Early interaction in autism spectrum disorder: Mothers' and children's behaviours during joint engagement

Short title: Mother-child interaction in ASD

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Abstract

Background: More knowledge about the interaction between young children with autism spectrum disorder (ASD) and their parents is one way to improve intervention. This study aims to investigate the behaviours of mothers and children with ASD during joint engagement, with a focus on pacing or rate (i.e., incidences per min) of their behaviours when being in this state. *Method:* Video-recordings of 10 min of free-play between 58 children (2-4 years) diagnosed with childhood autism and their mothers were used to examine rate of mothers' and children's behaviours (i.e. toy introduction, toy expansion, positive affect and language) during joint engagement, the association between rate of mothers and children's behaviours, the relation between rate of mothers' behaviours and time in joint engagement, and how child factors might be associated with the latter. *Results:* Mothers[(m)] and children[(c)] showed similar rate of positive affect (M^m=0.6/M^c=0.5) and toy expansion (M^m=0.7/M^c=0.7) per min, while mothers talked almost three times more than their children (M^m=10.2/M^c=3.8). In contrast, mothers introduced fewer toys compared to the children (M^m=0.7/M^c=1.2). Rate of mothers' toy introduction, toy expansion and positive affect was inversely related to time in joint engagement (Regression coefficient = -70.7 to -48.5, p=.006 to .024). Rates of mothers' and children's behaviours were associated (Spearman rank order coefficient = .53 to .29 to, p< .001 to .03), but neither rate of children's behaviours nor mental age was associated with the observed relation between rate of these maternal behaviours and time in joint engagement. *Conclusion:* Time in joint engagement was related to rate of mothers' behaviours and children's mental age, but not to rate of children's behaviours in this study. Thus, intervention teaching parents of young children with autism strategies designed to increase time in joint engagement may be vital. The complex nature of the interaction between mother and child behaviours in promoting joint engagement warrants further elucidation.

Introduction

Joint engagement is a behavioural state where the child and their social partner are actively involved with the same object or event (Bakeman & Adamson, 1984). If the child does not make any overt behaviour toward the partner, but shows signs of being aware and is engaged in the shared activity, the child is in supported joint engagement. But if the child also, for example, looks at the partner, smiles, and gives her a block, the child is in coordinated joint engagement. Children with autism spectrum disorder (ASD) are less likely to stay in joint engagement; especially in coordinated joint engagement (Adamson, Bakeman, Deckner, & Romski, 2009; Bottema-Beutel, Yoder, Hochman, & Watson, 2014). In a study of 108 young children (58 with typical development (TD), 29 with Down syndrome (DS) and 23 with ASD), Adamson et al. (2009) found that children with TD and DS spent approximately 75% of the play time with their mothers in either supported or coordinated joint engagement, whereas the children with ASD spent only 50% of the time in these states. Further, they reported that children with ASD spent 41% of the time either totally unengaged or engaged only with a toy, as compared to the children with DS and TD who spent 19% and 18%, respectively, in these states. Joint engagement episodes form an essential basis for social learning and language acquisition (Mundy & Sigman, 2006), and more time in joint engagement is related to faster language acquisition in children with TD (Adamson et al., 2009; Carpenter, Nagell, & Tomasello, 1998) and ASD (Adamson et al., 2009; Bottema-Beutel et al., 2014; Kasari, Paparella, Freeman, & Jahromi, 2008). Consequently, as more time jointly engaged may have positive effects on children with ASD, an understanding of parental behaviours that might increase time in joint engagement is needed.

Behaviours such as visual co-ordination (Collis & Schaffer, 1975), supportive object play (Roach, Barratt, Miller, & Leavitt, 1998), and introducing and manipulating toys (Raver & Leadbeater, 1992) have been shown to maintain joint engagement with children with TD. Although the benefit of various parental behaviours in maintaining joint engagement is less studied in children with ASD, parents' responsiveness, imitation of children's play, and engagement in toys within the child's focus have been reported to create joint interactions that last longer (Freeman & Kasari, 2013; Kasari, Gulsrud, Wong, Kwon, & Locke, 2010; Patterson, Elder, Gulsrud, & Kasari, 2013; Shire, Gulsrud, & Kasari, 2016). As children with ASD are

