)

When comparing all three coders, in pairs and all together, there was little or no agreement. Agreement between A and C was *none*; ICC=-.211 (95% CI=-.969–.596), percentage=57.4%, κ=.362 and α=.5633 (table 5). Agreement between B and C was *none* or *moderate*; ICC=-.114 (95% CI=-3.023–.758), percentage=68.8%, κ=.443 and α=.5792 (table 5). When comparing all three coders, agreement was *none*; ICC=.000 (95% CI =-.429–.605), percentage=61.9% and α=.5495 (table 5). Only κ comparing B and C showed any agreement at all (*moderate*), none of the other comparisons showed any acceptable reliability on the *instrument generally*.

Figure 2 shows the ratings of all three raters on the eight video recordings, coder A scoring considerably lower than coders B and C, and coder B scoring somewhat higher than coder C. Median values were 13.1 (A), 16.0 (B) and 15.5 (C).

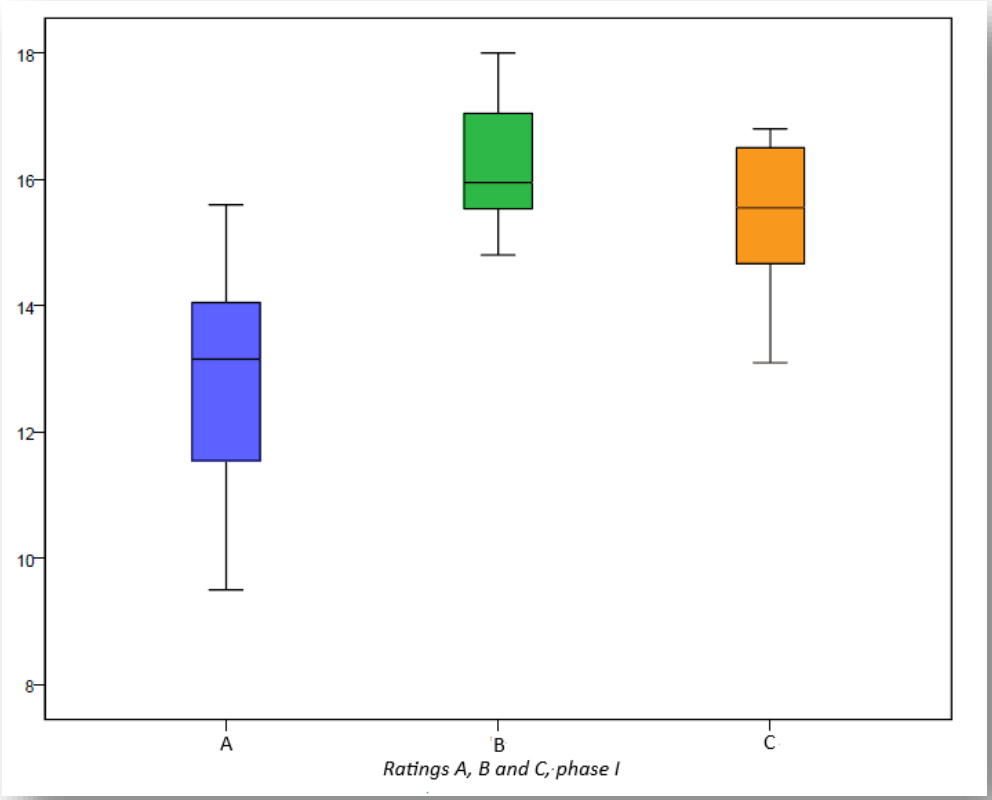

Figure 2. RAACS total scores by coders A, B and C, median, maximum and minimum values calculated (n=8)

Each item

When comparing the coders' scores of the individual items in RAACS 3, a few comparisons showed acceptable agreement (table 5). Item 1 showed *moderate* ICC between B and C (ICC=.695, 95% CI=-.501–.939). Item 2 showed *good* agreement in percentage in all comparisons (A-B 82.4%, A-C 86.3%, B-C 100%, and all three raters 98.8%). Item 4 showed *moderate* ICC between A and B (ICC=.652, 95% CI=.037–.869), *good* agreement in percentage between B and C (80.8%). Item 6 showed *moderate* ICC between A and C (ICC=.586, 95% CI=-.134–.915). Item 7 showed *excellent-good* agreement in most comparisons, A-C ICC=.980, 95% CI=.908-.996, percentage=98.6%, κ=.795 and α=.800, A-B percentage=95.9% and B-C percentage=95.9%. When comparing all three coders the agreement was ICC=.702 (95% CI=-.029-.936) and percentage=96.3%.

