

# Factors affecting infant toy preferences: Age, gender, experience, motor development, and parental attitude

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## Abstract

In contrast to the anecdotal claim that “male infants like cars and female infants like dolls,” previous studies have reported mixed findings for gender-related toy preferences in infancy. In Experiment 1, we explored the emergence of gender-related preferences using face–car pairs (Experiment 1a,  $n = 51$ , 6–20 months) or face–stove pairs (Experiment 1b,  $n = 54$ , 6–20 months). In Experiment 2 ( $n = 42$ , 14–16 months), we explore the effect of toy properties, infants' past toy exposure, activity levels, and parental attitudes on such preferences using a wider range of toys. For both studies, infants demonstrated a general preference for faced stimuli over other objects, except for male infants who showed no preference between dolls and cars at around 15 months. Infants' prior experience participating in motor-intensive activities, with wheeled toys and parental attitudes appeared to relate to female infants' preferences for dynamic toys. These results indicate a range of factors influence gendered toy preferences and suggest that nurture plays an important role.

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## INTRODUCTION

The debate about whether there are “boy toys” and “girl toys” or just toys has swung back and forth across recent decades. Some studies suggest that male children prefer “male-typical” toys (i.e., vehicles, construction tools, guns) and female children prefer “female-typical” toys (i.e., dishes, dolls accessories, cosmetics) (Connor & Serbin, 1977; Fulcher & Hayes, 2018; Golden & Jacoby, 2018; Liss, 1981; Pasterski et al., 2005; Reich, Black, & Foliaki, 2018; Zosuls et al., 2009), whereas others present mixed (e.g., Connellan, Baron-Cohen, Wheelwright, Batki, & Ahluwalia, 2000) or counter-evidence (e.g., Servin, Bohlin, & Berlin, 1999). Further, it remains unclear when any gendered toy preferences emerge and what factors may drive such preferences. This paper examines gender differences in the emergence of visual preferences for faces and toys among infants aged between 6 and 20 months (Experiment 1), and the influence of a range of previously underexplored factors including stimulus properties, toy exposure, levels of motor-intensive activities, and parental attitudes on such preferences (Experiment 2).

Results of infants' preference for gender-congruent toys are mixed. Connellan et al. (2000) showed that more male newborns look longer to a physical-mechanical mobile with a picture made from a scrambled face than to a whole face picture (43% vs. 25% of the sample), whereas more female newborns look longer to a whole face picture (36% vs. 17%). However, the same study finds 32% of male and 47% of female neonates do not show any preference between the pictures. Similarly, male 3- to 8-month-old infants make more fixations to a toy truck than to a doll but do not show longer looking time, whereas their female peers look longer to a doll compared to a toy truck, although the number of fixations does not differ between the toy types (Alexander, Wilcox, & Woods, 2009). Moving to slightly older infants, Lutchmaya and Baron-Cohen (2002) found that at 12 months, male infants paid more attention to moving cars, whereas female infants paid more attention to moving faces. A recent study by Boe and Woods (2018) also found male infants aged 12 months showed a preference for trucks over dolls in a grasping task, whereas 12-month-old female infants showed no such preference. Similarly, an observational study during a laboratory play session reported that female but not male infants aged 10–18 months interact longer with dolls than other toys such as trucks (Roopnarine, 1986). However, Servin et al. (1999) found no consistent gender-specific toy preferences for 1-, 3- and 5-year-olds when comparing “male-typical” (e.g., cars, construction toy), “female-typical” (e.g., doll, tea set), and neutral (e.g., view-master, playing cards) toys. In addition, a considerable amount of literature illustrates that face-like stimuli seem to be preferred over other stimuli for both male and female infants from the prenatal stage (Reid et al., 2017) to infancy (Farroni et al., 2005; Johnson, Dziurawiec, Ellis, & Morton, 1991; Leo & Simion, 2009; Mondloch et al., 1999; Pascalis, de Haan, & Nelson, 2002; Quinn, Kelly, Lee, Pascalis, & Slater, 2008). Using a preferential looking paradigm with paired stimuli presented simultaneously, a general looking preference for dolls or doll faces over cars or trucks for both male and female infants was observed at 5 months (Boe & Woods, 2018; Escudero, Robbins, & Johnson, 2013) and at 12 months (Jadva, Hines, & Golombok, 2010). Crucially, these observations challenge claims on gender-specific toy preferences. Last but not least, a recent meta-analysis by Todd et al. (2018) measured 1,600 children aged between 12 and 93 months and found a positive correlation between male children's age, but a negative quadratic correlation between female children's age, and percentage of time playing with gender-congruent toys. This indicates that male children play more with male-typical toys as they grow older, and female children's preference for female-typical toys decreases at around 48 months and increases thereafter. Studies with infants younger than 12 months were not included in the meta-analysis.