often object focused or unengaged (L. B. Adamson, R. Bakeman, D. F. Deckner, & M. Romski, 2009; Bottema-Beutel et al., 2014; Kasari et al., 2010), parents seemingly need to be more proactive during the interactions in order to create reciprocity between themselves and the child. Not only *what* parents do but also *how frequently* they provide input might be critical to maintaining joint engagement. For example, if a mother and her child with ASD are playing with blocks, the mother may increase the likelihood of remaining jointly engaged with the child if the pacing or rate of her behaviours is appropriate. If she provides too much or too little input, the child may "default" and revert to being object engaged or unengaged. Not only parental behaviour, but also child characteristics and behaviours can affect time in joint engagement. It is likely for example that a child's mental age may affect their ability to process and respond to adults' input and thus the ability to stay in joint engagement (Adamson et al., 2009).

The overall aim of the present study was to investigate the behaviours of mothers and children with ASD during joint engagement, with a specific focus on pacing or rate (i.e. incidences per min) of their behaviours when in this state. First, we examined typical rates of mothers' and children's behaviours during joint engagement. Second, we looked at the relation between rate of mothers' behaviours and time in joint engagement. Third, we explored the relation between rate of mothers' behaviours and children's behaviours. Last, we investigated the association between child factors, such as mental age and rate of child behaviours (relative to maternal behaviours), and time spent in joint engagement. The last- mentioned relation was studied to understand the weighted influence of mothers' versus children's behaviours. The behaviours studied were expansion of ongoing toy play, introduction of new toys, positive affect and talking, as these items overlap with behaviours previously shown to facilitate joint engagement with children with ASD and TD (e.g. Kasari et al., 2010; Raver & Leadbeater, 1992).

Method

Design

This study used a concurrent correlation design using baseline data from an intervention trial (Kaale, Fagerland, Martinsen, & Smith, 2014; Kaale, Smith, & Sponheim, 2012)

Participants

The sample included 58 mother-child dyads (three children from the original intervention study were excluded due to missing video-recordings essential for the present study). These children, identified by ten Child and Adolescent Mental Health Clinics (CAMHC) in East and West Norway, were invited to participate in the study. The participants met the following inclusion criteria: (a) age 24–60 months, and (b) an ICD-10 diagnosis of childhood autism set by a multidisciplinary team. Exclusion criteria were (a) severe neurological disorders (e.g. cerebral palsy, hearing deficits), and (b) non-Norwegian speaking parents. The children participating in the study had diverse cognitive and language levels, and socio-economic backgrounds (Table 1).

[Table 1 here]

Procedure

The measures were drawn from the baseline assessment in the intervention study carried out from 2006 to 2008. The study was approved by The Norwegian National Committee for Research Ethics. Written consent was obtained from parents.

Measures

Developmental level and language: Developmental level was assessed with Mullen Scales of Early Learning (MSEL; Mullen, 1997). The Norwegian standardization of Reynell Developmental Language Scales (RDLS; Hagtvet & Lillestøen, 1985) was used to assess language age.

Joint engagement: To assess time in joint engagement, 10 min of mother–child free-play were video-recorded using one camera placed on a stand. All dyads were give the same standard set of toys, including a picture book, two toy phones, a car, building blocks, a ball, miniature figures, six large marbles, and a stuffed animal. The mothers were instructed to play as they typically would do, but were encouraged to try to keep themselves and their child in the range of the camera. The recordings were subsequently coded by research assistants who were blind to the study purpose for duration of six mutually exclusive engagement states (unengaged, on-looking, person engagement, object engagement, supported joint engagement, and coordinated joint engagement) (Bakeman & Adamson, 1984). Only the joint engagement episodes, accumulated across supported and coordinated joint engagement, were included in the present analyses. Supported joint engagement was coded when the child and mother were actively involved with the same toy, but the child was not overtly acknowledging the mother. Coordinated joint engagement was coded when both child and mother were actively directing their attention to the shared toy and to each other. Total time in the two engagement states was calculated and collapsed to one variable named joint engagement, a practice which is consistent with other studies (e.g. Gulsrud, Hellemann, Shire, & Kasari, 2015; Kasari, Freeman, & Paparella, 2006; Patterson et al., 2013).

