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Humor and social cognition: Correlational and predictive relations in 3- to 47-month-olds

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ABSTRACT

We examined the relations between humor and social cognition in early development. In Study 1, 84 3- to 47-month-olds completed social cognition and humor lab tasks. Parents completed the Early Social Cognition Inventory and the Early Humor Survey. Once age was controlled for, there was a positive relation between the parental surveys, but no relation between the lab tasks. Study 2 ($N = 573$) extended the surveys to a large diverse sample, finding this relation held for children under 1 year, and 1-, 2-, and 3-year-olds; and within gender, socio-economic status (parent education; household income), country (UK, USA), and ethnicity (Black, Asian, and minority ethnic ethnicity, White ethnicity). In Study 3, 214 parents from Study 2 repeated the surveys six months later. Humor predicted social cognition, but not the reverse. Social cognition and humor may be related in day-to-day life, but this relationship is difficult to capture in the laboratory.

Social cognition refers to having knowledge of one's own and others' mental states (Beer & Ochsner, 2006) and allows young children to learn from others and communicate with people (Gergely & György, 2006; Tomasello, 1995). Humor generally involves deriving pleasure from noticing or creating an incongruity, and is often shared with others (Hoicka & Akhtar, 2012; McGhee, 1979; Shultz, 1976). Humor encourages people to make friends (Wanzer et al., 1996), cope with stress (Kuiper et al., 1993; Martin & Lefcourt, 1983), and be creative (Ziv, 1989). Humor is often considered to be an aspect of social cognition such as emotionality (Mireault et al., 2014; Mireault et al., 2015; Mireault et al., 2018; Mireault, Sparrow, et al., 2012), joint engagement (Reddy, 2001; Reddy & Mireault, 2015), intentionality (Hoicka, 2016; Hoicka et al., 2017; Hoicka & Akhtar, 2011; Hoicka & Butcher, 2016; Hoicka & Gattis, 2008, 2012; Leekam, 1991; Loizou, 2005), imitation (Hoicka, 2016; Hoicka & Akhtar, 2011, 2012; Hoicka & Butcher, 2016; Hoicka & Gattis, 2008), desire (Repacholi & Gopnik, 1997) and belief (Hoicka & Gattis, 2008; Leekam, 1991). However, there is little research examining the general relation between humor and social cognition in the early years, when both of these skills first emerge (Carpenter, Akhtar, et al., 1998; Hoicka & Akhtar, 2012; Hoicka et al., 2020; Jones, 2007; Mireault et al., (2015,2014); Mireault, Poutre, et al., 2012). The goal of these studies is to determine whether (1) humor and social cognition are linked in 3- to 47-month-olds, across a variety of age groups and demographic groups; and (2) humor predicts socio-cognitive development 6 months later, vice versa, or both.

Several researchers have suggested that early humor involves socio-cognitive skills, including understanding joint engagement, emotions, intentions, imitation, desires, and beliefs. In the first year, infants often rely on others' emotional cues and feedback to appreciate and produce humor (Mireault et al., 2015; Mireault, Poutre, et al., 2012; Reddy, 2001). For instance, from 5 months, infants

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smile longer at humorous events if parents are also smiling and laughing, rather than being neutral (Mireault et al., 2015), suggesting that infants process others' emotions to interpret humor. Furthermore, joint engagement, that is, sharing attention by two agents (Carpenter, Nagell, et al., 1998) has been suggested to be at the core of infants' understanding of humor (Reddy, 2001; Reddy & Mireault, 2015), as children from 7 months have been observed to engage in humor to re-elicit others' attention. From 1 year, parents use intentional cues, including specific acoustic patterns, disbelief language, and smiling, to signal they are joking, and toddlers use these cues to determine whether or not an unexpected action is a joke (Hoicka, 2016; Hoicka et al., 2017; Hoicka & Akhtar, 2011; Hoicka & Butcher, 2016; Hoicka & Gattis, 2008; Hoicka & Martin, 2016; Hoicka & Wang, 2011). In terms of imitation, children copy jokes as early as the first year both in naturalistic and lab environments (Hoicka, 2016; Hoicka & Akhtar, 2011, 2012; Hoicka & Butcher, 2016; Hoicka & Gattis, 2008). Towards 2 years of age, children distinguish what they and others want; and how and why their desires may be different from others' (Repacholi & Gopnik, 1997). Knowing what other people like may benefit their joke choices when producing humor in later life. One study found that the use of desire-related mental states such as want, which is positively linked to humor production in sibling relationships, facilitates building social relationships in 5-year-olds (Paine et al., 2021). Conversely, making jokes that offend people can create an awareness that it will weaken their social relationships. A further important aspect of humor is that children understand that the joker has expressed a falsehood, but does not expect the audience to believe the falsehood (Hoicka et al., 2008; Leekam, 1991). For instance, 4-year-olds distinguish jokes and lies based on whether the speaker shares information with the audience suggesting they should believe or disbelieve the content of the utterance (Leekam, 1991).

Conversely, humor is implicitly theoretically assumed to be part of early social cognition, as shown through social cognition scales and tests. The Theory of Mind Scale for children with pervasive developmental disorders for children as young as 5 years, developed by Muris et al., 1999, includes understanding of humor as a subscale. The Theory of Mind Inventory (ToMI) (Hutchins et al., 2012) for children from 2.5 years includes items involving jokes, teasing, and sarcasm. The Children's Social Understanding Scale (CSUS) for children as young as 2 years (Tahiroglu et al., 2014) aims to measure the social cognition skills of preschoolers with six subscales. The intention subscale of the CSUS includes looking at the difference between being serious and joking and understanding of teasing. The inclusion of humor items in social cognition scales (Hutchins et al., 2012; Muris et al., 1999; Tahiroglu et al., 2014) suggests that humor is a component of social cognition in early development. Indeed, the humor items are reliable within the overall social cognition scales. These studies point to a probable link between humor and social cognition in early development.

Surprisingly, however, to our knowledge, the general relation between humor and social cognition has not been studied in early childhood. Therefore, the goal of this study is to discover whether (1) humor and social cognition, as broad constructs, are linked in children between 3 and 47 months; (2) any such correlation is specific to children within a specific year of age (0, 1, 2 or 3 years), or whether it is a broader relation across early childhood; (3) any correlations are consistent across different demographics groups, including gender, socio-economic status (SES), and culture; and (4) humor predicts social cognition over time, vice versa, both, or neither. We chose a wide age range as both humor and social cognition continuously develop across the first 4 years (and even beyond), with several key skills potentially being linked to each other. For instance, in the first year, humor appreciation may relate to joint attention (Mireault et al., 2014); in 1-year-olds it may relate to imitation (Hoicka & Gattis, 2008); in 2-year-olds, it may relate to intention understanding (Hoicka & Akhtar, 2011; Hoicka & Gattis, 2008); and in older children it may relate to desires and beliefs (Leekam, 1991; Paine et al., 2021). Thus, we would not expect the relationship between humor and social cognition to exist only within a short age range. By limiting research to a small age range, we may only capture one or two aspects of social cognition in relation to humor, such as joint attention, or intention understanding. Similarly, limiting the age range might force us to compare only certain types of humor development to social cognition, e.g., physical, but not verbal, humor in the first year. By focusing on a wide age range, we can better understand the general relationship between humor development and socio-cognitive development.

To test the hypotheses, we conducted three related studies. In Study 1, ($N = 84$) children participated in a series of social cognition tasks and a humor appreciation and re-production test in the lab. Parents also completed surveys about their children's humor and socio-cognitive development: The Early Humor Survey (EHS) (Hoicka, Soy Telli, Prouten, Leckie, Browne, Mireault, et al., 2021) and the Early Social Cognition Inventory (ESCI) (Hoicka, Soy Telli, Prouten, Leckie, Browne, Nurmsoo, et al., 2021). These surveys were chosen because they could be used with children from 3 to 47 months, and because these surveys do not overlap – there are no socio-cognitive items on the EHS, nor any humor items on the ESCI. Study 2 extended the survey measures in Study 1 to a large international sample, allowing us to examine whether the relation between humor and social cognition might hold within smaller age groups, and within different demographic groups including gender, SES (parent education, parent income), and culture (UK, USA; Black, Asian and Minority Ethnic (BAME) ethnicity, White ethnicity). In Study 3, a subset of parents from Study 2 repeated the surveys six months later to examine the longitudinal relations between humor and social cognition. We hypothesized that there would be a positive relation between humor and social cognition in young children across a variety of demographic groups. Over time, we expected social cognition to predict humor and vice versa. We predicted this because if humor is assumed as a component of social cognition, it may allow children to practice socio-cognitive skills such as understanding complex intentions, others' perspectives, and emotions; and imitating others' actions with specific reasons. Similarly, social cognition may underpin different features of humor understanding.

1. Study 1

The aim of Study 1 was to investigate the relation between humor and social cognition in children aged between 3 and 47 months in a laboratory setting, and using parent surveys. We chose to test a large age range because social cognition develops across early childhood, with imitation (Meltzoff & Decety, 2003) and joint engagement (Carpenter, Nagell, et al., 1998) emerging in the first year; intention in the second year (Meltzoff, 1995), and beliefs in the third year (Wimmer & Perner, 1983). Similarly, humor appreciation

Table 1
The Demographic Characteristics of the Participants in All Studies.

