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Number and type of toys affect joint attention of mothers and infants

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ABSTRACT

Establishing joint attention with a caregiver on a physical object provides an optimal environment for language learning for infants. In the present study, we investigated whether 12-month-olds and their mothers establish higher quality joint attention interactions in the presence of fewer compared to more toys. As a secondary goal, we investigated how different types of toys affect how mother-infant dyads establish joint attention. In a five-minute free play setting, mothers and infants participated in either Five Toy ($n = 48$) or Twelve Toy ($n = 33$) groups. They were given organizational (i.e., toys that require arrangement of parts), responsive (i.e., toys that emit sounds via manipulation), and symbolic toys (i.e., toys that elicit pretend play). Results showed that compared to the Twelve Toy group, joint attention interactions in the Five Toy group were less frequent, lasted longer, were more likely to be initiated by maternal following than by maternal directing of infants' attention, and more likely to be coordinated in which infants demonstrated awareness of the mothers' simultaneous attentional focus by looking at their mothers, vocalizing, or turn-taking. We further found longer joint attention durations on organizational compared to symbolic toys, which were preferred to a lesser extent by the dyads. With responsive toys, mothers were more likely to initiate joint attention by following their infants' attention. Joint attention interactions lasted longer and were more likely to be coordinated in the second half compared to the first half of the play session, suggesting that over time it became easier for the mothers and infants to settle on certain toys for more elaborate play. In sum, mothers and infants establish higher-quality joint attention with fewer toys in general and with organizational toys in particular.

1. Introduction

1.1. Joint attention

Joint attention is the ability to share experiences with a partner while attending to the same object, person, or event together, and it is thought to optimize infants' capacity to gain knowledge from social interactive environments (Bruner, 1981; Bakeman & Adamson, 1984; Carpenter et al., 1998; Tomasello & Todd, 1983; Yu & Smith, 2013). Infants' ability to establish joint attention develops early. At

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around 6 months of age, infants start to respond to the joint attention bids of adults by following their gaze, vocalization, and pointing (Butterworth & Cochran, 1980; Scaife & Bruner, 1975). At around 9 months, infants can initiate joint attention episodes with their partners using their own cues such as gestures and vocalizations (Butterworth & Cochran, 1980; Bakeman & Adamson, 1984; Moore et al., 1995). Around their first birthdays, infants start distributing their attention between objects and their partners (Crais et al., 2004; de Barbaro et al., 2016) and start producing attentional cues such as declarative pointing by which they call their partners' attention to something interesting (Butterworth & Morissette, 1996; Camaioni et al., 2004; Carpenter et al., 1998; Liskowski et al., 2004). The nature of joint attention in infant-adult interactions also changes across time. For example, Bakeman and Adamson (1984) showed that, from 6 to 18 months, infants gradually spent more time in coordinated joint attention, where the child and the partner attend to the same activity and the child evidences awareness of the partner's involvement by looking at the partner, vocalizing, or turn-taking behaviors. On the contrary, the time infants spend in passive joint attention where the child and the partner attend to the same activity but the child does not show awareness of the other person's involvement did not change over time.

Individual differences in establishing and maintaining joint attention with an adult predict later sociocognitive and communicative development. Engaging in joint attention with caregivers is found to predict children's development of language (e.g., Carpenter et al., 1998) and intelligence (Saxon et al., 2000). Joint attention episodes that last longer and are initiated by maternal following as opposed to redirecting the infant's attentional focus result in more optimal child language outcomes (Baldwin et al., 1996; Carpenter et al., 1998; Tomasello & Farrar, 1986; Tomasello & Todd, 1983). Though we know that individual differences in joint attention episodes of mother-infant dyads exist and are consequential for children's development, we do not yet know the factors that underlie these differences. Previous research shows that maternal behaviors such as sensitivity and control are among the factors that affect the duration of joint attention interactions (Londoño & Farkas, 2018; Raver & Leadbeater, 1995). However, whether the material factors in the physical environment of the interaction may influence joint attention features is unexplored. In the present study, we examined the effects of the number of toys (whether there are fewer or more toys) and type of toys (i.e. toys that emit sounds upon manipulation, toys that elicit pretend play, vs. toys that require arranging according to size) in the physical environment on joint attention episodes of 12-month-old infants and their mothers.