Despite the discrepancies in previous literature, if infants do present gender-specific toy preferences (at least in some studies), the driving forces become an inevitable question. To date, several

explanations have been proposed, yet none has been deemed decisive either due to mixed findings or lack of direct evidence. The first sets of evidence across ages and species suggest some role for biological/hormonal differences between males and females that contribute to early gender-specific toy preferences. Prenatal sex hormones have been shown to modify sex-dimorphic behavior and temperamental sex differences (Ehrhardt & Meyer-Bahlburg, 1981), and human androgen levels appear to be related to gender-related toy preferences, such that high androgen level increases male toy preference among females (Berenbaum, 1999; Berenbaum & Hines, 1992; Hines & Kaufman, 1994). Similarly, infants' testosterone levels before 6 months were associated with their gender-typed behavior at 14 months (Lamminmäki et al., 2012). Further, young monkeys reach for "gender-typical" toys (male: car, ball, wheeled toys; female: doll, pot, plush toys) more than toys that are typical for the other gender in humans, arguing for some biological rather than social basis for toy preferences (Alexander & Hines, 2002; Hassett, Siebert, & Wallen, 2008). Nineteen-month-olds with more "male-typical" digit ratios, which are linked to higher exposure to masculinizing hormones in the womb, are likely to be rated as having higher activity during play and show less "female-typical" toy preference (Alexander & Saenz, 2012). Once again, it has to be noted that not all studies on hormonal effects reveal congruent findings. While a positive correlation was observed between male infants' ( $n = 63$ ) gender-specific toy preferences (e.g., trucks over dolls) during structured play and their prenatal progesterone levels, no such correlation was found for female infants ( $n = 63$ ) and no correlation was observed between gender and prenatal estradiol and testosterone levels (van de Beek, van Goozen, Buitelaar, & Cohen-Kettenis, 2009).

Alternatively, many have suggested that environmental factors may play a role in gendered toy preference (Bandura, 1977; Ehrhardt & Meyer-Bahlburg, 1981; Fagot & Hagan, 1991; Langlois & Downs, 1990; Martin, 1999; Martin, Wood, & Little, 1990). Roopnarine (1986) hypothesized that caretakers may contribute to the gender-specific socialization of their infants. Since we ran our own studies, there have been several, which are particularly relevant to this question. Boe and Woods (2018) showed that across age and gender, infants' preference for trucks was predicted by the duration of home play with trucks, which was further predicted by the number of trucks in the home. This evidence suggests that parental selection of types of toys (e.g., dolls vs. trucks), or early gender socialization, can alter infants' development of social identities in the first year after birth. An alternative interpretation would be that parents may be selecting toys according to their perceptions of the infants' pre-existing preferences. Parents rate gender-congruent and gender-neutral toys as more desirable than gender-incongruent toys for their children aged 3–6 years (Kollmayer, Schultes, Schober, Hodosi, & Spiel, 2018). A recent online survey was conducted by Weisgram and Bruun (2018) in which 238 prospective and 96 current parents' preferences on gender-specific toy purchases were measured. Results showed that parents planned to purchase gender-congruent toys for their prospective or own children. Additionally, mothers with non-traditional gender-typed toys as a child would also purchase non-traditional gender-typed toys for their own children. This indicates that parental attitudes toward gender may determine what toys appear in the home environment, influencing children's toy preference. Though being a crucial factor, direct evidence on the environmental impact on infant gender-specific toy preferences is lacking.

With respect to the emergence of infant gender-specific toy preference, previous studies found no gender-specific or general toy preferences when comparing toys with faced stimuli among 5-month-olds (Boe & Woods, 2018; Escudero et al., 2013) and even 12-month-olds (Jadva et al., 2010; Servin et al., 1999). This indicates experience may be required for infants to develop robust gender-specific toy preference in the second year after birth. Meanwhile, a group of studies suggest that transitions in infant gender-related preferences occur at and after 14 months (Lamminmäki et al., 2012), though perhaps in a gradual fashion (Lauer & Yhang, 2016). Zosuls et al. (2009) reported infants' mild gender

differences in play at 17 months, which increased at 21 months, and by 19 months, they observed spontaneous production of gender labels. At 18 and 19 months, male infants spend more time playing with cars and female infants with dolls when both toys are presented in the experiment, although they interact with these toys with equal frequency (Alexander & Saenz, 2012). Infants at this age seem to be aware of gender-specific toy preferences themselves, in that they link girl photographs with dolls and boy photographs with cars (Serbin, Poulin-Dubois, Colburne, Sen, & Eichstedt, 2001).