Mothers' behaviours: Mothers' positive affect, toy introduction, toy expansion and child-directed talk were coded during the joint engagement episodes. Mothers' positive affect comprised smiles, laughter, clapping, high-fives, and cheerful utterances (e.g. "Wow!"). Mothers' toy introduction included presentation of a new toy while discontinuing using the previous one. Mothers' toy expansion was noted as using a toy of mutual focus in a new way, adding a new toy to the ongoing toy play and expanding the ongoing toy play verbally. Mothers' talk was noted as the presence of meaningful child-directed utterances within intervals. All joint engagement episodes were divided into 4-sec intervals, and presence/no presence of child-directed talk was recorded for each interval. Interval coding was used for this variable as speech is less discrete, and thus frequency is better reflected by such coding. Mothers' positive affect, toy introduction, toy expansion, and talk were coded in four separate viewings of the same video

segment to ensure that every instance of the behaviours was captured. Rate per min of mothers' positive affect, toy introduction, toy expansion and child-directed talk was calculated to form four independent variables (e.g. total number of toy expansions, divided by time in joint engagement, multiplied by 60 sec). The latter variables were used in the analyses as we were interested in the rate per min rather than the total incidences of the behaviours.

Children's behaviours: Rate per min of children's positive affect, toy introduction, toy expansion and talk was coded from the same video recordings; applying the same definitions and coding rules as for rate of mother's behaviours.

Inter-rater reliability

Inter-rater reliability was calculated based on double coding of 16-21% randomly selected mother–child play recordings using intra-class correlation coefficients (ICC) estimates (two way mixed model – absolute agreement, single measures). ICC was .94 for time in joint engagement (.88 for supported joint engagement and .96 for coordinated joint engagement) and .92 for mothers' positive affect, .65 for mothers' toy introduction, .81 for mothers' toy expansion, and .96 for children's positive affect, .92 for children's toy introduction, and .93 for children's toy expansion.

Statistical analyses

Descriptive statistics was calculated for all the study variables, including time in joint engagement and rate per min of mothers' and children's behaviours. A multiple linear regression analysis was performed to estimate the proportion of variance in time in joint engagement accounted for by rate of mothers' positive affect, toy introduction, toy expansion and talk, together, as well as the relative importance of each of the four maternal behaviors on time in joint engagement. Spearman's rank-order correlation was computed to estimate the bivariate associations between rate of

mothers' behaviours, and rate of children's behaviours and children's mental age. The influence of child factors (i.e. rate of children's behaviours and mental age) on the relation between rate of the maternal behaviours and time in joint engagement was investigated by performing five separate analyses, wherein rate of children's positive affect, toy introduction, toy expansion and talk, and mental age were included one variable at a time to the original regression model.

Results

The mother–child dyads spent an average of 4:27 min in joint engagement during the 10-min play (Table 2). Rate of mothers' toy introduction, toy expansion and positive affect during joint engagement varied from 0.6 to 0.7 per min, while rate of children's behaviours ranged from 0.5 to 1.2 per min. Rate of 4-sec intervals of mothers' child-directed talk was 10.2 per min, while rate of children's talk was 3.8 intervals per min.

[Table 2 here]

Rate of mothers' behaviours and time in joint engagement

Twenty-nine percent of the variance in time in joint engagement (R²=.29 (adjusted R²=.24), *F*=5.518*, p*<.001) was accounted for in the multiple linear regression model with all four maternal behaviours included (i.e., mothers' positive affect, toy introduction, toy expansion and talk) (Table 3). In this model rate of mothers' toy introduction, toy expansion and talk was each significantly associated with time in joint engagement, independent of the contribution of the other variables. However, the directions of the effects were mixed. Rates of mothers' toy introduction and toy expansion were negatively associated with time in joint engagement, whereas mothers' talk was positively associated with time in joint engagement. For example, as shown in Table 3 time in joint engagement decreased on average by 64 sec for every unit of increase in mothers' toy introduction

when the other maternal behaviours were held constant. Similarly, time in joint engagement decreased with 71 sec for every unit of increase in mothers' toy expansion when the other maternal behaviours were held constant.