1.2. Effect of the number and type of toys on children's play and parent-child interactions

The number and the properties of toys in the environment affect children's play behaviors. Dauch et al. (2018) found that toddlers aged 18–30 months had longer durations of play and played with toys in a greater variety of ways (e.g., dumping, pretending, matching, inserting) when they had four compared to sixteen toys available. Similarly, Bjorklund and Bjorklund (1979) found that toddlers aged 12–20 months engaged in longer durations of play when there were three compared to twelve and twenty toys in the environment. Furthermore, toddlers played with organizational toys (i.e. toys with parts to be manipulated and arranged in an order) in a greater variety of manners compared to responsive (i.e. toys that emit visual/auditory responses upon manipulation) and symbolic toys (i.e. toys used in pretend play). The number of toys also affects children's attention such that in the presence of a single toy, one-year-olds had a longer focused attention span compared to when six toys were available (Ruff & Lawson, 1990). For preschool-aged children, there are similar findings that children were distracted more, spent more time off task, and demonstrated smaller learning gains in highly decorated classrooms compared to less decorated ones (Fisher et al., 2014).

Apart from having an effect on children's play behaviors and attention, the properties of toys affect parent-child interactions too. Gavrilov et al. (2012) found that when preschool-aged children played with social toys such as dolls, they initiated joint attention with their parents more frequently compared to conditions where they played with non-social toys such as construction toys. The type of toys is related to parental language input and behaviors as well. When playing with non-electronic toys, parents provide richer language input in quality and quantity and display more responsive, instructive, and encouraging behaviors towards their children compared to playing with electronic toys (Sosa, 2016; Wooldridge & Shapka, 2012). How toys are presented also affects infants' attempts to establish joint attention; Puccini et al. (2010) found in what was called a context of regard (i.e. walking in a room filled with objects on a wall), infants initiated joint attention by pointing at objects for their caregivers more frequently than in a context of free play. To our knowledge, there is only one study looking at the effects of the number of toys on infants' play with their mothers. In the home environment, van Nguyen (2011) found that as the number of toys in the room increased, the number of times infants got distracted and looked away from the toys increased.

1.3. Current study

While some studies have studied how type and number of toys influence children's attention, play behaviors, and parent-child interactions separately, it remains an open question whether joint attention in mother-infant dyads changes in relation to the quantity and type of toys in the immediate environment. The first goal of the present study was to examine the effect of the number of toys on the features of joint attention episodes to be established between 12-month-olds and their mothers. For this purpose, we examined joint attentional behaviors in Five Toy and Twelve Toy groups, where mother-infant dyads either played with five or twelve toys in a free play setting. Based on previous findings, we expected shorter and more frequent joint attention interactions in the Twelve Toy group. We further hypothesized that infants' shorter attention span in the presence of more toys would lead mothers to make more attempts to establish joint attention with their infants leading to a higher proportion of joint attention interactions initiated by maternal direction rather than maternal following of the infant's attention in the Twelve Toy group compared to the Five Toy group. Again, due to infants' higher distractibility in the Twelve Toy setting, we expected joint attention interactions to be mostly terminated by the infants. Finally, we expected infants in the Five Toy group to show awareness of the mothers' simultaneous joint attentional

Table 1
Demographic Information.

	Five Toy Group M (SD)	Twelve Toy Group M (SD)
<i>n</i>	48 (27 girls)	33 (15 girls)
Infant age	12.2 months (9.3 days)	12.1 months (7.6 days)
Mother's age	32.1 (5.6)	31.5 (5.9)
Maternal education	11.4 (4.0) years	12.0 (5.6) years

Note. Information about maternal education was missing for 9 participants.

focus (i.e. coordinated instead of passive joint attention) to a greater extent due to longer joint attention interactions with less chance of distraction.

A secondary exploratory goal of the study was to investigate whether joint attention in mother-infant dyads would differ according to the type of toys. The properties of toys such as whether they require a construction or arrangement of parts (i.e. organizational toys), emit sounds or visual responses upon manipulation (i.e. responsive toys), or elicit pretend play (i.e. symbolic toys) might influence the features of joint attention episodes. In the present study, both Five Toy and Twelve Toy groups were presented with organizational, symbolic, and responsive toys. As this was the first study investigating the effects of the type of toys on mother-infant joint attention, we did not have any specific hypotheses.