Strong agreement was only shown for a few items, item 2 on all comparisons using percentage, item 4, but not in all comparisons, and item 7 in several comparisons. The

agreement in item 7 was only a superficial agreement, as nearly all rates were zero in this item. This was also the case in one of the earlier studies (Almsenius and Karlsson, 2008).

Table 5. Reliability for coders A, B, and C, using RAACS 3 (phase I) on intraclass correlation coefficient (ICC), percentage of exact agreement (%), Cohen's Kappa (κ), and Krippendorff's Alpha (α)

Parent behavior scale items	Agreement A and B				Agreement A and C				Agreement B and C				Agreement A, B and C		
Parent …	ICC n=20	% *n min=170 n global=20*	κ	α	ICC n=8	% *n min=73 n global=8*	κ	α	ICC n=8	% *n min=73 n global=8*	κ	α	ICC n=8	% *n min=73 n global=8*	α
1. attends to and confirms the child's communication	-.030	40.0%	.021	-.0869	-.101	52.1%	.109	-.0295	.695	69.9%	.010	.0651	-.444	53.8%	-.0701
2. adjusts physically to the child	-.273	82.4%	-.059	-.0935	*	86.3%	*	-.0662	*	100.0%	*	*	*	90.8%	-.0431
3. gives the child space to communicate	.151	44.7%	.030	.0627	.514	32.9%	.030	-.0553	.111	52.1%	.097	.1257	.462	46.5%	.0876
4. clarifies his or her own communication	.652	61.8%	.312	.3168	.010	54.8%	.035	-.1865	-.109	80.8%	.165	.1189	.243	66.2%	.0712
5. communicates according to the child's focus of interest or conversational topic	.360	47.1%	.142	.1069	-.237	37.0%	-.011	-.0369	.083	68.5%	.097	.1691	-.281	51.1%	.0327
6. expands on the child's communication	.240	32.4%	.022	.0143	.586	43.8%	.178	.0198	.088	16.4%	.024	-.4608	.338	31.0%	-.0741
7. uses AAC	-.144	95.9%	-.017	-.0180	.980	98.6%	.795	.8000	-.207	95.9%	-.014	-.0140	.702	96.3%	.3208
8. adapts and is engaged (global)	.264	50.0%	.005	.1081	-.750	50.0%	-.231	-.2500	-.400	75.0%	-.143	-.0714	.097	66.6%	.0316
9. adjusts to the communicative level of the child (global)	.412	55.0%	.237	.1664	*	12.5%	*	-.6667	*	75.0%	*	-.0714	.186	41.6%	-.1926
Total n=20 / 8 (RAACS scores ICC) n=1230/528 (minutes used in %, κ and α)	.330	56.4%	.368	.5245	-.005	57.4%	.362	.5633	-.114	68.8%	.443	.5792	.000	61.9%	.5495

** not possible to calculate*

Changes to the instrument

After discussions and a joint rating of parts of an audio-video recording by coders A, B and C, suggestions of changes to the instrument were sent to the RAACS developers. These changes were related to the target group (parents of infants with neurodevelopmental delays) and to uncertainties in the instructions and design of the manual. After approval, the following changes were made:

Table 6. Problems in RAACS 3 and changes made to the instrument

Problem in RAACS 3	Changes and additions
Different approaches (due to lack of instructions) when problem solving discrepancies in the recordings	Instructions were added, e.g. how to use recordings shorter than ten minutes and how to interpret parts of the recordings when the interaction was disturbed by external events.
Lack of instructions and examples related to the new target group, parents of infants – items 3, 5, 6 and 7 'Ceiling effects' in items 1, 2 and 4 (parents often got a maximum result)	In the manual a short text was added to each item, describing the nature of the behavior in focus. More examples were also added, with clarifications in the instructions. Many of these examples were related to the new target group, parents of infants.
Difficulties in and different approaches to rating frequency of parental behavior	Instructions like 'occurs once or twice' or 'occurs more than three times' were replaced with the expressions 'occasionally' and 'consistently'. This change was believed to force the raters to assess the possibilities for a behavior and rate the parent's behavior according to this, rather than counting occurrences.
Lack of instructions in the global items Two important qualities were merged in one item (no 8), *adapting* and *being engaged*	Instructions and examples were added to the global items, since the instruction 'base your rating on your overall impression of the parent's communicative style' was too indistinct. Item 8 was divided into the new item no 8, *the parent adapts* and the new item no 9, *the parent is engaged*. Item 9, *the parent adjusts to the communicative level of the child,* was renumbered no 10.