	Study 1	Study 2	Study 3
N	84	573	214
Children's Age by Month:			
Mean	23.11	26.79	31.08
SD	13.22	10.94	10.60
Range	3–46	3–47	8–53
Age by Year:			
< 1 Year	$N = 22$	$N = 35$	$N = 3$
Mean	8.18	7.83	9.33
SD	2.44	2.93	1.15
1 Year	$N = 25$	$N = 200$	$N = 59$
Mean	16.28	17.46	19.42
SD	2.86	3.40	2.98
2 Years	$N = 17$	$N = 194$	$N = 80$
Mean	30.65	28.97	29.37
SD	2.64	3.57	3.41
3 Years	$N = 20$	$N = 144$	$N = 54$
Mean	41.65	41.42	43.43
SD	2.92	3.46	5.09
Children's Gender:			
Female	41	288	106
Male	43	283	108
Not Reported	0	2	0
Children's Ethnicity:			
Arab	0	1	0
Black	0	5	2
East Asian	0	3	0
Of Mixed Ethnicity	6	16	7
Other[†]	0	26	13
South Asian	0	6	0
White	74	511	190
Not Reported	4	5	2
Children's Country:			
Australia	0	10	5
Canada	0	10	5
United Kingdom	84	452	156
United States	0	67	35
Other Country	0	27	12
Not Reported	0	7	1
Parents' Age by Year:			
Mean	34.49	33.79	33.62
SD	5.62	5.15	4.54
Range	22–66	18–65	18–44
Parents' Gender:			
Female	71	493	202
Male	2	38	10
Not Reported	11	42	2
Parents' Ethnicity:			
Black	0	5	2
East Asian	0	8	4
Of Mixed Ethnicity	2	8	3
Other[†]	0	16	8
South Asian	0	5	1
White	69	490	193
Not Reported	13	41	3
Parents' Education:			
High School	18	60	19
Community College	0	25	10
Undergraduate	32	177	65
Postgraduate	29	268	118
Not Reported	5	43	2
Household Income[‡]:			
Australia: *N*	*NA*	5	*NA*
Mean		$93,000 AUD	
SD		$50,941	
Range		$50,000–$170,000	
Canada: *N*	*NA*	5	5
Mean		$92,000 CAD	$113,000 CAD
SD		$43,243	$48,938

(*continued on next page*)

Table 1 (*continued*)

	Study 1	Study 2	Study 3
Range		$50,000 – $160,000	$60,000 – $190,000
United Kingdom: *N*	69	204	104
Mean	£ 54,166 GBP	£ 56,611 GBP	£ 56,799 GBP
SD	£ 23,506	£ 27,409	£ 33,209
Range	£ 12,000 - £ 120,000	£ 6000 – £ 183,000	£ 9000 – £ 200,000
United States: *N*	*NA*	25	33
Mean		$121,400 USD	$142,030 USD
SD		$55,683	$50,319
Range		$22,000 – $200,000	$47,000 – $250,000
Recruited			
babylovesscience.com	0	469	214
Sheffield Cognitive Developmental Lab	84	104	0

Note. [†]Parents identified ethnicity information as Other, but without specification. [‡]We did not report household incomes in other countries as further samples were less than five.

emerges from 4 months according to observation-based research (Mireault, Poutre, et al., 2012); or even as early as 2 months based on parent reports (Hoicka, Soy Telli, Prouten, Leckie, Browne, Mireault, et al., 2021). As discussed in the introduction, many different aspects of social cognition (e.g., emotion, intention, belief) are fundamental to humor development, while humor is also thought to be a part of social cognition itself (Hutchins et al., 2012; Muris et al., 1999; Tahiroglu et al., 2014). Children participated in a series of social cognition tasks and a humor appreciation/ re-production test. We implemented 11 short social cognition tasks to measure how much children understand others' minds. We presented 21 jokes, and 21 normal control acts, to measure whether children smile or laugh at increasingly advanced jokes and whether they produce them. Furthermore, parents completed the EHS (Hoicka, Soy Telli, Prouten, Leckie, Browne, Mireault, et al., 2021) and the ESCI (Hoicka, Soy Telli, Prouten, Leckie, Browne, Nurmsoo, et al., 2021) to find out whether both measures (laboratory; parental report) are consistent. Such an approach may give us ecologically valid findings.

2. Method

For all three studies, we report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the studies (Simmons et al., 2012). Researchers can access original data by collaborating with the authors.

2.1. Participants

Previous research found that social cognition correlates with a variety of other individual difference measures, including parent-child talk, attachment, executive function, and lying in early development with effect sizes of 0.29–0.55 (Carlson et al., 2004; Fu et al., 2018; Ontai & Thompson, 2008). Therefore, we sought to power our study to find a moderate effect size. A power analysis found 84 participants were needed for a two-tailed moderate correlation ($r = 0.3$), with $\alpha = 0.05$, power = 0.8 (Faul et al., 2007). The demographic characteristics of the participants are presented in Table 1. All children were exposed to English, but 13 of them were exposed to other languages as well. Children were recruited from the database of the Sheffield Cognitive Development Group, the Facebook page of this group, Bounty packs, and Facebook advertizing. Further children were excluded because they did not complete tasks or were unwilling to join in (26), experimental error (9), technical problems with the videos or equipment (3), parental interference (2), or because of a development disability (1). We examined whether there were any age or gender differences between our final sample ($N = 84$) and the children who did not want to participate ($N = 26$ for gender, $N = 25$ for age, as one parent did not report it). An independent-samples t-test for age violated Levene's test for equality of variance, $F = 8.26$, $p = .005$. When equal variance was not assumed, there was no difference in mean age between the children who participated (M =725.63 days, $SD = 401.76$) and those who did not ($M = 728.16$ days, $SD = 294.92$), $t(53.14) = -0.03$, $p = .973$. A Mann–Whitney U test for gender found no difference between children who participated (41 female, 43 male) and those who did not (8 female, 18 male), Mann–Whitney $U = 895$, $Z = -1.61$, $p = .107$. This suggests that there is no sampling bias in terms of age or gender. Seven parents completed the EHS, and five parents completed the ESCI, of the children who were unwilling to participate. We ran two linear regressions on EHS and ESCI scores as the dependent variables separately, and age as the independent variable on children who completed the experiment and those who did not to obtain unstandardized residuals of EHS and ESCI scores, controlling for age. The unstandardized residuals of the EHS, controlling for age, for children who did not participate ($M = 0.63$, $SD = 3.57$) were higher than for those children who did participate (M = - 0.05, $SD = 3.04$). This suggests that we do not have evidence that the children who were unwilling to participate understood humor less well than children who did. However, the unstandardized residuals of the ESCI, controlling for age, for children who did not participate ($M = -1.31$, $SD = 2.25$) were lower than for those children who did participate ($M = 0.08$, $SD = 3.74$). Thus, children who did not complete the tasks might not have had the same level of socio-cognitive understanding as the rest of the sample. Ethical approval was obtained from the Psychology Department at the University of Sheffield for the project "The relationship between humour development and social cognition from 3 months to 47 months: A lab study", Reference Number 013845.

2.2. Materials

The materials for the humor appreciation/ re-production test were a teddy bear, a glove, a toy pig, a toy cow, a toy dog, a feather ball, a doll, a small towel, a toy sheep, three toy blocks, a hat, straws, a toy horse, a plastic spoon, a book, a toy plane and a sheet of crumpled paper.

The materials for the social cognition test were a toy watering can for the joint engagement task; a transparent plastic box and a toy goat for the own goal task; a toy bird for the imperative and declarative production of pointing task; a toy carrot and two cubes for the point following task; a blue dog toy and two toy bricks for the gaze following task; a big fish box in Fig. 1(a mechanism including a button that has a door that can be opened automatically) for the imitation of intentional actions task; a plate of broccoli and crackers for the desire task; four pictures of children's faces for the affective labeling task; a monkey puppet, an elephant puppet, a toy orange, a picture of an ice-cream cone and a picture of a bar of chocolate for the affective perspective-taking task; and two dolls, a marble and two small baskets for the false belief task.

Two SONY digital video cameras were used to record both tasks. The laboratory room had a small green table and four chairs for children and a big table and two chairs for parents. The Early Humor Survey (EHS, see Appendix A) (Hoicka, Soy Telli, Prouten, Leckie, Browne, Mireault, et al., 2021) and the Early Social Cognition Inventory (ESCI, see Appendix B) (Hoicka, Soy Telli, Prouten, Leckie, Browne, Nurmsoo, et al., 2021) were used. The EHS and the ESCI consisted of 21 and 20 yes/no questions, respectively. The EHS asked parents whether their child appreciates and/ or produces each type of humor. Two examples of the EHS are, "Peekaboo/ hide and seek, including variation, e.g., hiding objects in bags and revealing them" and, "Playing tricks on people, e.g., putting salt in the sugar bowl." Two examples of the ESCI are, "Is your child aware of their own desires?" and, "Does your child point to share information with you?" A Toshiba laptop was used to collect the survey data through Qualtrics.

2.3. Design

It was a correlational design. There were six variables for the humor appreciation and re-production test: a Joke Smile score, a Joke Laugh score, and a Joke Copy score for the humor trials; and a Control Smile score, a Control Laugh score and a Control Copy score for the control trials. There was one variable for the social cognition test which was the total social cognition score. Two other correlational measures were the EHS score and the ESCI score. The humor and social cognition tests were counterbalanced, with the order assigned at random to children.

2.4. Procedure

Before the study, parents signed consent forms and were informed about the study, and then completed the EHS and the ESCI. The experimenter played with the children in the lounge area for a warm-up until the children felt comfortable and ready for the study. Humor and social cognition tests were counterbalanced to avoid any order effects.