Finally, how mothers and infants initiate, maintain, and terminate joint attention may change during the free play session. Earlier during the play, the presence of several toys may be more distracting for the infant; hence, joint attention episodes may last shorter in the first half compared to the second half of the play session. Therefore, we also investigated the differences in mother-infant joint interactions with respect to the timing of the joint attention episodes during free play.

2. Method

2.1. Participants

The data came from two different longitudinal studies of infants conducted in the same laboratory in a metropolitan city in Turkey. Mothers and infants in the Five and Twelve Toy groups visited the laboratory several times between 8 and 18 months and between 8 and 12 months, respectively. Two infants in the Five Toy group were excluded from the study because one was preterm and one was diagnosed with developmental delay. Table 1 summarizes participants' demographic information. Mothers' age and education level (in years) did not differ between groups according to independent-samples t-tests.

2.2. Materials and procedure

Parents' education levels and age were recorded at 8 months. At 12 months, after mothers and infants took part in other tasks in an hour-long visit¹, they participated in a 5-minute free play on a play rug on the ground. Interactions of the dyads were video recorded by two video cameras in the Twelve Toy group and four video cameras in the Five Toy group. The video cameras were located in different corners of the room.

Table 2 summarizes the toys and their properties for both groups. Following the previous coding scheme used by Bjorklund and Bjorklund (1979), we coded the toys as (1) *responsive* if the toys were designed to emit visual/auditory responses upon manipulation (e.g., a squeak toy), (2) *organizational* if the toys required the arrangement of different parts (e.g., stacking rings), and (3) *symbolic* if the

Table 2
Properties of Toys in the Five Toy and Twelve Toy Groups.

Five Toy Group	Twelve Toy Group
drum with two drumsticks (responsive)	drum with two drumsticks (responsive)
car (symbolic)	house (symbolic)
tower puzzle (organizational)	tower puzzle (organizational)
shape sorter (organizational)	rabbit (responsive)
duck (responsive)	wheel (responsive)
	two ships (responsive)
	two sleigh bells (responsive)
	carrot (responsive)
	plane (responsive)
	toy camera (symbolic)

Note. All the toys used in the study were non-electronic. All responsive toys emitted sounds upon manipulation.

¹ Mothers and infants participated in a 5-minute decorated room paradigm. Infants completed three eye tracking tasks measuring attention along with other tasks aiming to measure their sociocognitive skills (e.g., helping and imitation).

Table 3
Coding Scheme for Joint Attention Episodes.

Items	Definitions
Duration	Duration of each joint attention episode (in milliseconds)
Source of initiation	
Mother follows	When the mother joined into the infant's ongoing focus of attention
Mother directs	When the episodes started with the mother's attempt to shift the attention of the infant to a toy or activity
Type of joint attention episodes	
Coordinated	When the infant demonstrated explicit awareness of the mother's involvement through looks at the mother's face, vocalizations, gestures, or turn-taking activities
Passive	When both partners looked at the same object or activity, but the infant showed little awareness of the mother's involvement
Agent of termination	
Mother	When the mother first looked away from the jointly attended object or activity for at least 3 s
Infant	When the infant first looked away from the jointly attended object or activity for at least 3 s

Note. 1. Each joint attention interaction was marked from the beginning until the end and their durations were extracted from ELAN software in milliseconds. 2. If the last joint attention episode was ended by the experimenter at the end of five minutes, that episode was not included in the calculation of average duration.

toys were designed to elicit pretend play (e.g., doll). Both conditions contained toys from each category. There were minor differences in the presentation of toys: the toys were given in a basket in the Five Toy group and on the floor on a play rug in the Twelve Toy group. In both conditions, mothers were told to play with their infants just like they would play at home.