Inter-rater reliability of the adapted instrument

Agreement with regard to the *instrument generally* improved in many comparisons. Agreement between coders A and C coding the six new video recordings was *good* using ICC; ICC=.864 (95% CI=.194–.980), low on percentage, 71.2%, moderate using κ=.562 and α=.7453 (table 6). Agreement between A and D was *poor* using ICC; ICC=.406 (95% CI=-4.613–.920), *low* on percentage, 74.2%, *moderate* in κ=.593 and α=.7282 (table 6). Agreement between C and D was *poor* in ICC; ICC=.281 (95% CI=-3.263–.897), *low* on percentage, 65.1%, and *moderate* in κ=.469 and α=.6924 (table 7).

Comparing all three coders, the agreement was *moderate* in ICC (ICC=.629, 95% CI=-.490–.944), percentage 70% and *moderate* α=.7227 (table 7).

Figure 3 shows the ratings of all three raters on the six video recordings. Median values are spread out, A and C having 16.5 and 15.6 points respectively, and D having a higher value of 18 points.

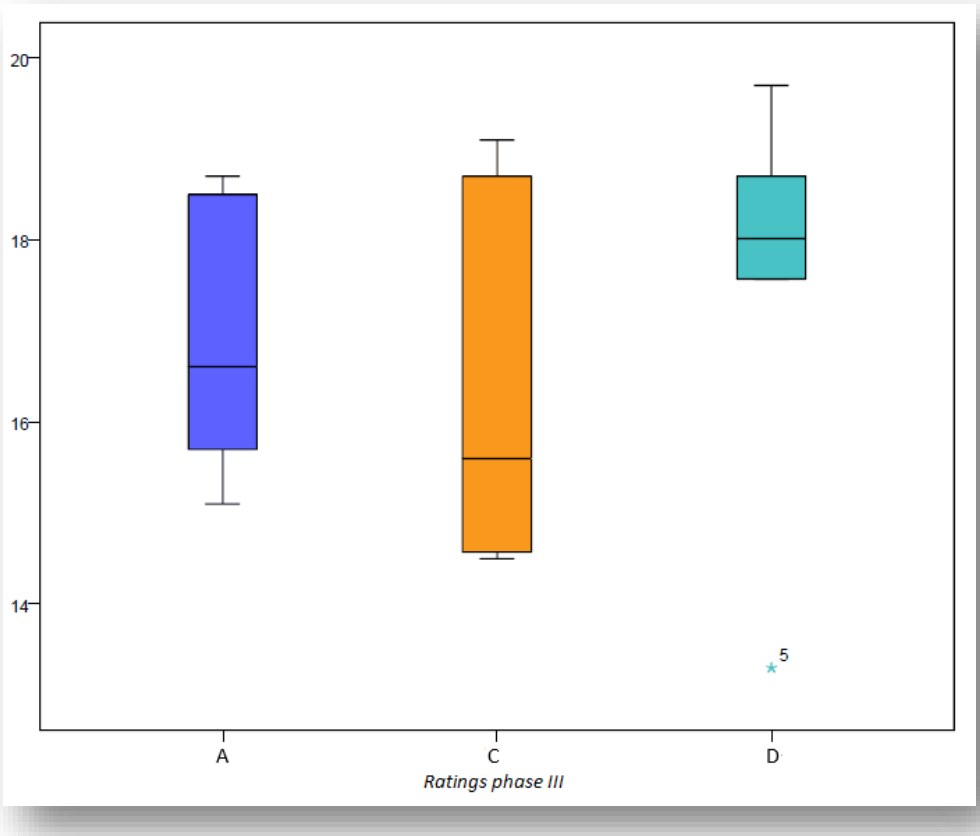

Figure 3. RAACS total scores by A, C and D, median, maximum and minimum values calculated (n=6)