2.4.1. Humor appreciation and re-production test.

Five blocks included 21 control actions/ utterances and 21 jokes in total (see Appendix C for the full list). Each block consisted of four or five control actions or utterances followed by four or five humorous actions or utterances. Jokes started with the types of humor that most children would understand (e.g., peekaboo), and ended with the types of humor that the least number of children would

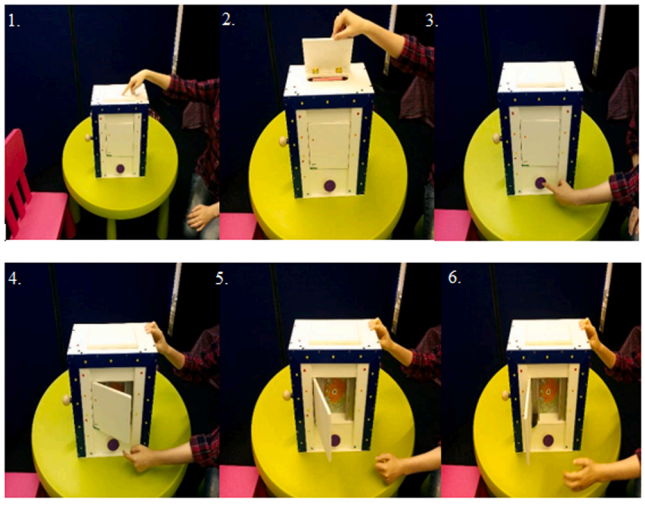

Fig. 1. Details of the Fish Box Trial. The Second Photo Demonstrates where the Experimenter said, "Whoops!" The Third Photo Demonstrates where the Experimenter said, "There!".

understand (e.g., puns) based on the EHS (Hoicka, Soy Telli, Prouten, Leckie, Browne, Mireault, et al., 2021). Control actions/ utterances were matched in content to the jokes (e.g., the experimenter waved as a control action for peekaboo as both involve using one's hands). The experimenter and the child sat face to face. The experimenter said to the child, "I am going to show you some things!" Before showing each action, the experimenter said, "Look" to focus their attention, then did the action or utterance (e.g., peekaboo or waving their hand). Each action was repeated twice. A small laugh followed each action. This was done in both the joke and control trials as we wanted to highlight the jokes with a laugh, but we wanted to ensure that if children laughed or smiled, it was in response to the joke, not laughter itself. Therefore, we used a small laugh after both joke and control trials, which could be construed as humor, or general happiness. Children were then asked, "Can you try?" in the control trials, and "Can you joke?" in the joke trials. The experimenter waited up to 10 s for the child's response. After the child's response, the experimenter said, "Okay!" regardless of the response. If the child did not smile/ laugh/ copy at all within one humor block, the experiment was stopped. Because we had a wide age range, from 3 to 47 months, we did not expect younger children to show an understanding of the later types of jokes (e.g., puns). We used this stop rule to avoid any distress for children. The experiment was video recorded. Some children were offered breaks between blocks if needed.

3. Social cognition test

Initially, this test consisted of 13 different short tasks to measure how young children understand others' minds. However, two of the social cognition tasks, the imperative production of pointing task (Camaioni et al., 2004), and level 1 perspective-taking task (Moll & Tomasello, 2006), were excluded from the study because children often produced responses that could not be coded, such as climbing over the table to grab objects instead of pointing. As some children were very young and were not expected to pass later tasks (e.g., Affective Perspective Taking), we again used a stop rule to avoid distress. When children did not pass three tasks in a row, the test was ended. All tasks were video recorded.

3.1. Joint engagement task (previously all children passed at 9 months)

The experimenter played with a toy watering can in silence while alternating her gaze between the child and the object. The episode lasted around 15 s or until the child looked from the object to the experimenter's face and back to the same object (Carpenter, Nagell, et al., 1998).

3.2. Own goal task (previously all children passed at 9 months)

We used this task to measure whether children act on their own goals by intentionally removing an obstacle to reach a target object. Carpenter, Nagell, et al. (1998) refer to the object to be removed as a "goal toy" (p. 44) suggesting children's own goals are involved in the task. We included this task to capture one of children's own socio-cognitive states, as children may learn to understand others' socio-cognitive states by comparing them to their own (Meltzoff, 2007). A toy goat was placed on the table in front of the child. A transparent plastic box was positioned upside down over the toy such that the child could see the toy but could not obtain it without moving the box. Then, the experimenter said, "Can you get the toy?" and waited up to 10 s for a response. If they did not succeed, the experimenter repeated the verbal prompt one more time (Carpenter, Nagell, et al., 1998).

3.3. Imperative and declarative production of pointing task (previously children passed at 11 months).

The experimenter flew a toy bird around using her hand for up to 10 s. The experimenter hid the bird behind her back so that the child could not see it. The experimenter said, "What happened?" and waited up to 5 s for a response. If there was no response, the experimenter repeated the question and waited for another 5 s. The experimenter named the toy, "It is a bird" (Camaioni et al., 2004).

3.4. Point following task (previously children passed at 11 months).

This task measured whether children look where an adult points. The experimenter gave the child a toy carrot to play with. Then, the experimenter put two different cubes in two separate locations on the table. The experimenter pointed to one of the cubes with her right hand while alternating her gaze between the child's eyes and the cube. The experimenter's pointing continued up to 10 s, or until the child looked at the correct cube (Carpenter, Nagell, et al., 1998). Children were given a toy to play with in line with the original paradigm, so that children had to move their attention away from the object they were holding to the object to which the experimenter was attending to show a clear shift in attention. It was not expected that children should be too distracted by the toy they were given as most children passed this task by 11 months in the original study.

3.5. Gaze following task (previously children passed at 11 months).

This task measured whether children look where an adult looks. The experimenter gave the child a blue dog toy to play with. Then the experimenter put two toy blocks in two separate locations on the table. The experimenter turned her head between the child and one of the blocks. The experimenter's head turns continued either until the child fixated on the correct brick or until the experimenter turned her head ten times (Carpenter, Nagell, et al., 1998). Children were given a toy to play with for the same reasons as the point

following task.

3.6. Imitation of arbitrary action task (previously children passed at 12 months)

This task measures whether children copied arbitrary actions. The experimenter patted the plastic box with her hand several times. The experimenter oriented the box toward the infant and said, "Can you do that?" and waited up to 5 s for the child to begin a response. If there was no response, the experimenter repeated the action one more time and waited for another 5 s (Carpenter, Nagell, et al., 1998). Carpenter, Nagell, et al. (1998) did not specify how long they waited for a response. However, we chose 5 s in order to ensure we kept children's interest in the task battery. Given that they had two chances to start a response, this gave them a total of 10 s to start a response. Indeed, 88% of children responded within this time frame.

3.7. Imitation of intentional action task (previously children passed at 12 months)

This task measured whether children copy intentional actions and avoid accidental actions. We used a fish box that works with a battery (see Fig. 1). The experimenter flapped the top of the box and said, "Whoops!" and then pressed the purple button and said, "There!" and waited for the flap to open, showing a fish mechanically. The experimenter said, "Can you make it work?" and waited 5 s for the child to begin a response. If there was no response, the experimenter repeated the question and waited for around five more seconds (Carpenter, Nagell, et al., 1998). Carpenter, Nagell, et al. (1998) did not specify how long they waited for a response. However, we chose 5 s in order to ensure we kept children's interest in the task battery. Given that they had two chances to start a response, this gave them a total of 10 s to start a response. Indeed, 81% of children responded within this time frame.

3.8. Desire task (previously children passed at 18 months)

This task measured whether children are aware of others' desires. Two plates of food (broccoli and crackers) were presented, and the experimenter said, "Try these!" and waited until the child tried. First, the experimenter tasted the child's preferred food and acted disgusted and said, "Eww!" Second, the experimenter tasted the other food and said, "Yum!" and looked happy. The experimenter placed one hand, palm facing up, precisely between the two plates and said, "Can you give me some?" and waited up to 10 s. The experimenter repeated the question twice if necessary (Repacholi & Gopnik, 1997).

3.8.1. Affective labeling task (previously children passed at 2 years)

This task measured whether children are aware of others' emotions. The experimenter showed four pictures of children's faces, with happy, sad, angry, and afraid expressions. The experimenter asked, "How does this boy/girl feel?" and waited up to 10 s for a response (Denham, 1986).

3.8.2. Affective perspective-taking task (previously children passed at 2 years)

Four pictures of children's faces were placed in front of the child. First, the experimenter used a monkey puppet and said, "I have got an ice cream, yay!" while showing a picture of the ice cream. The experimenter asked the child, "How is the monkey feeling?" Second, the experimenter used the monkey puppet again and said, "I have got an orange" while showing a toy orange. Suddenly, the experimenter dropped the orange and said, "Oh, no!" The experimenter asked the child, "How is the monkey feeling?" Third, the experimenter used an elephant puppet and said, "I have got chocolate, oh no!" while showing a picture of the chocolate. The experimenter asked the child, "How is the elephant feeling?" Finally, the experimenter used the elephant puppet again and pretended that the elephant puppet was walking around and fell over suddenly, then said, "I fell over, yay!" The experimenter asked the child, "How is the elephant feeling?" After each question, the experimenter waited up to 10 s for a response and repeated the question if necessary. In this task, two of the items involved emotions that we might expect so should be easy to identify, while two involved emotions we would not expect (the third and the fourth scenarios above), so children would have to go beyond how they would feel and pay attention to the puppet's reaction instead (Denham, 1986).

3.8.3. Sally-anne task (previously children passed at 4.5 years)

This task measured whether children understand false beliefs. The experimenter introduced Sally and Anne, saying, "This is Sally, and this is Anne." The experimenter asked the child their names. "Who is she? Do you remember her name?" The experimenter said, "Sally is putting the ball into her basket and is hiding behind me. Anne is moving the ball into her basket and leaves as well. When Sally returns, where will she look for the ball?" The experimenter waited for around 5 s for a response and repeated the question if there was no response. The experimenter waited for another 5 s (Baron-Cohen et al., 1985).