2.3. Data coding

An interaction segment was coded as joint attention when both mothers and infants attended to the same object/activity for at least 3 s (Bakeman & Adamson, 1984; Tomasello & Todd, 1983). Joint attention episodes ended when either the mother or the infant looked away from the joint focus for at least 3 s. Some variables were coded at the dyad level (e.g., total amount of time spent in joint attention) and some were coded at the level of joint attention episode (e.g., average duration of each episode). At the dyad level, we coded (1) for the number of joint attention episodes, (2) the total amount of time spent in joint attention, (3) the number of times mothers attempted to initiate a joint attention interaction but infants did not respond, and (4) the total number of toys that the dyad touched, held, or played with. At the joint attention episode level, each joint attention episode was coded for (1) its duration, (2) whether it was coordinated or passive, (3) whether it was initiated by mother's following or directing of infant's attention, (4) whether it was terminated by the mother or the infant, (5) the type of toy that was involved, and (6) whether it occurred in the first or second half of the play session. Table 3 contains additional information about the coding scheme. Joint attention episodes were coded using the ELAN software (Lausberg & Sloetjes, 2009). The coding was done by the first author and an undergraduate student of psychology. Ten percent of the videos were selected for calculating interrater reliability. Cronbach alphas ranged from .85 to .98 indicating high reliability. Disagreements were resolved through discussion and reaching a consensus by two coders.

Since in the Five Toy group the dyads could pick which toys to take out of the basket to play with, we additionally coded the average number of toys the dyads had in front of them. For this purpose, we coded for the number of toys in front of the dyad for each 30 s period and computed an average value (i.e. sum of number of toys in each 30 s / 10 thirty-sec units). In the Twelve Toy group, all toys were on the play rug and visible to both mothers and infants. Only exceptions occurred for three dyads where some of the toys were off to the side for a short period of time.²

2.4. Data analysis

To compare the Five Toy and Twelve Toy groups in terms of the number of joint attention episodes, the total amount of time spent in joint attention (in milliseconds), and the number of times mothers attempted to initiate a joint attention interaction but infants did not respond, we used independent-samples t-tests. To investigate whether joint attention episodes differed in Five Toy and Twelve Toy groups in terms of their duration (in milliseconds), type (i.e. coordinated/ passive), source of initiation, and agent of termination, we used mixed effects regression models. For mixed effects models, the number and type of toys along with when the joint attention episode was established (i.e. in the first or second half of the play session) were entered into the analyses as fixed factors. For binary outcome variables, mixed effects logistic regression models were used. All models included by-child random intercepts. Categorical predictor and outcome variables were defined as factors in R (R Core Team, 2013) and were automatically dummy coded. The coding of predictor and outcome variables was as follows: group (0 = Five Toy, 1 = Twelve Toy), type of toy (-1 = organizational, 0 = responsive, 1 = symbolic), block (0 = first half, 1 = second half), source of initiation (0 = mother follow, 1 = mother directs), type of joint attention (0 = passive, 1 = coordinated), and agent of termination (0 = infant, 1 = mother). Outliers in the continuous variables (i.e. > mean + 3*SD) were eliminated before the analyses (i.e. only from the analyses that contained those variables). Accordingly, 13

² For one mother-infant dyad, one toy was off to the side for 153 seconds and two toys for 83 seconds; for the second dyad, one toy was out of sight for 60 seconds; for the third dyad, one toy for out of sight 55 seconds and two toys for 90 seconds.

out of 619 joint attention episodes were eliminated due to having an extremely long duration. Eleven out of these 13 eliminated episodes occurred in the Five Toy group. There were no outliers in mother-infant dyads in terms of the total duration spent in joint attention. Two mother-infant dyads from the Twelve Toy group were eliminated due to having too many JA episodes (i.e. $> \text{mean} + 3 \times \text{SD}$) from the analyses that compared the number of joint attention episodes between groups.

Mixed effects models were built with the *lme4* package (Bates et al., 2015) in R. Post-hoc pairwise comparisons (for different types of toys) corrected with Tukey's multiple comparisons test were run with the *emmeans* package (Lenth, 2020). Significance values of categorical predictors were obtained with the *simr* package (Green & MacLeod, 2016). Influential data points (i.e. data points which strongly influence the regression coefficients) in terms of participants were detected by using the *influence.ME* package (Nieuwenhuis et al., 2012). Influential data negatively affect the generalizability and statistical fit of a model. To decide whether a data point is influential, Cook's distance was used. Following van der Meer et al. (2010), cases were regarded as too influential if they had a larger Cook's distance than $4/n$, n being the number of children in the sample. From each model, a maximum of two children (0, 1, or 2) were eliminated due to being influential data points. Finally, we used *kappa.mer* and *vif.mer* functions to check for the multicollinearity in each model and did not find a multicollinearity problem (*kappa's* < 5.2 and *VIF's* < 1.3).