Each item

There was acceptable agreement in nearly all items (table 7). Item 1 showed *excellent* ICC between A and C (ICC=.934, 95% CI=.371–.991), *moderate* κ between A and D (κ=.412) and *good* ICC between all three coders (ICC=.762, 95% CI=.169–.962). Item 2 showed *absolute* agreement in all calculations between A and C, *moderate/good* ICC and percentage between all three raters (ICC=.737, 95% CI=-.083–.960 and 85%). Item 3 showed *excellent* ICC and *moderate* κ between A and C (ICC=.911, 95% CI=.340–.988 and κ=.496), *good* ICC between C and D (ICC=.771, 95% CI=-.302–.967); *good* ICC for all three raters (ICC=.849, 95% CI=.401–.977). Item 4 showed *good* ICC and percentage between A and D (ICC=.870, 95% CI=.227–.981, 83%), *good* ICC and percentage between C and D (ICC=.775, 95% CI=-.482–.965, 88.7%), *good* ICC and percentage for all three raters (ICC=.773, 95% CI=.182–.964, 83%). Item 5 showed *good* ICC and *moderate* κ between A and D (ICC=.844, 95% CI=-.167–.978, κ=.415) and *moderate* ICC for all three raters (ICC=.609, 95% CI=-1.011–.944). Item 6 showed *good* ICC between A and D (ICC=.842, 95% CI=.089–.977). Item 7 showed *excellent* ICC, *good* percentage and *moderate* κ between A and C (ICC=.909, 95% CI=.440–987, 83%, κ=.608); *excellent* ICC, *good* percentage, *good* κ and *moderate* α, between A and D (ICC=.942, 95% CI=.340–.992, 86.8%, κ=.687, α=.6839); *good* ICC and percentage and *moderate* κ between C and D (ICC=.889, 95% CI=.130–985, 81.1%, κ=.491), and finally *excellent* ICC and *good* percentage for three raters (ICC=.944, 95% CI=.778–.991, 84%). Item 8 showed *perfect* percentage between A and D (100%). Item 9 showed *good* ICC and percentage, *moderate* κ between A and C (ICC=.762, 95% CI=-.440–.966, 83.3%, κ=.571), *good* percentage and *moderate* κ between A and D (83.3%, κ=.571), *moderate* ICC for three raters (ICC=.750, 95% CI=-.089–.963). No agreement was found for item 10.

In item 7, ratings no longer resulted in zero values. The agreement was still good-excellent suggesting that this item had true value in the adapted version (table 7).

Table 7. Reliability for coders A, C, and D, using RAACS 4 (phase III) on intraclass correlation coefficient (ICC), percentage of exact agreement (%), Cohen's Kappa (κ), and Krippendorff's Alpha (α)

Parent behavior scale items	Agreement A and C				Agreement A and D				Agreement C and D				Agreement A, C and D		
Parent …	ICC n=6	% *n min=53 n global=6*	κ	α	ICC n=6	% *n min=53 n global=6*	κ	α	ICC n=6	% *n min=53 n global=6*	κ	α	ICC n=6	% *n min=53 n global=6*	α
1. attends to and confirms the child's communication	.934	66.0%	.356	.4520	.593	69.8%	.412	.3616	.496	54.7%	.177	.2230	.762	64.0%	.3483
2. adjusts physically to the child	1.000	100.0%	1.000	1.000	-.086	79.2%	.096	.0447	-.086	79.2%	.096	.0447	.737	85.0%	.4636
3. gives the child space to communicate	.911	73.6%	.496	.5855	.637	64.2%	.309	.3365	.771	64.2%	.315	.3805	.849	67.0%	.4375
4. clarifies his or her own communication	.410	79.2%	.055	.0447	.870	83.0%	.306	.3077	.775	88.7%	.340	.3438	.773	83.0%	.2278
5. communicates according to the child's focus of interest or conversational topic	.192	58.5%	.226	.2088	.844	71.7%	.415	.3878	.376	58.5%	.247	.2525	.609	64.0%	.2758
6. expands on the child's communication	-.227	39.6%	-.055	-.1106	.842	62.3%	.245	.3593	-.286	32.1%	-.104	-.2871	.282	46.0%	.0046
7. uses AAC	.909	83.0%	.608	.6077	.942	86.8%	.687	.6839	.889	81.1%	.491	.4952	.944	84.0%	.5996
8. is engaged in the child (global)	*	66.7%	*	-.1000	*	100.0%	*	*	*	66.7%	*	-.1000	*	78.0%	-.0625
9. adapts to the child (global)	.762	83.3%	.571	.5926	.762	83.3%	.571	.5926	.444	66.7%	.250	.3125	.750	78.0%	.4769
10. adjusts to the communicative level of the child (global)	*	66.7%	.000	-.1000	-4.000	33.3%	-.500	-.3750	*	66.7%	.000	-.1000	*	55.0%	-.2143
Total n=6 (RAACS scores ICC) n=396 (minutes used in %, κ and α)	.864	71.2%	.562	.7453	.406	74.2%	.593	.7282	.281	65.1%	.469	.6924	.629	70.0%	.7227

Intra-rater reliability

Intra-rater reliability was calculated using ICC comparing the first and second ratings by A assessing the ten videos as described above. The reliability was *excellent* (ICC=.998, 95% CI=.991–.999).

When analyzing the ratings on items 1—7, the agreement differed from ICC=.649 (item 2, the parent adjusts physically to the child) to ICC=.960 (item 7, the parent uses AAC). Both global items, no 8 and 9, were in perfect agreement.

Discussion

The aim of this study was to investigate the reliability of RAACS 3 when applied to ratings from audio-video recordings of parents' communication with their infants (aged four to 12 months) with suspected neurodevelopmental disorders. Another aim was to suggest possible changes to suit this target group, and to pilot test this new version, RAACS 4.