3.9. Coding

Humor coding was done across two dimensions: humor appreciation and humor re-production. Humor appreciation scores consisted of smiling and laughter at the experimenter's jokes, while humor production scores consisted of children's copying of jokes with smiling and/or laughter. We used children's re-production of jokes as a measure of humor production because children as young as 8 months old begin the production of humor by repeating jokes they find amusing (Hoicka & Akhtar, 2012; Hoicka & Gattis, 2008; Loizou, 2005; Reddy, 2001).

For smiling, children received one point for each joke if they smiled when the experimenter performed the joke. The total number of joke trials for which children smiled were summed to give a Joke Smile score between 0 and 21. In the control trials, children received one point for each control action/ utterance if they smiled when the experimenter performed. The total number of control trials for which children smiled were summed to give a Control Smile score between 0 and 21.

For laughter, children received one point for each joke if they laughed when the experimenter performed the joke. The total number of joke trials for which children laughed were summed to give a Joke Laugh score between 0 and 21. In the control trial, children received one point for each control action/ utterance if they laughed when the experimenter performed. The total number of control trials for which children laughed were summed to give a Control Laugh score between 0 and 21.

For copying, children received one point for copying a joke while they smiled or laughed as young children are significantly more likely to smile or laugh when producing, and re-producing, jokes versus sincere acts (Hoicka & Akhtar, 2011, 2012). The total number of joke trials were summed to give a Joke Copy score between 0 and 21. In the control trials, children received one point for each control action/ utterance for copying the control action/ utterance while they smiled or laughed. The total number of control trials were summed to give a Control Copy score between 0 and 21. If children never smiled, laughed or copied the jokes within a joke block, coding stopped, to be consistent with the testing stop rule.

Reliability coefficients of *Kuder-Richardson Formula 20* (*KR20*) = 0.98, *KR20* = 0.94 and *KR20* = 0.97 were found across trials for smiling, laughter and copying while smiling or laughing respectively. Because there was a wide age range, we also calculated internal reliability for each age group to show whether the humor trials are problematic for certain age groups. Table 2 shows internal reliability across humor trials within age group. A second coder coded 18 (21%) of the videos. Agreement was excellent, *Intraclass Correlation* (*ICC*) = 0.99 for smiling; *ICC* = 1.00 for laughter; *ICC* = 1.00 for copying.

Children scored one point on the *Joint engagement task* if they looked from the object to the experimenter's face and back to the same object, thus coordinating attention to both the adult and the object. Children scored one point on the *Own goal task* if children removed the obstacle. Children scored one point on the *Imperative and declarative production of pointing task* if children pointed to the object or gave a verbal cue asking for it. Children scored one point on the *Point following task* if children first looked at the toy to which the experimenter pointed. Children scored one point on the *Gaze following task* if children first looked at the toy that the experimenter looked at. Children scored one point on the *Imitation of arbitrary action task* if children reproduced the modeled action. Children scored one point on the *Imitation of intentional and accidental actions task* if children reproduced the intentional action, but not the accidental action. If children were attempting to reproduce the intentional action but were unsuccessful owing to lack of strength or dexterity, they were given credit for reproducing that action. Children scored one point on the *Desire task* if children offered their non-preferred food to the experimenter. Children scored one point on the *Affective labeling task* if children identified emotional dimensions for at least 3 out of 4 pictures. Children scored one point on the *Affective perspective-taking task* if children correctly identified how the puppets felt for at least 3 out of 4 scenarios. Specifically, the puppet with the ice cream expressed happiness; the puppet with the orange expressed sadness; the puppet with chocolate expressed sadness (even though he had chocolate); the puppet who fell expressed happiness (even though he fell). Children scored one point on the *Sally-Anne task* if children pointed to the previous location of the ball or said the previous location. Scores were summed for an overall social cognition score. If children did not pass three tasks in a row, coding stopped, to be consistent with the experimental stop rule. A reliability coefficient of *KR20* = 0.85 was found across all tasks. A second coder coded all videos for agreement. Agreement was very good, *ICC* = 0.87. Because there was a wide age range, we also calculated internal reliability for each age group to show whether the social cognition laboratory tasks are problematic for certain age groups. Reliability coefficients were *KR20* = 0.36 for under 1 year of age (*N* = 22); *KR20* = 0.69 for 1-year-olds (*N* = 25); *KR20* = 0.76 for 2-year-olds (*N* = 17) and *KR20* = 0.68 for 3-year-olds (*N* = 20).

For the EHS and the ESCI, parents replied "yes" or "no" for each item. Reliability coefficients of *KR20* = 0.87 for the EHS (*N* = 81), and *KR20* = 0.91 for the ESCI (*N* = 81) were found.

4. Results

4.1. Descriptive statistics and intercorrelations

Table 3 presents descriptive statistics of raw scores for laboratory and survey measures of social cognition and humor.

Laughter scores in both joke and control trials, and copying scores in both joke and control trials were positively skewed. However, we normalized laughter scores in joke trials with a fourth root transformation, and copying scores in both joke and control trials with cube root transformations to bring them to an acceptable level (Osborne, 2010). All final scores were within a level of skewness that is widely considered to be acceptable ± 2 (George & Mallery, 2010). Laughter in control trials appeared rarely, therefore, these scores

Table 2
Reliability Coefficients of KR20 across Humor Trials within Age Group.

	< 1 year of age	1-year-olds	2-year-olds	3-year-olds
Smiling	0.79	0.92	0.96	0.95
Laughter	0.90	0.85	0.86	0.88
Copying	-[a]	.86	0.94	0.94
N	22	25	17	20

Note. [a]KR20 score was not obtained as variability in the sample was too low.

Table 3
Descriptive Statistics of Raw Scores for all Variables.

	Mean	*SD*	Range
Social Cognition	4.39	2.84	0–10
Joke Smile	8.98	7.16	0–21
Joke Laugh	1.83	3.13	0–14
Joke Copy	4.75	6.39	0–20
Control Smile	7.15	6.62	0–19
Control Laugh	0.74	1.65	0–8
Control Copy	4.00	5.55	0–18
EHS	11.75	4.30	3–20
ESCI	12.89	5.30	1–21

Note. $N = 84$ for laboratory measures, $N = 81$ for survey measures.

turned into a categorical variable as laugh and no laugh across each condition.

Table 4 presents Pearson correlations for continuous variables, including Child Age, lab measures, and EHS and ESCI scores, but point biserial correlations for dichotomous variables for correlations involving gender. All variables were positively correlated with each other ($p < .01$) except for gender ($p > .05$).

4.2. Validity analyses

Paired samples t-tests were conducted to compare both smiling and copying between the joke and control trials to ensure that children appreciated the jokes. A Wilcoxon signed-rank test was conducted to compare laughter between the joke and control trials due to the low prevalence of laughter in the control trials. Children smiled significantly more in the joke ($M = 15.76$, $SD = 13.32$) than control ($M = 13.43$, $SD = 12.41$) trials; $t(83) = 5.80$, $N = 84$, $p < .001$, $d = 0.63$. A Wilcoxon signed-rank test found children laughed significantly more in joke trials ($M = 1.83$, $SD = 3.13$) than control ($M = 0.74$, $SD = 1.65$) trials, $Z = -4.44$, $p < .001$. However, there was no significant difference in the transformed scores for copying in the joke ($M = 0.99$, $SD = 1.07$) and control ($M = 0.92$, $SD = 1.02$) trials; $t(83) = 1.58$, $N = 84$, $p > .05$. Therefore, children found the joke trials funnier than the control trials, but did not reproduce actions more in the joke trials.

4.3. The relation between humor and social cognition based on children's performance

Table 4 presents the following partial correlation analyses between social cognition laboratory scores and Joke Smile scores; Joke Laugh scores; and Joke Copy scores controlling for Age in days; and Control Smile scores; Control Laugh scores or Control Copy scores respectively. All variables were positively correlated initially ($p < .01$), but no longer correlated when Age in days; and Control Smile scores; Control Laugh scores or Control Copy scores were controlled for ($p > .05$).

4.3.1. The relation between children's performance and parental surveys in humor and social cognition

Table 4 presents the following partial correlation analyses. The first partial correlation was conducted to determine the relation

Table 4
Summary of Pearson, Point Biserial and Partial Correlations for Variables. Partial Correlations are only Given for the Main Correlations of Interest: Social Cognition with Joke Smile, Joke Laugh, Joke Copy, and the EHS; and Joke Smile, Joke Laugh, Joke Copy, and the EHS with the ESCI.

Variables	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
1. Age in Days		0.02	0.75 * *	0.58 * *	0.49 * *	0.66 * *	0.57 * *	0.37 * *	0.62 * *	0.70 * *	0.72 * *
2. Gender[a]			-.06	0.07	0.14	0.01	0.09	0.17	-0.03	-0.04	0.09
3. Social Cognition				0.48 * * (−.01)[b]	.39 * * (−.01)	0.54 * * (.17)	0.48 * * (.10)	0.32 * * (.07)	0.47 * * (.01)	0.53 * * (−.01)	0.54 * *
4. Joke Smile					0.77 * *	0.89 * *	0.95 * *	0.58 * *	0.88 * *	0.40 * *	0.45 * * (.09)
5. Joke Laugh						0.73 * *	0.74 * *	0.66 * *	0.70 * *	0.34 * *	0.33 * * (−.02)
6. Joke Copy							0.84 * *	0.56 * *	0.92 * *	0.48 * *	0.51 * * (.14)
7. Control Smile								0.61 * *	0.85 * *	0.40 * *	0.46 * *
8. Control Laugh									0.48 * *	0.20	0.24 *
9. Control Copy										0.49 * *	0.45 * *
10. EHS											0.81 * * (.60 **)
11. ESCI											

Note. [a] Gender was coded as − 1 for girls and 1 for boys. [b] Values in parentheses are partial correlations (control variables: Age in days for all; Control Smile for Joke Smile; Control Laugh for Joke Laugh; and Control Copy for Joke Copy). * $p < .05$, * * $p < .01$, $N = 84$ for laboratory measures and $N = 81$ for surveys.

between social cognition laboratory scores and the EHS controlling for age in days. Other partial correlations were conducted to determine the relation between the ESCI and Joke Smile scores; Joke Laugh scores; and Joke Copy scores controlling for Age in days; and either Control Smile scores; Control Laugh scores or Control Copy scores respectively. All laboratory scores and survey scores were positively correlated initially ($p < .01$), but no longer correlated when Age in days; and Control Smile scores; Control Laugh scores or Control Copy scores were controlled for ($p > .05$).