3. Results

3.1. Five toy vs. twelve toy group

Table 4 summarizes descriptive information. As expected, mother-infant dyads in the Twelve Toy group engaged in joint attention interactions more frequently compared to the Five Toy group, $t(78) = -4.73, p < .001, d = 1.08$. However, groups did not differ in terms of the total duration they spent in joint attention, $t(79) = .96, p = .34$. Together these results suggest that joint attention episodes may have been shorter in the Twelve Toy group. To test this hypothesis, we conducted mixed effects regression analyses.

As shown in Table 4, dyads in the Five Toy group mostly established joint attention on organizational toys whereas mothers and infants in the Twelve Toy group mostly attended to responsive toys together. Therefore, the type of toys was used as a predictor variable in the analyses. Confirming our hypothesis, mixed effects regression analyses showed that a joint attention episode was more likely to last longer in the Five Toy compared to the Twelve Toy group (*coefficient* = $-6741, SE = 1511, p < .001$). The duration of a joint attention episode was also longer if it occurred in the second half rather than in the first half of the play session (*coefficient* = $2698, SE = 1387, p = .05$), and if the type of toy was organizational compared to symbolic (*coefficient* = $7742, SE = 2547, p = .007$).³ In terms of the duration of joint attention episodes, responsive toys did not significantly differ from organizational toys ($p = .09$) and symbolic toys ($p = .18$).

As expected, comparing the groups in terms of the initiation of JA episodes showed that mothers were more likely to initiate joint attention by directing their infants' attention in the Twelve Toy compared to the Five Toy group (*coefficient* = $-0.82, SE = 0.26, p = .001$). Mothers followed their infants' attention to initiate joint attention to a greater extent on responsive toys compared to organizational toys (*coefficient* = $-0.75, SE = 0.24, p = .005$) and symbolic ones (*coefficient* = $-1.25, SE = 0.42, p = .008$). There was no significant difference between organizational and symbolic toys ($p = .48$). In which half the JA episodes took place was not associated with how the JA episodes were initiated ($p = .54$).

Supporting our hypothesis, a joint attention episode was more likely to be coordinated in the Five Toy compared to the Twelve Toy group (*coefficient* = $-1.11, SE = 0.29, p < .001$). Furthermore, there was a greater chance of a joint attention interaction to be coordinated if the toy was not symbolic (organizational vs. symbolic toys: *coefficient* = $1.70, SE = 0.40, p < .001$, responsive vs. symbolic toys: *coefficient* = $1.57, SE = 0.39, p < .001$), and if the joint attention episode took place in the second half of the play session (*coefficient* = $0.47, SE = 0.20, p = .018$). There was no significant difference between organizational and responsive toys ($p = .83$).

Finally, contrary to our hypothesis, who terminated the joint attention episodes did not depend on which group mothers and infants were in ($p = .16$). However, a joint attention episode was more likely to be terminated by the mother if the toy was responsive compared to organizational (*coefficient* = $-0.98, SE = 0.24, p < .001$) and if the episode took place in the second half of the play session (*coefficient* = $-0.45, SE = 0.20, p = .027$). There were no differences between organizational and symbolic toys ($p = .70$), and responsive and symbolic ones ($p = .14$).

In sum, compared to the Five Toy group, in the Twelve Toy group joint attention episodes were shorter, more likely to be initiated by mothers' directing of infants' attention, and less likely to be coordinated. In terms of the type of toys, organizational toys elicited longer joint attention interactions than symbolic ones and joint attention was less likely to be coordinated on symbolic toys. Compared to other types of toys, for responsive toys, mothers were more likely to initiate joint attention by following their infants' attention and terminated joint attention to a greater extent.