In phase I of this study it was clearly shown that RAACS 3 was not reliable when assessing communicative behavior of parents of infants aged four to 12 months with suspected neurodevelopmental delays. When investigating *interrater reliability*, we could not find any agreement comparing the instrument *generally* and only identify agreement in a few *item* comparisons (table 5). In this study, only item 2, "the parent adjusts physically to the child", had acceptable agreement (table 5), compared to earlier studies, where nine of 12 items had an acceptable agreement in RAACS 2 (Broberg et al., 2012). One more item showed high agreement in RAACS 3 (AAC use in item 7), but this agreement was not relevant, as the ratings were more or less zero throughout all recordings (table 5). The differences between the coders when using RAACS 3 at first seemed systematic, as coders B and C rated higher than coder A. These differences were not consistent, however, indicating that changes had to be made to the instrument. *Intrarater* reliability of RAACS 3 was also investigated in phase I, calculated on ten audio-video recordings rated twice by one of the raters. ICC was used and showed excellent reliability. This result, however, relied on a small amount of ratings and was only performed by one of the raters.

After discussions and a joint rating of parts of one recording, by the coders in phase I, changes to the instrument (RAACS 3) were agreed upon with the RAACS developers. These changes were related to the target group (parents of infants with neurodevelopmental delays) and to uncertainties in the instructions and design of the manual. With these changes, a new version of RAACS was developed, named RAACS 4. The alterations and the related underlying problems are described in table 6. These changes seemed to have a positive effect on the result. In RAACS 4 interrater agreement still was rather low in *the instrument generally*, but considerably higher than in RAACS 3 (table 7). In several of the

items, reliability was improved (items 1, 3, 4 and 7, see table 7), but there were some issues remaining in a few of the items (items 5 and 6, see table 7). One important change in RAACS 4 was that of changed frequency instructions for most items. Rather than counting absolute numbers of occurrences (e.g. 'occurs more than three times') the expressions 'occasionally' and 'consistently' were added, forcing the raters to assess the options for a behavior and rate the parent's performance in relation to this, i.e. when the child acts in a way that opens up for communication and whether the parent takes that opportunity. These occurrences can be few during an interaction, but if the parent actually uses these opportunities he/she should be rated higher than a parent who does not (Landry et al., 2006; Warren et al., 2010). The impact of this change is difficult to assess in the analyses, but is presumed to have been important in the improved result in the instrument generally.

Three items had a 'ceiling effect' in RAACS 3, i.e. the parents often got a maximum score. These items were item 1 "the parent attends to and confirms the child's communication", item 2, "the parent adjusts physically to the child" and item 4, "the parent clarifies his or her own communication" (table 6). With extended instructions in RAACS 4, the 'ceiling effect' was no longer seen in two of these items. In item 1 the instructions now directs the coder to be extremely observant and critical as to when the parent actually seizes the possibility to act (Warren and Brady, 2007; Landry et al., 2006). In the item "the parent clarifies his or her own communication" (item 4) the ceiling effect was gone when the wanted behavior was described more thoroughly, i.e. that the parents' communication should be "adjusted to the child's level of understanding and focus of attention", as described by Warren et al. (2010) and Branson and Demchak (2009). The frequency instruction was also changed, from counting occurrences to observing when the parent could use a strategy and if he/she did use it. In the third item with ceiling effect issues, "the parent adjusts physically to the child" (item 2) the problem remained. A ceiling effect will probably always be present when rating the behavior of parents of infants in this item. Adjusting physically to their children seemed to come easy and natural for these parents (Landry et al., 2006; Brouwer et al., 2011), compared to parents of older children. The item varied a lot when parents of toddlers and older children were assessed (Broberg et al., 2012).

The coders in phase I, together with the developers, wanted to clarify four items (items 3, 5, 6, 7) with more detailed explanations and added examples, since these items experienced large differences between the coders in phase I. Some behaviors more related to infants and children who are non-responsive were included in the manual. In item 3 ("the parent gives the child space to communicate") e.g. the example "being expectant and encouraging even though the child does not respond" (Warren et al., 2010; Branson and Demchak, 2009) was added. In item 5 ("the parent communicates according to the child's focus of interest or conversational topic") e.g. the example "observing and following in any distractions" (Warren and Brady, 2007; Brouwer et al., 2011) was added. In item 6 ("the parent expands on the child's communication") examples and descriptions of early expanding behavior, e.g. observing an action and attributing communicative meaning to the action (Warren and