[Table 3 here]

Rate of mothers' positive affect was not significantly associated with time in joint engagement. This may be due to the relative high numbers of dyads with mothers showing no instances of positive affect (n= 19). In a sensitivity analysis, where we fitted a multiple regression model with the same variables as in the original model, but included data only for the mothers (n=39) who showed at least one instance of positive affect during joint engagement, rate of mothers' positive affect also bore a negative relation with time in joint engagement (-48.5, 95% CI: -90.2 to -6.8, p= .024).

Rate of mothers' behaviours, and rate of children's behaviours and mental age

When testing the association between rate of mothers' behaviours, and rate of children's behaviours and mental age, there was a positive association between rate of mothers' positive affect and rate of children's positive affect, rate of mothers' toy introduction and rate of children's toy introduction, rate of mothers' toy expansion and rate of children's toy expansion, and rate of mother's talk and rate of children's talk (Table 4). Rate of mothers' talk was associated with children's mental age, but rate of mothers' positive affect, toy introduction and toy expansion was not associated with children's mental age.

[Table 4 here]

The importance of child factors

Controlling for child factors, such as rate of their positive affect, toy introduction, toy expansion and talk, by adding these variables (one at a time) to the original regression model did not change the identified associations between rate of the four maternal behaviours and time in joint engagement. Further, none of the child behaviours were significantly associated with time in joint engagement in these models (estimated coefficient for rate of the four child behaviours from -15.8 to 7.73.2 with p-values from .113 to .759). When controlling for children's mental age, which was significantly related to time in joint engagement (estimated coefficient 3.2, 95% CI: .3 to 6.0, p= .031), rate of mothers' talk was no longer as clearly associated with time in joint engagement (estimated coefficient 10.6, 95% CI: -.3 to 21.6, p= .057). However, the previously identified association between the three other maternal behaviours and time in joint engagement did not change when controlling for children's mental age.

Discussion

This study used video-recorded mother-child play to investigate the behaviours of mothers and children with ASD during joint engagement, with a specific focus on rate of the participants' behaviours during this state.

In line with other researchers (Adamson et al., 2009; Kasari et al., 2006; Kasari et al., 2010), we found that the mother-child ASD dyads spent less than 50% of the playtime in joint engagement prior to intervention. Most of this time was in supported joint engagement. As many as two thirds of the dyads did not spend any time in coordinated joint engagement, and among those 20 that did, only four dyads spent more than 10% of the time in this state. Mothers talked much more than their children during joint engagement. This may not be surprising since the study comprised many children with low verbal abilities. Still, it is noteworthy that in the dyads where the children had a relatively high language level (language age > 36 months), mothers were also doing twice as much talking as their children. In contrast, the children exhibited a higher rate of toy introduction as compared to their mothers, while mothers and children showed quite similar rates of toy expansion and positive affect. Nevertheless, nearly half of

the children and one third of the mothers did not show any positive affect, such as smiling, clapping, laughter or cheerful comments during their time in joint engagement. The latter finding is different from reports of young children with TD, where positive affect is a vital part of joint engagement (L.B. Adamson & Bakeman, 1985; Kasari, Sigman, Mundy, & Yirmiya, 1990; Leavens et al., 2014), but is in accordance with previous studies of children with ASD (Mundy, Kasari, & Sigman, 1992; Venezia, Messinger, Thorp, & Mundy, 2004). The fact that a substantial portion of the mothers in the present study displayed no positive affect during interaction with their children with ASD, and the fact that a clear association was found between rate of mothers' and children's positive affect, suggest that the children's atypical display of affect may influence the behaviours of the mothers, as also alluded to in previous research (Dawson, Hill, Spencer, Galpert, & Watson, 1990). However, the interpretation of this finding warrants a caveat as the concurrent nature of the data means that the direction of the effects cannot be clarified.

Rates of mothers' toy introduction, toy expansion and positive affect were inversely associated with time in joint engagement. It is possible that children with ASD, compared to children with TD, have a more narrow bandwidth of effective stimulation (cf. Field, 1977), implying that they are more easily over-stimulated (Field, 1981). Thus, although maternal toy introduction, toy expansion and positive affect may be beneficial behaviours per see (Raver & Leadbeater, 1992; Roach et al., 1998), these activities may negatively influence time in joint engagement depending on the dose. This lends support to the notion that too frequent inputs can lead to over-stimulation of the child with ASD and thereby possibly interrupt joint engagement. However, there are alternative explanations. Possibly, mothers typically use a higher rate of these behaviours to try to maintain joint engagement with children who are more difficult to keep engaged. Previous studies have shown that caretakers of less able children with ASD tend to initiate more activities than caretakers of more able children with ASD (Doussard-Roosevelt, Joe, Bazhenova, & Porges, 2003; Kasari, Sigman, Mundy, & Yirmiya, 1988; Meirsschaut, Warreyn, & Roeyers, 2011). They might do this in an attempt to compensate for the children's deficits (Kasari et al., 1988). One might conjecture that time in joint engagement would have been even shorter if the mothers had been less active. Interestingly, mothers of younger, compared to older TD infants provide more frequent literal object inputs to increase time in joint engagement