3.2. Total number of toys

In both the Five Toy and the Twelve Toy groups, mothers and infants may have focused on certain toys and omitted playing with the rest. Thus, the total number of toys the dyads played with and to which category these toys belonged to may be important for how the

³ For each of the models reported in the manuscript, we tested whether including interactions between fixed effects (e.g., interaction between Group and Type of Toy) would improve the model fit. Since including interactions did not improve the model fit and hence did not explain additional variance, we did not report these models.

Table 4
Descriptive Results.

	Five Toy Group M (SD)	Twelve Toy Group M (SD)
Number of joint attention episodes	6.4 (2.2)	9.3 (3.3)
Total duration spent in joint attention (in sec)	190.9 (62.1)	177.6 (61.0)
Average duration of a joint attention episode (in sec)	36.1 (19.8)	19.8 (7.0)
Mother directs (%)	67.5 (22.9)	73.0 (17.5)
Coordinated joint attention (%)	65.3 (22.6)	42.0 (27.2)
Mother terminates (%)	42.2 (25.5)	44.3 (25.7)
Failed joint attention attempts	7.0 (5.0)	11.1 (7.9)
Total number of toys dyads played with	4.2 (1.0)	10.4 (1.6)
Joint attention established with		
organizational toys	48 %	22 %
responsive toys	38 %	73 %
symbolic toys	13 %	5 %
Timing of joint attention		
in the first half of the play session	46 %	47 %
in the second half of the play session	54 %	53 %

dyads initiated, maintained, and terminated joint attention. Thus, we reran the former analyses with the total number of toys as one of the predictor variables (i.e. fixed effects) instead of the group variable (i.e. Five vs. Twelve Toy). Results mirrored previous findings with the group as the predictor variable. Joint attention episodes lasted longer if the dyads played with fewer toys overall (*coefficient* = -964.2 , *SE* = 239.7 , $p < .001$), if the toy was organizational (organizational vs. responsive toys: *coefficient* = 3762 , *SE* = 1596 , $p = .049$; organizational vs. symbolic toys: *coefficient* = 7950 , *SE* = 2535 , $p = .005$), and if the dyad established the interaction in the second half of the play session (*coefficient* = -2917 , *SE* = 1387 , $p = .036$). Joint attention episodes established with responsive and symbolic toys did not significantly differ from each other in terms of duration ($p = .20$).

Mothers were more likely to direct rather than follow their infants' attention to initiate joint attention if the dyads played with more toys in total (*coefficient* = 0.10 , *SE* = $.04$, $p = .009$) and if the toy was not responsive (organizational vs. responsive toys: *coefficient* = 0.76 , *SE* = $.24$, $p = .004$; symbolic vs. responsive toys: *coefficient* = -1.56 , *SE* = $.47$, $p = .003$). There were no differences between organizational and symbolic toys ($p = .22$), and between the first and second half of the play session ($p = .55$).

There was a greater chance of a joint attention episode to be coordinated if the dyads played with fewer toys in total (*coefficient* = -0.15 , *SE* = 0.04 , $p < .001$), if the toy was not symbolic (organizational vs. symbolic toys: *coefficient* = 1.66 , *SE* = $.40$, $p < .001$; responsive vs. symbolic toys: *coefficient* = 1.51 , *SE* = $.39$, $p < .001$), and if the interaction took place in the second half of the play session (*coefficient* = 0.47 , *SE* = 0.20 , $p = .017$). There was no difference between responsive and organizational toys ($p = .78$). Finally, the total number of toys dyads played with was not related to who terminated the joint attention episodes ($p = .06$).

3.3. Correlations in the five toy group

The dyads in the Five Toy group could pick which toys to take out of the basket to play with. Therefore, we coded the number of toys the dyads had in front of them per each thirty second period and computed an average number of toys for each dyad. To examine the relations between the average number of toys in front of the dyad and joint attention-related behaviors in the Five Toy group, we conducted Pearson correlation analyses. As the number of toys increased, dyads engaged in more frequent ($r = .43$, $p = .002$) and shorter periods of joint attention interactions ($r = -.65$, $p < .001$), and spent less time in joint attention in total ($r = -.46$, $p = .001$). Furthermore, the number of toys was negatively related to the proportion of coordinated joint attention interactions ($r = -.39$, $p = .006$). The number of toys was not related to how the joint attention episodes were initiated and by whom they were terminated. The pattern of main findings of this correlational analysis thus largely mirror the results in our condition comparisons.