Brady, 2007; Warren et al., 2010; Branson and Demchak, 2009), were added. Item 7, "the parent uses AAC", only had examples of symbol-based AAC use in RAACS 3, so descriptions and examples of early AAC use were added, as described in e.g. Branson and Demchak (2009), Light et al., (2019), Romski et al. (2010), Jonsson et al. (2011) and Romski and Sevcik (2018), e.g. "using objects and gestures communicatively" and "expanding body communication from the child using objects, words, gestures, signs and/or symbols". These changes resulted in much better interrater agreement in the items "the parent gives the child space to communicate" (item 3) and "the parent uses AAC" (item 7) in RAACS 4 (table 7). However, the interrater agreement on item 5, "the parent communicates according to the child's focus of interest or conversational topic", increased only marginally (table 7). There was, in phase I, some confusion when to use item 1 or item 5, or both. This confusion may still be there and this needs to be investigated further. There were also remaining interrater agreement issues in item 6, "the parent expands on the child's communication". When using RAACS 3 this item was interpreted differently by the raters, one rater interpreting the examples in the instrument as depending on symbols. Even after the changes described above, agreement in this item was low, suggesting further clarifications being necessary.

Analyses of agreement in the global items in RAACS 4 were uncertain, due to the limited amount of ratings, only six for each global item. The new global item "the parent is engaged in the child" (no 8) often showed a ceiling effect in RAACS 4, i.e. the parents got maximum scores. Global item "the parent adjusts to the communicative level of the child" (no 10) was impossible to calculate with ICC, since there was too little variation, as one of the raters rated the same value in all ratings (table 7). The global items in RAACS 4 overall need more testing with a larger amount of ratings.

Limitations and future directions

There were limitations in comparisons of the results of phases I and III. All raters were not the same persons and the number of audio-video recordings coded were not the same. In the comparison between A and B in phase I, the only comparison with a larger number of recordings being coded, could not be used because rater B did not participate in phase III. The number of recordings used in phase III was small, since it was a pilot study. This made several of the calculations unreliable, especially on the global items where the amount of data was very limited.

Intra-rater reliability was only investigated in RAACS 3 and performed on a small amount of ratings and only by one of the raters. It is therefore proposed that intra-rater reliability should be investigated in RAACS 4 and by more than one coder.

Another limitation was the difference in procedures with regard to the use of initial training and consensus discussions. During phase I, no instructions to the coders and or consensus discussions were used, while the pilot test of RAACS 4, included two joint ratings and short consensus discussion. This means that the improved reliability might be the result of this

procedural change as well as of the adaptations that were made to the instrument. Probably both factors have contributed, which would have to be further researched and controlled in future reliability testing of RAACS 4.

As discussed above, interrater reliability in several of the items in the adapted RAACS 4 need to be investigated further, that is items 5 ("the parent communicates according to the child's focus of interest or conversational topic") and 6 ("the parent expands on the child's communication"), and all three global items. RAACS 4 also needs to be tested using a more structured study design with joint ratings and consensus discussions, to see if this would improve the reliability in specific items and in the instrument generally. It would also be of great interest to investigate internal consistency and validity of the instrument, to investigate if RAACS 4 measures parental responsivity and how the different items correlate. This was done on RAACS 2 (Broberg et al., 2012), and it would be of great value to do this again.

Conclusion

In this study the inter-rater reliability of the RAACS instrument (versions 3 and 4) was investigated when assessing communicative behavior of parents of infants aged four to 12 months with suspected neurodevelopmental delays. RAACS 3 could not be used reliably on this group. Adaptations were therefore made to the instrument, both in terms of accommodating communication behaviors of parents and their infants with a suspected neurodevelopmental delay, but also more generally in refining the instructions and definitions in regard to the coding scheme. In a pilot test, preliminary result of the adapted version, RAACS 4, showed better reliability compared to RAACS 3. This study indicates that joint ratings and consensus discussions are important when using RAACS for research purposes. The adapted version RAACS 4 could be useful when assessing the communicative style of parents of infants with neurodevelopmental delays. However, more studies are needed to further investigate the reliability and to validate RAACS 4, both for parents of infants, and parents of older children and more advanced levels of communication.

References

ALMSENIUS E. & KARLSSON, L., 2008, EFFEKTIV – an instrument for evaluation of communicative style in parents of children with communicative disability. Msc thesis, Gothenburg University. [In Swedish]

AMERICAN SPEECH-LANGUAGE-HEARING ASSOCIATION ASHA (2019), How does your child hear and talk? Birth to one year. asha.org/public/speech/development/01 [accessed 7 March 2020]

BATES, E., Language and the infant brain, 1999, Journal of Communication Disorders. 32, 195-205.