with their children (L. B. Adamson & Bakeman, 1984). They use various strategies to keep their infants interested in order to prolong the period of mutual toy exploration, but as the children get older and more competent, mothers typically transfer more of the responsibility for the joint play to their children (Bakeman & Adamson, 1984).

Rate of mothers' and children's behaviours was related, but only within the same type of behaviours. For example, rate of mothers' positive affect was related to rate of children's positive affect, not to the rate of the three other types of child behaviours, similarly, the rate of mothers' toy expansion was related only to rate of children's toy expansion. This suggests that the behaviours of mothers and children are strongly influenced by each other (Bell, 1979; Kasari et al., 1988), illustrating the importance of investigating how children's behaviours may affect the relation between rate of mothers' behaviour and time in joint engagement. Interestingly, we did not find that rate of children's behaviours was related to time in joint engagement, or that rate of children's behaviour affected the identified relations between mothers' behaviours and time in joint engagement. This suggests that mothers are the main contributor in maintaining joint engagement during play with their young children with autism. Further, we found no association between children's mental age and rate of mothers' toy introduction, toy expansion and positive affect. This concurs with Shire and colleagues' (2016) result that child cognitive scores did not predict parental responsivity. However, we found that children's mental age was related to how much time the dyads spent in joint engagement and to rate of mothers' talk during joint engagement. Thus, as we showed in our regression model, one would expect that the association between rate of mother's talk and time in joint engagement may be weakened when controlling for children's mental age, suggesting that higher rate of maternal talk possibly do not facilitate joint engagement per see, but rather that mothers align their child-directed talk with their children's abilities. The relative amount of mother's talk may be less important for joint engagement than timing and contextual fit, as noted by Gulsrud et al. (2015).

In conclusion, variation in time in joint engagement during play between mothers and their young children with autism was related to rate of mothers' behaviours and children's mental age, but not to rate of children's behaviours in this study. Thus, intervention teaching parents strategies designed to increase time in joint engagement may be vital. The results are strengthened by a fairly large sample size compared to similar studies, blind rating of the video-recordings and good inter-rater reliability. Still, some limitations are acknowledged. First, the coding was based on only one 10-min play episode; such single, short interactions should be enhanced with either longer or additional interaction sessions in future studies. Second, it is not known whether the findings will apply to the whole autism spectrum, since only children with a childhood autism diagnosis were included. Third, as a concurrent correlation design was used, the findings do not provide evidence as to whether a higher rate of maternal toy introduction, toy expansion and positive affect is "disruptive" to the maintenance of joint engagement, or conversely, if higher rate of these behaviours actually may prolong joint engagement with children who are more difficult to engage. Following methods used by Gulsrud et al. (2015) will likely provide more information about a possible direct effect of child and maternal behaviours on joint engagement. Studies that further unpack the dependent nature of parent and child behaviours on joint engagement will add to the information on appropriate targets for parent- mediated early interventions in ASD.

Key message

- Increased understanding of parent and child behaviours during joint engagement is important for identification of targets for parent-mediated early interventions in ASD

- Time in joint engagement was related to rate of mothers' behaviours and children's mental age, but not to rate of children's behaviours in this study

- Higher rate of some maternal behaviours was inversely related to time in joint engagement, but it is not clear yet if higher rate may facilitate or disrupt joint engagement

- The complex nature of the interaction between mother and child behaviours in promoting joint engagement warrants further elucidation