3.4. Failed attempts to initiate joint attention

Finally, we compared the groups in terms of the frequency of mothers' attempts to initiate joint attention with their infants. In line with our hypothesis, mothers in the Twelve Toy group more frequently attempted but failed to direct their infants' attentional focus compared to the mothers in the Five Toy group, $t(79) = -2.92$, $p = .005$, $d = .66$. There was also a significant positive correlation between the total number of toys that the dyads inspected or played with and the number of failed attempts to initiate joint attention, $r = .34$, $p = .002$. Supporting these findings, in the Five Toy group we found a positive correlation between the number of toys in front of the dyad and mothers' failed attempts to establish joint attention, $r = .41$, $p = .004$.

4. Discussion

This is the first study to show that both the number and the type of toys affect how mothers and infants initiate, maintain, and terminate joint attention. Results showed that in the presence of more toys, mothers and infants had shorter and more frequent joint attention episodes, which were less likely to be coordinated and more likely to be initiated by mothers' directing instead of following

their infants' attention. Furthermore, we found that mothers and infants established joint attention with organizational and responsive toys to a greater extent than symbolic ones. Given that longer and coordinated joint attention interactions that are initiated by maternal following of infants' attention are predictive of language development (Baldwin et al., 1996; Carpenter et al., 1998; Markus et al., 2000; Tomasello & Farrar, 1986; Tomasello & Todd, 1983), our findings suggest that having fewer toys in the environment and playing with organizational toys may be more beneficial in terms of the quality of shared attention to be established by the mother and the young child.

First, we turn to the discussion of the factors that were associated with the duration of joint attention. Our findings clearly show that in the presence of fewer toys, joint attention interactions lasted longer. Building on previous work showing that children exhibit shorter durations of attention and play in the presence of more toys (Dauch et al., 2018; Ruff & Lawson, 1990; van Nguyen, 2011), we suggest that infants showed shorter periods of sustained attention and were more distracted when there were more toys in front of them leading to shorter joint attention interactions. Further, when there were more toys, mothers established joint attention more frequently with their infants to take into the scope of attention a more numerous set of toys, but spent less time on each toy before shifting to the next. This conclusion is supported by the finding that mother-infant pairs displayed failed attempts at establishing joint attention more frequently when there were more toys in the environment.

Joint attention episodes lasted longer when playing with organizational compared to symbolic toys. With organizational toys, it may be more likely for the mothers and infants to engage in goal-directed activities that may take a longer time. For example, while playing with a shape sorter, sorting the objects according to their shapes and putting the shapes into correct places are goal-directed actions and require a long duration of shared play. On the other hand, symbolic toys were not preferred by the mother-infant dyads to the same extent. The most likely reason is that 12-month-old infants were too young to engage in pretend play. Future studies may look into whether symbolic toys elicit longer shared attention for older infants and their mothers.

The finding that joint attention interactions lasted longer and were more likely to be coordinated in the second compared to the first half of the play session may suggest that earlier in the play session, the toys that the dyads have not yet examined may act as distractors and thus shorten joint attention interactions. Our findings suggest that as the dyads explored more toys over time, they found it easier to settle on certain toys to attend together for longer periods of time. Future work may assess how joint attention processes change over a longer play session in the presence of fewer and more toys.

Joint attention interactions were also more likely to be coordinated if the dyads played with fewer toys and the toy was organizational or responsive instead of a symbolic one. We suggest that during longer joint attention interactions, which mostly occurred in the presence of fewer toys, infants found more opportunities to track their mothers' attentional focus to shared objects. Furthermore, organizational and responsive toys may elicit turn-taking games to a greater extent than symbolic ones. For example, an organizational toy such as a tower puzzle prompts mothers and infants to put the pieces on top of each other by taking turns. Similarly, when the dyads play with a responsive toy such as a drum, they may use the sticks to hit the drum by taking turns. These kinds of situations may prompt infants to pay attention to their mothers' eye gaze and thus coordinate attention between their mothers and the toys or activities.