In brief, discrepancies have been observed across previous literature on infants' gender-specific toy preferences. In addition, although the influence of some potential factors has been discussed in previous literature, very few studies have directly measured their effect on infants' toy preferences (but see Boe & Woods, 2018). These factors may include, but are not limited to, the age of infants tested, individual toy experience and parental attitudes, and stimulus properties of the toys themselves. In the current study, we examined the abovementioned factors across the two experiments. Experiment 1 examined the age at which gender preferences emerge using a large participant age range from 6 to 20 months and the same stimuli used in Escudero et al. (2013; faces–cars, faces–stoves). In Experiment 2, we studied infant response at 14–16 months, with new toys (cars, tea sets, dolls, strollers), which tested whether stimuli's visual and motor properties affect infant toy preferences. We also included parental questionnaires relating to previous toy experience, general activity levels, and parental attitudes to gender. We predicted that infants' gender-congruent toy preference would emerge as a function of age: Young infants (close to 5 months after birth) would prefer faced stimuli irrespective of their gender, whereas older male infants would be more prone to mechanical toys such as cars and female infants would keep their sensitivity to social toys such as faced stimuli. We also predicted that toy properties (mechanical locomotive aspects for male, social aspects for female infants), infant prior toy experience, infant overall motor activity level, and parental attitudes on children's gender-specific toy play may all positively contribute to infants' gender-specific toy preferences. The examination of age would not only test replicability of previous findings (i.e., Escudero et al., 2013) but also advance knowledge on the emergence of gender-specific toy preference. The investigation of the relationship among infant looking preference, toy characteristics and parental-report measures provides an innovative approach to the field.

## 1 | EXPERIMENT 1: EXPLORING THE ONSET OF GENDER-SPECIFIC TOY PREFERENCES (6–20 MONTHS)

In Escudero et al. (2013), four- to five-month-old infants' toy preferences with mechanical objects (cars, stoves) and faced stimuli (humans, dolls) were tested using an eye-tracking preferential looking paradigm. The study used multiple exemplars per stimulus category and presented social versus non-social stimuli side by side, providing infants with the opportunity to express preferences, allowing for more direct comparisons than presenting the items one at a time (i.e., each pair shows an actual preference rather than just an overall looking time) and subsequently a better understanding of the relative preferences. The object pictures were assigned to four paired categories, which included comparisons of toy versus real objects (two conditions) and mechanical objects versus faces (two conditions). For the toy versus real conditions, comparisons included (a) toy mechanical objects (i.e., toy cars, toy stoves) versus real objects in the corresponding category, and (b) doll faces versus human faces. For comparison of mechanical objects versus faces, pairs included (c) toy mechanical objects versus doll faces, and (d) real mechanical objects versus human faces (Figures 1 and 4). The previous results demonstrated that at 5 months, both male infants and female infants prefer face stimuli over mechanical objects (Escudero et al., 2013), consistent with previous studies reporting





**FIGURE 1** Stimuli for Experiment 1a. The four stimuli categories from top to bottom rows: Real female faces, female doll faces, toy cars, and real cars

infants' preference for face-like stimuli over other objects (Johnson et al., 1991; Leo & Simion, 2009). Crucially, no gender-specific toy preference was observed. However, it has been argued that infants show gendered toy preferences in independent play at 9 months and their critical gender knowledge advances at 18 months (Todd, Barry, & Thommessen, 2017). Meanwhile, a transition of preference for male infants from dolls to cars has been suggested to occur between 12 and 18 months (Jadva et al., 2010). These findings lead to the hypothesis that such infants' gender-specific toy preferences may emerge later than 5 months.