BRANSON, D. & DEMCHAK, M., 2009, The use of augmentative and alternative communication methods with infants and toddlers with disabilities: a research review. Augmentative and Alternative Communication. 25(4), 274–286.

BROBERG, M., FERM, U. & THUNBERG, G., 2012, Measuring responsive style in parents who use AAC with their children: development and evaluation of a new instrument. Augmentative and Alternative Communication. 28(4), 243-253.

BROUWER, C. E., DAY, D., FERM, U., HOUGAARD, A. R., RASMUSSEN, G. & THUNBERG, G., 2011, Treating the actions of children as sensible: investigating structures in interactions between children with disabilities and their parents. Journal of Interactional Research in Communication Disorders. 2.2, 153-182.

CHEN, D., KLEIN, M. D., & HANEY, M., 2007, Promoting interactions with infants who have complex multiple disabilities: development and field-testing of the PLAI Curriculum. Infants & Young Children. 20:2, 149-162.

DARRAH, J., PIPER, M. & WATT, M. J., 1998, Assessment of gross motor skills of at-risk infants: predictive validity of the Alberta Infant Motor Scale. Developmental Medicine & Child Neurology. 1998, 40(7), 485–91.

DAWSON, G., ROGERS, S., MUNSON, J., SMITH, M., WINTER, J., GREENSON, J., DONALDSON, A. & VARLEY, J., 2010, Randomized, controlled trial of an intervention for toddlers with autism: the Early Start Denver Model. Pediatrics. 125(1), e17.

EBERHART, B., FORSBERG, J., FÄLDT, A., NILSSON, L., NOLEMO, M., THUNBERG, G., 2017, Tidiga kommunikations- och språkinsatser till förskolebarn inom barnhabilitering. [Early communication and language interventions for preschool children in habilitation.] (Föreningen Sveriges Habiliteringschefer: Göteborg).

ELIASSON, A.-C., HOLMSTRÖM, L., AARNE, P., NAKEVA VON MENTZER, C., WEILAND, A.-L., SJÖSTRAND, L., FORSSBERG, H., TEDROFF, K. & LÖWING, K., 2016, Efficacy of the small step program in a randomised controlled trial for infants below age 12 months with clinical signs of CP; a study protocol. BMC Pediatrics. 16, 175.

ELLO, L. M. & DONOVAN, S. J., 2005, Assessment of the relationship between parenting stress and a child's ability to functionally communicate. Research on Social Work Practice. 15:6, 531-544.

FERM, U., ANDERSSON, M., BROBERG, M., LILJEGREN, T., & THUNBERG, G. (2011). Parents and course leaders' experiences of the ComAlong augmentative and alternative communication early intervention course. Disability Studies Quarterly: Mediated Communication. 31(4).

HALLGREN, K. A., 2012, Computing inter-rater reliability for observational data: an overview and tutorial, Tutorials in Quantitative Methods for Psychology. 8, 23-34.

HAYES, A. F. & KRIPPENDORFF, K., 2007, Answering the call for a standard reliability measure for coding data. Communication Methods and Measures. 1, 77-89.

HOROVITZ, M. & MATSON, J. L., 2011, Developmental milestones in toddlers with atypical development. Research in Developmental Disabilities. 32, 2278-2282.

JONSSON, A., KRISTOFFERSSON, L., FERM, U. & THUNBERG, G., 2011, The ComAlong communication boards: parents' use and experiences of aided language stimulation. Augmentative and Alternative Communication. 27(2), 103-116.

KASARI, C., GULSRUD, A. C., WONG, C., KWON, S. & LOCKE, J., 2010, Randomized controlled caregiver mediated joint engagement intervention for toddlers with autism. Journal of Autism and Developmental Disorders. 40, 1045-1056.

KOO, T. K. & LI, M. Y., 2016, A guideline of selecting and reporting intraclass correlation coefficients for reliability research. Journal of Chiropractic Medicine. 15, 155-163.

LANDRY, S. H., SMITH, K. E. & SWANK, P. R., 2006, Responsive parenting: establishing early foundations for social, communication, and independent problem-solving skills. Developmental Psychology. 42(4), 627-642.

LENNARTSON, E. & SÖRENSSON, K., 2010, The communicative styles of parents before and after attending an AKKtiv ComAlong communication course. MSc thesis, Gothenburg University. [In Swedish]

LIEBERMAN, M., LOHMANDER, A. & GUSTAVSSON, L., (2019), Parents' contingent responses in communication with 10-month-old children in a clinical group with typical or late babbling. Clinical Linguistics & Phonetics, DOI: 10.1080/02699206.2019.1602848

LIEBERMAN, R. G. & YODER, P., 2012, Play and communication in children with autism spectrum disorder – a framwork for early intervention. Journal of Early Intervention. 34:2, 82-103.