The number of toys was associated with how the dyads initiated joint attention. Instead of following the attentional focus of infants, mothers initiated joint attention mostly by directing their infants' attention to a new toy when there was a larger set of toys around. In the presence of more toys, infants may get distracted more easily and mothers may try to direct their infants' attention to a particular toy to establish joint attention. Further, when there are more toys around, mothers may want to introduce each object to their infants leading to more shared interactions initiated by maternal directing of infants' attention. In the current study, 12-month-olds seldom initiated joint attentional interactions. This is in line with the findings of Tomasello and Todd (1983) in which infants attempted to initiate joint attention to a lesser extent than their mothers.

How joint attention was initiated was affected by the type of toys too. Mothers were more likely to initiate joint attention by following their infants' focus on responsive toys compared to organizational and symbolic ones. Responsive toys such as a duck or a drum that emit sounds might have attracted the attention of 12-month-olds more than organizational and symbolic toys. Furthermore, responsive toys may be easier for infants to understand and play on their own. Therefore, infants may have shown more interest in responsive toys and then mothers may have joined the play of the infants.

Contrary to our expectations, by whom the joint attention episodes were terminated was not related to the number of toys. In both groups it was mostly the infants who looked away from the shared focus of attention first, probably due to their limited attention span. As children's distractibility decreases and focused attention durations increase with age (Ruff & Capozzoli, 2003; Ruff & Lawson, 1990), future research can examine whether this pattern shows a change with older children. Interestingly, compared to organizational toys, mothers were more inclined to terminate joint attention if the toys were responsive. This is probably because responsive toys do not provide different ways for shared play between the mother and the infant such that one person can play with the toy without the active engagement of the partner. Further, mothers may be less inclined to terminate joint attention when playing with organizational toys since these toys may be perceived as having a higher educational value. Mothers also tended to end joint attention in the second half compared to the first half of the play session more frequently. This may suggest that the mothers were eager to experiment with different toys before the play session was over.

That the differences between the two groups were replicated within the Five Toy group by assessing the relationship between joint attention-related features and the average number of toys in front of the dyad shows that our findings are robust. One of the limitations of the study was having different mother-infant dyads in the two conditions. Since the data came from two different longitudinal studies, the sizes of the samples were different. Future research may employ a within-subjects design. Due to the data coming from different studies, we had some differences in the presentation of the toys such that the toys were presented in a basket in the Five Toy Group but on the floor in the Twelve Toy Group. This may have altered mothers' behaviors such that mothers in the latter group may have thought that they had to play with all of the presented toys. However, this does not seem to be likely since in both groups the

dyads usually played with all of the given toys. Another possible limitation of the study was the higher proportion of responsive toys in the Twelve Toy group that may have led mothers and infants in this group to play with responsive toys to a greater extent compared to the Five Toy group. Finally, joint attention interactions were observed for a mere 5-minute free play sample in the laboratory; future studies can examine whether these findings can be generalized to play interactions of longer duration and the home environment.

Since our study took place in a laboratory room, toys were the main source of attraction for the infants and their mothers. On the other hand, in the home environment there are various sources of distraction that may attract caregivers' or infants' attention to other things than play. Regarding the physical environment, household chaos, i.e. the level of disorganisation or environmental confusion in the home, may be one important factor affecting joint attention between infants and their caregivers. In chaotic homes, parents are less responsive and stimulating towards their children and children may be less proficient in focusing and controlling their attention (Marsh et al., 2020). Future work may look into the relations between joint attention and household chaos.

To conclude, our findings indicate that the number and type of toys in the environment affect how joint attention is established, maintained, and terminated between 1-year-olds and their mothers. The present study demonstrates that when playing with young children, caregivers should opt for fewer toys with parts to be manipulated and played by taking turns with the caregiver. Findings are relevant to researchers when designing and comparing across studies of joint attention, and may inform applied interventions targeting enhancing coordinated shared attention in infants and caregivers. Our findings suggest that opting for fewer toys in early child care and education settings may be facilitative of shared attention on a certain object or activity with young children.

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Author statement

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Declaration of Competing Interest

The authors report no declarations of interest.

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