4.3.2. Posthoc analyses between humor and social cognition for children over 1 Year Only

As reliability coefficients for children under 1 year were low (see Table 2), we also ran posthoc analyses for children over 1 year only. As the sample size was smaller ($N = 62$), this only allowed us to look for a large correlation ($r = 0.5$), with $\alpha = 0.05$, power = 0.8 (Faul et al., 2007) (rather than a moderate correlation). Table 5 presents the descriptive statistics of raw scores for children over 1 year only.

We ran posthoc analyses to check whether there was any correlation among laboratory variables controlling for Age in days, and Control Smile (for Joke Smile); Control Laugh (for Joke Laugh), or Control Copy (for Joke Copy) scores in children who were over 1 year of age. Social cognition laboratory scores and smiling (r' =0.02, $p = .88$, $N = 62$), laughter (r' = −0.03, $p = .86$, $N = 62$) and copying (r' =0.16, $p = .23$, $N = 62$) in humor trials were not correlated when control variables were accounted for.

We also looked at how many children did not complete the whole test due to the stop rule for children over 1 year. Sixty-five per cent ($N = 40$) of children had to stop early. Then, we ran partial correlation analyses among the sample who completed all tasks and those who had to stop early to find out whether the stop rule might reduce overall correlations. As the sample for those who completed the task was only $N = 22$, we could only look for very large correlations in that group. Social cognition laboratory scores and smiling (r' =0.15, $p = .56$, $N = 22$), laughter (r' = −0.20, $p = .44$, $N = 22$) and copying (r' =0.22, $p = .38$, $N = 22$) in humor trials were not correlated when control variables were added among the sample who completed all tasks. Social cognition laboratory scores and smiling (r' = −0.07, $p = .69$, $N = 40$), laughter (r' = −0.09, $p = .62$, $N = 40$) and copying (r' =0.07, $p = .69$, $N = 40$) in humor trials were not correlated when control variables were added among the sample for whom the stop rule was used. This suggests that the stop rule did not mask the potential relationship between humor and social cognition; however future research might examine this question with larger samples.

4.4. The relation between humor and social cognition based on parental surveys

Lastly, we ran a partial correlation while controlling for age to determine the relation between the EHS and the ESCI. The correlation remained significant between humor and social cognition, and was very strong (see Table 4 and Fig. 2).

5. Discussion

We found positive correlations between smiling, laughter, and copying scores for the humor trials and social cognition in the lab. However, these measures no longer correlated once we controlled for age, and smiling, laughter, or copying scores (respectively) in the control trials. Because the partial correlation was.17 between the social cognition laboratory measures and copying in joke trials, but not significant (and.16 for children over 1 year only, based on our posthoc analyses), future research may consider replicating the study with a larger sample over 1 year to determine whether a smaller significant correlation may exist. Both the social cognition and humor appreciation and re-production tests showed good validity for the entire sample. This validity persisted for the humor appreciation test even if we divided the sample into age groups of under 1 year, 1 year, 2 years, and 3 years. However, while validity was acceptable for 1-, 2-, and 3-year-olds on the humor re-production measure, and the Social Cognition Test, it was not acceptable for children under 1 year, suggesting the test battery was not ideal for this younger age group. Future research should focus only on children over 1 year, or identify a more appropriate social cognition test battery to include children under 1 year. Future research should also explore for correlations within the lab tasks for larger samples within each year of age.

As we expected, children smiled and laughed more in the humor trials than the control trials, showing that children did appreciate the humor in the experiment. However, it is worth noting that children did not laugh to a great extent in the joke trials, even though they did so significantly more than during the control trials. This is a similar finding to a past lab experiment with 30- and 36-month-

Table 5
Descriptive Statistics of Raw Scores for all Variables within Age Group.

	Mean (*SD*)			Range		
Age Groups	1	2	3	1	2	3
Social Cognition	3.48 (1.76)	5.70 (2.49)	7.40 (2.16)	1–7	1–9	1–10
Joke Smile	9.16 (6.02)	10.88 (7.70)	13.95 (6.98)	0–18	0–21	0–21
Joke Laugh	1.68 (2.78)	1.70 (2.71)	3.95 (4.31)	0–12	0–10	0–14
Joke Copy	2.92 (3.63)	5.23 (6.12)	11.80 (6.89)	0–12	0–16	0–20
Control Smile	6.92 (5.66)	9.12 (7.09)	11.70 (6.66)	0–18	0–19	0–19
Control Laugh	0.64 (1.50)	1.00 (2.21)	1.40 (1.96)	0–7	0–8	0–7
Control Copy	2.52 (3.18)	4.65 (5.82)	9.60 (6.27)	0–10	0–16	0–18
EHS	10.61 (3.09)	14.12 (3.35)	15.05 (3.49)	3–16	9–20	7–20
ESCI	10.88 (4.02)	16.65 (2.60)	16.70 (4.01)	0–17	10–21	5–21

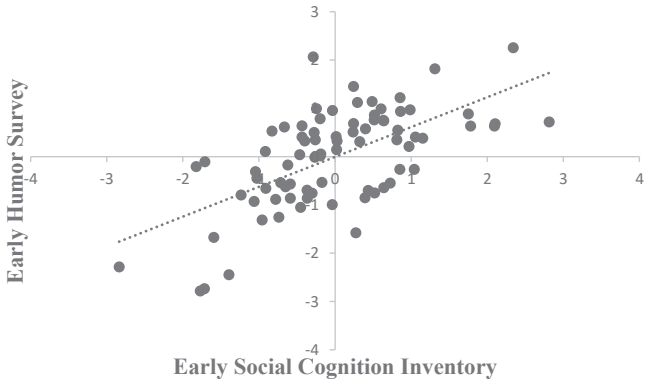

Fig. 2. The Relation between the Standardized Residuals of the EHS and ESCI, Controlling for Age.

olds which found that while children laughed significantly more often when an experimenter joked, compared to acting sincerely, again, their overall rate of laughter when joking was somewhat low (12% for 30-month-olds; 35% for 36-month-olds) (Hoicka & Akhtar, 2011). Thus, laughter may not serve as a perfect marker of humor appreciation in toddlers, at least in a lab setting. Similarly, while children smiled significantly more during the joke versus control trials, the overall difference was around 2.5 smiles per participant, suggesting caution should be taken in using smiling as a marker of humor appreciation. Indeed, another study found that 16- to 20- and 20- to 24-month-olds smile more in humorous than neutral literal contexts with their parents within an experimental setting, but only for a couple seconds per minute (Hoicka & Butcher, 2016). Thus, laughter and smiling may be more general markers of social play, even if they are amplified in a humorous context. Finally, while the experimenter always gave a small laugh after both joke and control trials, it is possible that the experimenter exaggerated her smiling or laughter slightly more in the joke trials. Future research could use video recordings of the jokes and control acts with the exact same laugh response to avoid this possibility.

In terms of parental surveys, there was a positive relation between humor and social cognition scores between the surveys alone, even when accounting for age, but not between the surveys and the laboratory tasks. The relationship between the humor and social cognition surveys were completed by the same informant, thus, overlap between the two may also be due to shared methods variance. For instance, part of the correlation may be attributable to some parents over- or under-reporting about their children's behaviors more generally. It is also possible that parent reports on the EHS were based on children's propensity to smile or laugh, rather than understand jokes, and that smiling and laughing relate to social cognition. However, the EHS shows that parents tend to report humor appreciation which is developmentally appropriate, for instance, focusing only on physical humor in the first year, and later reporting verbal humor from 2 years (Hoicka, Soy Telli, Prouten, Leckie, Browne, Mireault, et al., 2021).

Altogether, these results suggest that it may be easier to capture a relation between humor and social cognition in everyday life

Table 6
Descriptive Statistics and Intercorrelations between the ESCI and EHS for the Whole Sample and Each Demographic Group.