LIGHT, J., MCNAUGHTON, D., BEUKELMAN, D., KOCH FAGER, S., FRIED-OKEN, M., JAKOBS, T. & JAKOBS, E., 2019. Challenges and opportunities in augmentative and alternative communication: Research and technology development to enhance communication and participation for individuals with complex communication needs. Augmentative and Alternative Communication. 35:1, 1-12.

MCNAUGHTON, D., LIGHT, J., BEUKELMAN, D. R., KLEIN, C., NIEDER, D. & NAZARETH, G., 2019. Building capacity in AAC: A person-centred approach to supporting participation by people with complex communication needs. Augmentative and Alternative Communication. 35:1, 56-68.

MILGROM, J., NEWNHAM, C., MARTIN, P. R., ANDERSON, P. J., DOYLE, L. W., HUNT, W. H., ACHENBACH, T. M., FERRETTI, C., HOLT, C. J., INDER, T. E. & GEMMILL, A. W., 2013, Early communication in preterm infants following intervention in the NICU. Early Human Development. 89, 755-762.

MITCHELL, S., BRIAN, J., ZWAIGENBAUM, L., ROBERTS, W., SZATMARI, P., SMITH, I. & BRYSON, S., 2006, Early language and communication development of infants later diagnosed with autism spectrum disorder. Developmental and Behavioral Pediatrics, 27:2, 69-78.

NIP, I. S. B., GREEN, J. R. & MARX, D. B., 2011, The co-emergence of cognition, language, and speech motor control in early development: A longitudinal correlation study. Journal of Communication Disorders. 44, 149-160.

NORDBERG, A., MINISCALCO, C., LOHMANDER, A. & HIMMELMANN, K., 2013, Speech problems affect more than one in two children with cerebral palsy: Swedish population-based study. Acta pædiatrica. 102, 161-166.

OLLER, D. K., EILERS, R. E., NEAL, A. R. & SCHWARTZ, H. K., 1999, Precursors to speech in infancy: the prediction of speech and language disorders. Journal of Communication Disorders. 32, 223-245.

PATTEN, E., BELARDI, K., BARANEK, G. T., WATSON, L. R., LABBAN, J. D. & OLLER, D. K., 2014, Vocal patterns in infants with autism spectrum disorder: canonical babbling status and vocalization frequency. Journal of Autism Development Disorder, 44, 2413-2428.

PENNINGTON, L. & MCCONACHIE, H., 2001, Predicting patterns of interaction between children with cerebral palsy and their mothers. Developmental Medicine and Child Neurology. 43, 83-90.

ROMSKI, M., SEVCIK, R. A., ADAMSON, L. B., CHESLOCK, M., SMITH, A., BARKER, R. M. & BAKEMAN, R., 2010, Randomized comparison of augmented and nonaugmented language interventions for toddlers with developmental delays and their parents. Journal of Speech, Language, and Hearing Research. 53, 350-364.

ROMSKI, M. & SEVCIK, R. A., 2018, The complexities of AAC intervention research: emerging trends to consider. Augmentative and Alternative Communication. 34:4, 258-264.

ROSENBAUM, P., PANETH, N., LEVITON, A., GOLDSTEIN, M. & BAX, M., 2006, A report: the definition and classification of cerebral palsy April 2006. Developmental Medicine and Child Neurology. 49, issue supplement s109, 8-14.

THUNBERG, G., CARLSTRAND, A., CLAESSON, B. & RENSFELDT FLINK, A., 2011, ComAlong – a handbook on communication development and communication support. [KomIgång – en föräldrakurs om kommunikation och kommunikationsstöd.] Habilitering och Hälsa, Västra Götalandsregionen.

VIERA, A. J., & GARRETT, J. M., (2005). Understanding interobserver agreement: The Kappa statistic. Family Medicine. 37, 360-3.

WARREN, S. F. & BRADY, N. C., 2007, The role of maternal responsivity in the development of children with intellectual disabilities. Mental Retardation and Developmental Disabilities. 13, 330-338.

WARREN, S. F., BRADY, N., STERLING, A., FLEMING, K. & MARQUIS, J., 2010, Maternal responsivity predicts language development in young children with Fragile X syndrome. American Journal of Intellectual and Developmental Disabilities. 115:1, 54-75.

WARREN, S. F., FEY, M. E., FINESTACK, L. H., BRADY, N. C., BREDIN-OJA, S. L. & FLEMING, K. K., 2008, A randomized trial of longitudinal effects of low-intensity responsivity education/prelinguistic milieu teaching. Journal of Speech, Language, and Hearing Research. 51, 451-470.