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Table 1: Participant characteristics (N=58)	Mean/No. (%)	(SD)	Range
Children			
Chronological age, months	48.5	(8.5)	29-60
Mental Age[1], months	27.8	(11.6)	9-59
Developmental Quotient[1]	56.6	(19.5)	16-105
Receptive language age[2], months	23.3	(11.0)	6-60
Expressive language age[2], months	21.4	(12.0)	3-60
Gender			
Male	46 (79%)		
Female	12 (21%)		
Children have one or more siblings[3]	48 (83%)		
Children live with[4]			
Mother and father	46 (79%)		
Shared arrangement or mother only	10 (17%)		
Mothers			
Education level[5]			
University, more than 4 years	12 (21%)		
University/college, up to 4 years	14 (24%)		
Completed high school	24 (41%)		
Completed elementary school	7 (12%)		
Ethnicity[6]			
Norwegian	36 (62%)		
Immigrants	18 (31%)		

[1]Mullen Scales of Early Learning (MSEL)

[2]Reynell Developmental Language Scales (RDLS), but for children scoring < 4 stanine for 1.5 years language age was based on MSEL

[3]missing data: 3 children

[4] missing data: 2 children

[5] missing data: 3 mothers

[6] missing data: 4 mothers

not all percentages sums up to 100% as the missing data account for 3-7%

Table 2: Time in joint engagement and rate of mothers' and children's behaviors during joint engagement (N=58)

	Mean	(SD)	No. (%) showing 0[2]
Joint engagement, min	4:27	(2:12)	0 (0%)
Supported joint engagement, min	4:16	(2:05)	0 (0%)
Coordinated joint engagement, min	0:13	(0:35)	38 (66%)
Rate of mothers' positive affect, per min	0.6	(0.8)	19 (33%)
Rate of mothers' toy expansion, per min	0.7	(0.6)	3 (5%)
Rate of mothers' toy introduction, per min	0.7	(0.7)	8 (14%)
Rate of mothers' child-directed talk[1], per min	10.2	(3.0)	1 (2%)
Rate of children's positive affect, per min	0.5	(0.7)	26 (45%)
Rate of children's toy expansion, per min	0.7	(0.6)	5 (9%)
Rate of children's toy introduction, per min	1.2	(0.8)	2 (3%)
Rate of children's talk[1], per min	3.8	(3.4)	8 (14%)

[1] 4-sec intervals with presence of talk
[2] Number of children showing 0 instances of the respective behaviours

Table 3: Multiple linear regression model with rate per min of mothers' behaviors as independent variables and time in joint engagement during mother–child play as dependent variable (N=58)

	Time in joint engagement, seconds Estimated coefficient (95% CI)
Intercept	224.0 (107.1 to 340.9)
Rate per min of mothers' positive affect	-28.7 (-68.8 to 11.3)
Rate per min of mothers' toy introduction	-64.1 (-108.5 to -19.6)**
Rate per min of mothers' toy expansion	-70.7 (-125.7 to -15.6)*
Rate per min of mothers' talk[1]	15.7 (5.3 to 26.0)**

R²= .29 (adjusted R²=.24), p=.001
** p<.01, *p<.05
[1] 4-sec intervals with presence of talk per minute

Table 4: Correlation[1] (95% CI) between rate of mothers' behaviors during joint engagement and rate of children's behaviours and mental age (N=58)

	Children's positive affect	Children's toy introduction	Children's toy expansion	Children's talk	Children's mental age
Mothers' positive affect	**.42 (0.18, 0.61)****	-.22 (-0.45, 0.04)	-.03 (-0.29, 0.23)	-.05 (-0.30, 0.21)	.02 (-0.24, 0.28)
Mothers' toy introduction	.06 (-0.20, 0.31)	**.49 (0.27, 0.66)****	.20 (-0.06, 0.44)	.02 (-0.24, 0.28)	.03 (-0.23, 0.29)
Mothers' toy expansion	.03 (-0.23, 0.29)	.16 (-0.10, 0.40)	**.53 (.32, 0.69)****	-.07 (-0.32, 0.19)	-.19 (-0.43, 0.07)
Mothers' talk[2]	.15 (-0.11, 0.39)	.05 (-0.21, 0.30)	.24 (-0.02, 0.47)	**.29 (0.03, 0.51)***	**.33 (0.08, 0.54)***

[1]Spearman rank order correlation, 2-tailed, * = p< .05, ** = p< .01
[2]4-sec intervals with presence of talk