		Social Cognition			Humor			
	N	Mean	*SD*	Range	Mean	*SD*	Range	*r* (*r* ')
Age in Years								
Whole sample	573	14.95	4.81	0–21	11.89	4.17	0–20	0.71 * * (0.38 ***)
0	35	5.60	3.96	0–19	6.00	4.17	0–20	0.66 * * (0.50 **)
1	200	12.07	3.44	3–21	9.35	3.10	2–17	0.50 * ** (0.38 ***)
2	194	16.52	3.32	2–21	12.97	3.19	5–20	0.48 * ** (0.40 ***)
3	144	19.09	2.02	12–21	15.39	2.90	3–20	0.27 * * (0.26 **)
Gender								
Female	288	15.32	4.88	1–21	12.01	4.38	0–20	0.72 * * (0.36 ***)
Male	283	14.56	4.73	0–21	11.77	3.98	1–20	0.70 * * (0.38 ***)
Ethnicity								
BAME	62	16.24	4.29	5–21	12.61	3.99	2–20	0.68 * * (0.37 **)
White	507	14.78	4.86	0–21	11.79	4.19	0–20	0.72 * * (0.37 ***)
Country								
United Kingdom	452	15.12	4.67	0–21	12.01	4.19	0–20	0.72 * * (0.38 ***)
United States	67	14.45	5.72	0–21	11.60	4.17	1–20	0.67 * * (0.30 *)
Parent Education								
Degree	445	14.78	4.93	0–21	11.65	4.22	0–20	0.71 * * (0.35 ***)
No degree	86	15.14	4.30	5–21	12.30	3.89	2–19	0.65 * * (0.46 ***)
Household Income (UK)								
≥ £50.,000	122	15.08	5.05	1–21	11.57	4.36	0–20	0.69 * * (0.30 **)
< £50,000	83	14.55	4.45	3–21	11.92	3.97	2–20	0.69 * * (0.38 ***)

Note. Values in parentheses are partial correlations controlling for age in days.

through parent reports compared to lab tasks. Our survey findings, but not our lab findings, also suggest that humor may be an aspect of social cognition. We consider explanations for this in the general discussion. Given our findings, we next sought to replicate our survey findings with a larger sample size (Davis-Kean & Ellis, 2019). As well as allowing us to be confident of any positive survey result, it would also allow us to examine correlations within different demographic groups. In particular, we could look at the correlation between humor and social cognition within smaller age ranges, gender, countries (UK, USA), parents with and without an undergraduate degree; children from both BAME and White ethnic groups; and children from higher or lower income families within the UK.

6. Study 2

6.1. Method

6.1.1. Participants

Study 1 found a partial correlation of $r' = 0.60$ between the ESCI and EHS. In order to determine if we could replicate this within different demographic sample, we used a more conservative estimate of $r' = 0.50$. Power analyses found 29 children were needed for a two-tailed large correlation ($r = 0.5$), with $\alpha = 0.05$, power $= 0.8$ (Faul et al., 2007) per demographic group. Participants were recruited online through Facebook advertizing across countries worldwide for which English was the official language, press releases, Bounty packs within Sheffield, England , and social media. Participants who repeated the survey 6 months later (see Study 3) either received a £ 5 GBP Amazon voucher (or country currency equivalent), or £ 2 was donated to UNICEF. The different demographic groups included age by year; gender; countries (UK, USA); parents with and without an undergraduate degree; children from both BAME and White ethnic groups; and children from higher or lower income families within the UK ($Median_{\text{income}} = 50.000$ GBP). Our overall sample was $N = 573$, with each demographic group having at least 35 participants (See Table 6 for participant numbers per demographic group). Ethical approval was obtained from the Psychology Department at the University of Sheffield for the project " The effects of technology on young children's learning, play, and social skills", Reference Number 011854.

6.2. Measurements

We used the EHS and ESCI as detailed in Study 1.

6.3. Design

It was a correlational design. The main variables were the total EHS and ESCI scores. Child age in days was a control variable. The variables were correlated across the entire dataset, as well as within different demographic groups, i.e., within each year of age; boys and girls; across different countries (UK, USA); parents with and without an undergraduate degree; children from both BAME and White ethnic groups; and children from higher or lower income families within the UK.

6.4. Procedure

Parents who completed the surveys on babylovesscience.com ticked boxes to indicate their consent for the surveys. Parents who completed the survey in the lab ticked boxes on a paper consent form. The surveys took around 10 min in total.

7. Results

Table 6 presents descriptive statistics of raw scores, intercorrelations and partial correlations for humor and social cognition for the whole sample, and within each demographic group. Both the total humor score and the total social cognition score were negatively

Fig. 3. The Relation Between the Standardized Residuals of Humor and Social Cognition Scores Controlling for Age.

skewed; however, humor data were normalized with a 1.5 root transformation after reflection while social cognition data were normalized with a square root transformation after reflection to bring them to an acceptable level (Osborne, 2010). All scores were on a widely acceptable level of skewness between ± 2 (George & Mallery, 2010). There was a positive correlation between humor (reflected transformed) and social cognition (reflected transformed) controlling for age, which was statistically significant ($r' = 0.38$, $N = 573$, $p < .001$, see Fig. 3).

* $p < .05$, * * $p < .01$, * ** $p < .001$.

7.1. Replicability in Different Demographic Groups

Table 6 shows all raw and partial correlations (controlling for age) were significant and positive in each demographic group.

8. Discussion

We found that there was a moderate positive correlation between humor development and social cognition in young children based on parental reports, controlling for age. This again suggests humor may be an aspect of social cognition. Further investigation suggests the relation holds across all 4 years of age and different demographic groups. This suggests the relation between humor and social cognition in the early years is robust, spanning from infancy through the preschool years, no matter who is involved (as far as we examined), which makes the findings much more generalizable. However, this does not tell us about the nature of the relation – whether humor predicts social cognition; social cognition predicts humor; or both. The following longitudinal analyses will allow us to learn more about predictive relations between humor and social cognition.

Surprisingly, the partial correlation was highest in children under 1 year of age, and lowest in 3-year-olds. One possibility is that the relationship between humor and social cognition is stronger the younger children are, and dissipates as they age. Another possibility is that this result is due to the survey measures. In particular, both the ESCI and EHS show most variability in children under 1 year (based on the standard deviations), and the least variability in 3-year-olds. More sensitive measures in older children might reveal stronger partial correlations between humor and social cognition. A third possibility is that parents of younger children are more likely to be biased by a parental halo and/or a social desirability effect, leading to some parents over-reporting on both the ESCI and EHS. Given that our sample in Study 2 was older than that in Study 1 on average, this might explain why the overall correlation of the ESCI and EHS in Study 2 was not as strong as that in Study 1.

9. Study 3: longitudinal relations

9.1. Method

9.1.1. Participants

While the general correlations between the EHS and ESCI were $r' = 0.60$ in Study 1, and $r' = 0.38$ in Study 2, when age was accounted for, it seemed likely that any longitudinal relations would be less strong. Therefore, we planned sample sizes to detect small to medium effect sizes, rather than medium to very large effect sizes to be conservative. We ran a power analysis for linear multiple regression with 3 variables (age at Time 2, same survey at Time 1, other survey at Time 1), focusing on the R^2 increase from one survey at Time 1 on the other Survey at Time 2, with a small to medium effect size ($f^2 = 0.05$), with $\alpha = 0.05$, and power = 0.80 (Davis-Kean & Ellis, 2019; Faul et al., 2007). The power analysis suggested 159 participants were needed. The demographic characteristics of the participants at T2 are presented in Table 1. On average, parents in the 6-month longitudinal sample completed the surveys 6 months after previously completing it ($N = 214$; $SD = 17$ days; Range = 4 months, 8 days – 7 months, 13 days).

9.2. Measurements

We used the EHS and ESCI as detailed in Study 1.

9.3. Design

It was a longitudinal correlational design. The main variables were the total humor scores at T1 and T2, the total social cognition score at T1 and T2, and age in days at T2.

Table 7
Descriptive Statistics for Humor and Social Cognition at T1 and T2.

	Mean	*SD*	Range	Skewness	Kurtosis
Humor T1	11.46	4.03	1–20	-0.10	-0.47
Humor T2	13.30	3.68	2–20	-0.32	-0.17
Social Cognition T1	14.55	5.00	0–21	-0.53	-0.62
Social Cognition T2	16.68	4.02	3–21	-0.90	0.24

Note. $N = 214$.

9.4. Procedure

Parents were contacted around 6 months after completing the surveys at Time 1 to repeat the surveys online at home.

10. Results

Given that there were positive relations between humor and social cognition within every year of age, we collapsed data from all children together to look at our longitudinal analyses. Table 7 presents descriptive statistics of raw scores for humor and social cognition at T1 and T2. As with the previous data, the total humor scores at T2 were negatively skewed as were the total social cognition scores at T1 and T2. Humor T2 and social cognition T1 data were normalized with square root transformations after reflection, while social cognition T2 data was normalized with a cube transformation after reflection to bring them to an acceptable level (Osborne, 2010). All scores were on a widely accepted level of skewness between ± 2 (George & Mallery, 2010).

Table 8 presents Pearson correlations for all variables. Spearman's rho correlations were applied for gender. All variables were positively correlated with each other ($p < .01$) except for gender, which did not correlate with any variables ($p > .05$). Gender was therefore not included in any multiple regression analyses.

Hierarchical multiple regression was conducted to examine whether humor predicts social cognition six months later (see Table 9). We chose this analysis based on past work examining predictive relations between executive function and Theory of Mind in young children (Hughes & Ensor, 2007). Social cognition at T2 was entered as the dependent variable. Social cognition at T1 and age in days at T2 were entered on step one, and humor at T1 was entered on step two as independent variables. The overall regression model was found to be significant. In predicting social cognition (T2) the variable humor (T1), when entered on step two, accounted for a significant increase in R^2 with a small effect size. The positive beta coefficient indicates that the higher humor scores at T1, the greater the increase in social cognition from T1 to T2, controlling for Age at T2.

Another hierarchical multiple regression was conducted to examine whether social cognition predicts humor six months later (see Table 10). Humor at T2 was entered as the dependent variable. Humor at T1 and age in days at T2 were entered on step one, and social cognition at T1 was entered on step two as independent variables. The overall regression model was found to be significant in predicting humor at T2. The variable social cognition at T1, when entered on step two, did not account for a significant increase in R^2.

11. Discussion

We found that there was a positive one-way relation between humor and social cognition six months apart. While humor predicted social cognition across time, with a small effect size, social cognition did not predict humor. This may suggest that more advanced humor development in young children allows children to improve their socio-cognitive skills over time, but that the reverse is not the case. One explanation is that humor may be one of the earliest types of social cognition to emerge, thus predicting social cognition more generally later on. Another explanation is that humor is not a type of social cognition per se but allows children to practice socio-cognitive skills early on. These possibilities are discussed further in the general discussion.

One limitation is that parental reports are negatively skewed which may indicate the effect of age, since all ages are collapsed together. It may also reflect a halo effect and/or social desirability as mentioned in Study 2. Another limitation is that, while we controlled for age at time 2, and social cognition at time 1 in the hierarchical regression, it is possible that other un-measured variables related to humor development may account for our findings. For instance, children with more outgoing personalities may be deemed to understand humor better at time 1, and social cognition better at time 2. Thus, future research should control for more individual difference variables.

12. General discussion

This is the first study to investigate the general relation between humor and social cognition in children between 3 and 47 months of age. While Study 1 found small to moderate positive relation between humor and social cognition using lab tasks, these correlations disappeared once age was accounted for. In contrast, a large correlation was found between parent report measures of humor and social cognition, even when age was accounted for, using the EHS and ESCI respectively. Study 2 extended the survey findings of Study 1 on a much larger sample, and not only replicated the finding, this time with a moderate to large effect size, but also replicated the

Table 8
Summary of Pearson and Spearman's Rho Correlations for All Variables.

Variables	*1*	*2*	*3*	*4*	*5*	*6*
1. Age T2		-0.04	0.66 * *	0.58 * *	0.80 * *	0.67 * *
2. Gender[†]			-.02	0.04	0.11	0.06
3. Humor T1				0.72 * *	0.66 * *	0.64 * *
4. Humor T2					.55 * *	0.63 * *
5. Social Cognition T1						0.82 * *
6. Social Cognition T2						

Note. [†] Gender was coded as − 1 for girls, 1 for boys. * *$p < .01$, $N = 214$.

Table 9
Summary of Hierarchical Multiple Regression Analysis for Humor at T1 Predicting Social Cognition at T2.

	R^2	ΔR^2	β
Step 1	0.67		
Age T2			0.04
Social Cognition T1			0.78 * **
Step 2	0.69	0.017	
Humor T1			0.18 * *

Note. p * * $< .01$, p * ** <0.001, $N = 214$.

Table 10
Summary of Hierarchical Multiple Regression Analysis for Social Cognition at T1 Predicting Humor at T2.

	R^2	ΔR^2	β
Step 1	0.54		
Age T2			0.18 * *
Humor T1			0.61 * **
Step 2	0.54	0.001	
Social Cognition T1			0.05

Note. p * * $< .01$, p * ** <0.001, $N = 214$.

correlations within every demographic subset measures, including 0-, 1-, 2-, and 3-year-olds; boys and girls; British and American children; children with BAME and White ethnicities; children whose parents had or did not have a degree; and children from lower and higher income families within the UK. Study 2 therefore not only replicated our survey results from Study 1, but demonstrated they are robust, cutting across a variety of demographic groups. Finally, Study 3 suggests that early humor development predicts socio-cognitive development 6 months later with a small effect size, but that the reverse does not hold.

Our survey results converge with previous research suggesting humor and social cognition are linked in early development. Early humor development has previously been linked to emotions (Mireault et al., 2018, Mireault et al., 2015, Mireault et al., 2014; Mireault, Sparrow, et al., 2012), joint engagement (Reddy, 2001; Reddy & Mireault, 2015), intentionality (Hoicka, 2016; Hoicka et al., 2017; Hoicka & Akhtar, 2011; Hoicka & Butcher, 2016; Hoicka & Gattis, 2008, 2012; Leekam, 1991; Loizou, 2005), imitation (Hoicka, 2016; Hoicka & Akhtar, 2011, 2012; Hoicka & Butcher, 2016; Hoicka & Gattis, 2008), desire (Paine et al., 2021), and belief (Hoicka & Gattis, 2008; Leekam, 1991). Our survey results reinforce these findings, suggesting early humor relates to social cognition more generally. Previous survey measures of social cognition assumed that humor was an aspect of early socio-cognitive development (Happé, 1994; Muris et al., 1999; Tahiroglu et al., 2014), and our survey findings lend support to these assumptions.

13. Longitudinal relations between humor and social cognition

Our longitudinal results suggest that early humor development predicts socio-cognitive development 6 months later, but that the reverse does not hold. One possibility is that producing and appreciating humor could allow young children to practice and develop socio-cognitive skills, as it is a fundamentally interpersonal process (Reddy, 2001, 2008). For instance, Mireault, Sparrow, et al. (2012) pointed out that humor includes joint attention in infants so that sharing humorous activities with others may also lead to better joint attention. Furthermore, when infants did not laugh at jokes, they engaged more in social referencing, potentially to gain more information about the humorous episode (Mireault et al., 2014). Humor could also allow young children to practice understanding others' complex intentions and beliefs, and to encourage imitation in an emotionally positive environment (Hoicka, 2016; Hoicka & Gattis, 2008; Hoicka & Martin, 2016; Leekam, 1991). Indeed, toddlers respond appropriately to parents' joking cues (e.g., smiling, infant-directed speech, disbelief language and actions) through smiling, laughter, and imitation, suggesting parents scaffold imitation, and emotion, intention, and belief understanding, through humor (Hoicka, 2016; Hoicka & Butcher, 2016; Mireault et al., 2018, Mireault et al., 2015, Mireault et al., 2014; Mireault, Poutre, et al., 2012).

Another possibility is that humor is a socio-cognitive skill in and of itself (Deschrijver & Palmer, 2020). Given its early emergence, humor may therefore be one of the first socio-cognitive skills to develop. As such, humor may reflect the emergence of social cognition in general. Therefore, humor may predict later social cognition not because it allows children to practice socio-cognitive skills, but because it is a socio-cognitive skill that other socio-cognitive skills may build on. Future research should explore these possibilities.

This does raise the question as to why early social cognition did not predict humor 6 months later. For instance, since young children imitate jokes, and use cues like smiling and disbelief language to pick up on jokes (Hoicka et al., 2008; Hoicka & Akhtar, 2011; Hoicka & Butcher, 2016; Hoicka & Gattis, 2012; Hoicka & Martin, 2016), we might expect that young children who have more socio-cognitive skills in their repertoire, such as imitation, and understanding intentions, emotions, and beliefs, would pick up on more types of humor over the next 6 months. One possibility is that these socio-cognitive skills increase the frequency of humor appreciation, such that children could pick up on and demonstrate their understanding more readily, but do not necessarily increase the number of *types* of humor that children appreciate. Appreciating new types of humor may be more dependent on other skills, e.g., increased motor skills may allow children to understand more types of physical humor (e.g., funny bodily actions), while increased language skills may

allow children to understand more types of verbal humor (e.g., mislabeling). Future research should look at how other types of skills influence early humor development, and how that interacts with socio-cognitive development.

14. Lab-based relation between humor and social cognition

While our survey results consistently showed a positive relation between humor and social cognition, our lab task did not, once age was accounted for. One possible explanation may be that the relation between social cognition and humor depends on different research settings. Punch (2002) emphasized the sensitivity of research contexts and settings in child studies. Child studies may have different sample sizes with limited demographics, may include different cultural backgrounds, and may use different measurements such as observations, surveys or laboratory tasks. Some studies have found no differences between research settings. For instance, 14-month-olds did not differentiate how they searched for information when they did so in either the home or the laboratory (Schieler et al., 2018). Likewise, 2-year-olds were good at copying new skills from a live model regardless of the research setting (home vs laboratory) (Strouse & Troseth, 2008). A case study showed that a child with ASD improved his communication skills using a speech-generating device regardless of whether he was at home, school, or the clinic (Waddington et al., 2017). However, other research has found some differences across research settings. While toddlers imitated from video clips in the laboratory, they did not do so at home from their television (Strouse & Troseth, 2008). A case study showed that many oppositional behaviors of a child decreased at home with his caregiver's appropriate attention, but not at school (Wahler et al., 2004). The generalization of behaviors happens in some situations but fails in others. In the case of humor, children may demonstrate explicit behaviors, especially joking ones, to their parents in their naturalistic environment comfortably rather than to an experimenter in the laboratory. Indeed, one study found that while infants laughed when parents revealed their faces from behind a mask, they often cried when a stranger did so (MacDonald & Silverman, 1978), suggesting familiarity with the joker might be key in early humor. Therefore, parental surveys, which reflect children's natural environment, may be a better way to capture the relation.

Another possible explanation is that individual differences in other skills might have masked any relations in the lab task. For instance, one study investigated associations between temperament and social responsiveness in young children (Salley et al., 2013). Salley et al. (2013) found, for instance, that the more shy children were at 3 or 4 years, the less likely they were to be socially motivated or socially communicative. Discomfort, an aspect of negative affect, at 2 years predicted lower social cognition, social communication, and social motivation at 4 years. Greater levels of fear, another aspect of negative affect, in 3 year-olds also predicted lower levels of social cognition and social communication at 4 years. Studies which examined the link between social cognition and temperament directly in preschoolers found that ToM skills positively correlated with shyness (LaBounty et al., 2017; Lane et al., 2013). Correlational temperament-humor studies draw the same picture. According to an fMRI study, shyness was negatively related to brain activity in humor processing among school-aged children (Vrticka et al., 2013). Beyond that, while affiliative and self-enhancing humor styles were negatively associated with shyness, aggressive and self-defeating ones were positively associated with it in a Turkish undergraduate sample (Erozkan, 2009). Young children may be unresponsive in social cognition and humor tasks due to temperament traits, masking their true abilities. Future studies should consider temperament traits as moderators to reveal whether a relation between humor and social cognition could be found in a lab setting.

Another possible reason we did not observe a relation between humor and social cognition in the lab is because our humor lab measure might not adequately capture individual differences. Children smiled and laughed more in-joke trials rather than control trials, demonstrating the task worked at the group level. Laboratory tasks on early humor development have mainly focused on group differences so far (Hoicka & Akhtar, 2011; Hoicka & Gattis, 2008; Mireault et al., 2014, Mireault et al., 2015), not individual differences. Thus, the problem may be a failure of capturing individual differences in humor in a laboratory setting. This explanation is consistent with previous studies (Mireault, Sparrow, et al., 2012; Ruch, 1997). One study investigated whether humor appreciation from 3-to-6 months predicts attachment security at one year using two designs to measure humor appreciation in infants (Mireault, Sparrow, et al., 2012). One of them was an observational design at home called "state humor" whereas the other one was a survey design called "trait humor." These two measurements were not correlated. Furthermore, only parent-reported humor predicted attachment security, not the researchers' observations. It suggests that parent reports and observational measures of early humor capture different things.

15. Limitations and future directions

The clearest limitation of this paper is that the lab tasks in Study 1 did not find the same results as our surveys in Studies 1–3. As discussed earlier, controlling for other individual difference variables, such as temperament, as well as narrowing the age range, may allow the relation to be revealed in future research. As discussed previously, temperament may be one factor that could mediate the relation between humor and social cognition. Similarly, verbal ability is closely related to both aspects of humor development (Hoicka, 2014) and social cognition (Miller, 2006). Thus, future studies should consider controlling not only for temperament, but also language skills, as well as other potential moderators, to develop a better understanding of the relation between humor and social cognition. Future studies should also evaluate each age group individually, as the relation between humor and social cognition may change across development.

However, it may instead be necessary to focus on developing lab and observational measures of humor which can reveal children's individual differences, rather than showing what children understand at a group level. One possibility may involve using familiar people, e.g., parents, as experimenters to ensure children feel comfortable appreciating and producing humor (MacDonald & Silverman, 1978; Sroufe & Wunsch, 1972). Another possibility may involve exposing children to a variety of jokes for each type of humor,

so that children do not have to show they find one particular joke funny in order to reveal they appreciate that type of joke in general (Hoicka, Soy Telli, Prouten, Leckie, Browne, Mireault, et al., 2021).

Finally, future research should examine in more detail why and how earlier humor development predicts later socio-cognitive development. For instance, experiments may determine whether being exposed to humor increases performance on social cognition tasks. Such experiments could also moderate how children are exposed to humor, such as changing the type of humor, the content of the jokes, or the social context, to see which aspects might encourage better socio-cognitive development.

16. Conclusion

Study 1 found that humor and socio-cognitive development correlate in children between 3 and 47 months based on parent-report surveys, but not based on a set of lab tasks. Study 2 replicated the survey findings with a very large sample, and continued to replicate these findings within every demographic group measured, including 0-, 1-, 2-, and 3-year-olds; boys and girls; children in the UK and USA; children with BAME and White ethnicities; children whose parents had or did not have degrees; and children from higher or lower income families within the UK. Study 3 found humor development predicted socio-cognitive development 6 months later, but the reverse was not the case. This may be because, in early development, humor provides a positive, socially engaging way to practice socio-cognitive skills such as imitation, intention understanding, emotion understanding, and belief understanding. Future research should focus on heterogeneity among different research settings to make the findings generalizable, and consider individual differences, such as age, temperament and language, in how this relation develops.

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Appendix A

For the following, tick Yes if your child finds it funny when others make this joke type and/or makes this joke type him/herself to be funny. You can save time by leaving the item blank if the answer is No.

- Making strange voices (not just strange noises)
- Making fun of others, e.g., calling someone a poopoohead
- Strange actions with objects, e.g., use the wrong end of a spoon, put cup on head
- Saying strange things/mixing up concepts/nonsense (e.g., dinosaurs eat the wall; cats have five legs; dogs say moo), including nonsense variations of knock-knock/why did the chicken cross the road jokes
- Referring to gross things, e.g., poo, sneezing, smelly feet, etc.
- Mislabeling objects/events, e.g., calling a car a banana; could be in song, or intentionally giving you the wrong answer
- Aggressive acts, e.g., spitting out water, throwing things, pushing people, etc.
- Tickling, including variations, e.g., using objects to tickle, e.g., stick or feather
- Peekaboo/ hide & seek, including variations, e.g., hiding objects in bags and revealing them
- Strange body movements, e.g., head through legs, kicking legs in the air
- Scaring people, e.g., jumping out at them, or yelling
- Chasing, including variations, e.g., making toys chase each other
- Socially unacceptable situations, e.g., putting a cat on the dining table, saying naughty words, etc.
- Playing tricks on people, e.g., putting salt in the sugar bowl
- Acting like something else, e.g., an animal, another person, etc.
- Inventing words, e.g., schmoogly
- Pulling/making silly faces, e.g., scrunching up face
- Showing normally hidden body parts, e.g., lifting shirt to reveal tummy; taking off clothes
- Teasing, e.g., offering an object and taking it away
- Making puns, that is, jokes where words have double meanings, e.g., Why are fish so smart? Because they live in schools

Appendix B

For the following, tick Yes if your child has the skill. You can save time by leaving the item blank if the answer is No.

- Does your child follow where you look to look at the same things as you?
- Is your child aware of other people's motives? E.g., that they might give someone a gift in order to make them happy.

- Is your child aware of their own desires? E.g., prefer chocolate over broccoli.
- Is your child aware that other people may know the same information they do? E.g., they know where a certain book is kept, and they know that their dad knows where that book is kept too.
- Is your child aware of others' perspectives, e.g., could they tell sometimes they can see something, but someone else can't, because it's not in their line of sight?
- Is your child aware of his/her own mistakes? E.g., if s/he drops something by accident.
- Does your child perform actions intentionally? E.g., stack blocks on purpose, instead of by trial and error.
- Does your child follow where you point to look at the same things as you?
- Does your child look back and forth between you and objects, instead of only looking at you or an object?
- Does your child understand that sometimes things aren't as they appear? E.g., something that looks hard might feel soft.
- Does your child copy others in order to achieve the same goal? E.g., copying pressing a button to make a song play on a toy.
- Is your child aware that sometimes other people don't have the same beliefs as them? E.g., your child might think dogs are the best animal, but they understand that their sister thinks cats are the best animal.
- Is your child aware of their own emotions? Happy, sad, angry, etc.
- Does your child point to get information from you? E.g., to get a toy that is out of reach.
- Does your child understand that sometimes other people have different desires to themselves? E.g., other people might like broccoli, even if they don't.
- Does your child point to share information with you? E.g., point to show you a dog in the park.
- Is your child aware of other people's emotions? E.g., happy, sad, angry, etc.
- Is your child aware that other people have the same beliefs as them? E.g., that dogs are the best animals.
- Is your child aware that sometimes other people don't know the same information they do? E.g., child might know where a toy is, but dad might not.
- Does your child understand what it means for others to make mistakes? E.g., that they dropped a plate by accident.
- Does your child perform actions with specific goals in mind? E.g., stacking blocks specifically to make a house.

Appendix C

This appendix presents the jokes and their control actions used in Study 1.

Jokes	Control actions
Making a (kind of) monkey squawk	Humming "twinkle twinkle little star" tune
Peekaboo	Waving
Tickling teddy bear's tummy and saying "tickle, tickle, tickle!"	Cuddling teddy bear
Pulling mouth to sides with fingers and sticking out tongue	Scratching face
Humorously waggling arms	Clapping hands
Putting glove on a foot	Putting glove on a hand
Making a toy pig chase a toy cow and saying, "I'm gonna get you!"	Making the toy pig and the toy cow walk side by side and saying, "We're going for a walk!"
Speaking in a humorous high voice to say, "The dog is crossing the road."	Using a normal voice to say "The dog is crossing the road" whilst making a toy dog walk along with the table
Getting down on all fours, mimicking a dog and saying, "Woof! Woof!"	Walking around the room and saying, "I like walking!"
Humorously teasing by offering and withdrawing feather ball from parent	Offering to gives feather ball toy to parent, letting parent take the toy
Yelling "boo!" at parent whilst their back is turned (parents react scared)	Saying "hello!" to parent
Humorously lifting the top of a doll and showing stomach, saying, "Look! Her tummy!"	Covering the doll over with a small towel, like putting a blanket over it, saying, "Look, a blanket!"
Smelling the doll's bum and saying, "Ewww! It's smelly!"	Holding the doll out in front of them, looking at the doll and saying, "I like this doll!"
Holding a hat and saying, "This is a sheep!"	Holding a toy sheep and saying, "This is a sheep!"
Parent builds a tower using toy bricks, and then the experimenter knocks it over (parent looks surprised)	Building a tower using toy bricks
Dropping straws on parent's head (parent looks surprised)	Putting a hat on the parent's head
Holding a toy horse and saying, "The horse goes Quack! Quack Quack!"	Holding the toy horse and saying, "The horse goes Neigh! Neigh!"
Holding a spoon and saying, "This is a schmoogly!"	Holding the spoon and saying, "This is a spoon."
Leaning back and putting feet on the table	Holding a book and putting it on the table
Saying to parent, "I've got you a nice gift!" The experimenter hands the gift (crumpled paper) (parent looks disappointed)	Saying to parent, "I've got you a nice gift!" whilst covering hands. The experimenter hands the gift to the parent (parent looks happy)
Experimenter says, "Why are teddy bears never hungry? Because they're always stuffed!"	Experimenter says, "Why are teddy bears never hungry? Because they eat a lot!"

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