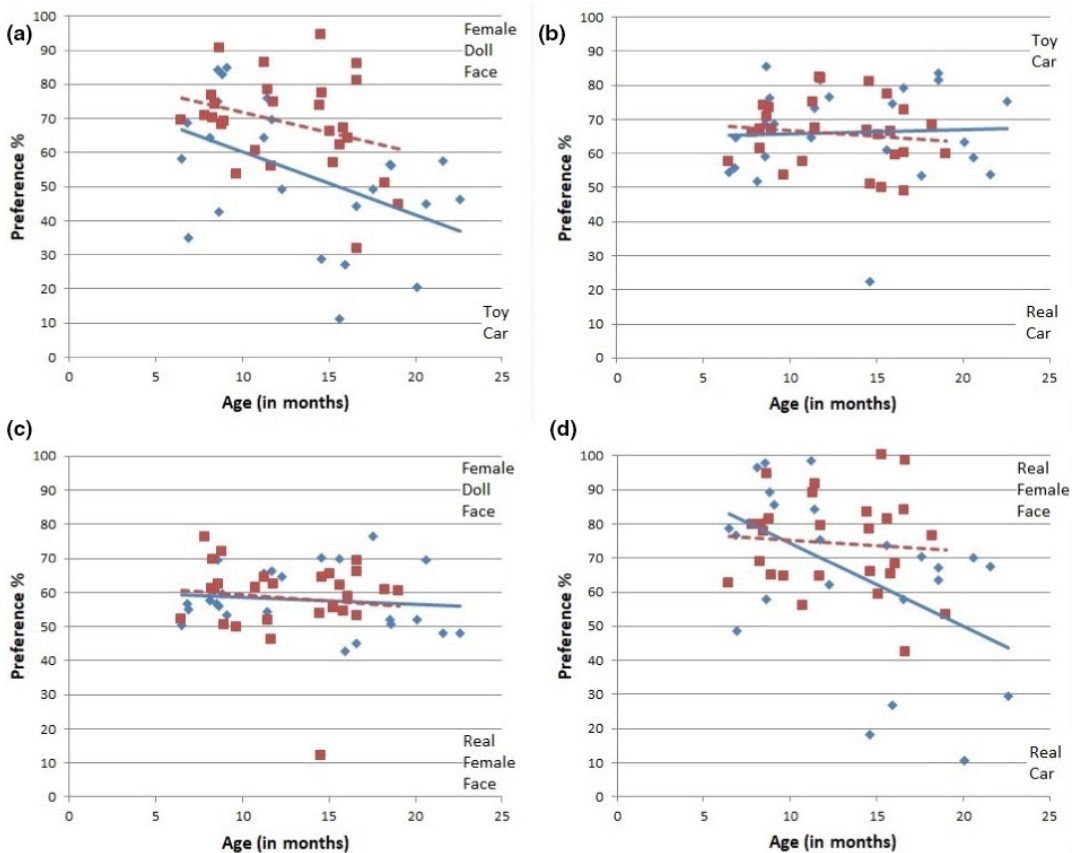
To examine this hypothesis and to extend upon our previous research, we targeted a large participant age range from 6 months (just above the age tested in Escudero et al., 2013) to 20 months (just above that in Jadva et al., 2010) in Experiment 1. Partially functioning as a replication verification of the previous study, the same stimuli and testing paradigm as Escudero et al. (2013) were used, with cars and female faces tested in Experiment 1a and stoves and male faces tested in Experiment 1b. These stimuli would reveal not only infants' potential preference between mechanic and social stimuli but also whether their preference is linked to the level of “reality” in the objects.

## 1.1 | EXPERIMENT 1A: FEMALE FACES VERSUS CARS

### 1.1.1 | Methods

#### *Participants*

Infants were recruited by telephone call and emails through a private database, which consisted of parents and infant details. The final sample of participants comprised 51 Australian infants aged from 6 to 20 months: 27 female and 24 male infants (see Figure 2 for age distributions). The number of



**FIGURE 2** Scatterplot of male infants' (blue diamonds) and female infants' (red squares) age tested and looking time preferences in Experiment 1a for: (a) female doll faces versus toy cars; (b) toy cars versus real cars; (c) female doll faces versus real female faces; (d) real female faces versus real cars. In each case, 50% is no preference

participants per gender satisfied G power analysis with a medium effect size ( $f = 0.5$ ). An additional 23 infants were observed but not included in the final sample due to crying ( $n = 2$ ), being inattentive to the experiment ( $n = 7$ ), parental interference ( $n = 1$ ), second-time participation ( $n = 2$ ), or fewer than 4 usable trials in which infants look at the screen in one or more condition ( $n = 11$ ). The last criterion was set to enhance the data reliability at the individual level in order to examine the spread of results for individuals and the correlation between age and preference. As discussed in Escudero et al. (2013), many previous studies have only used two trials per condition, but this gives less reliable results (although the analysis showed the general pattern of results was the same with only two trials). All infants were full-term and with no known developmental difficulties. All caregivers provided informed consent.

### Stimuli and design

The stimuli were the same as in Escudero et al. (2013, Experiment 1a). They were static pictures from one of four categories: real female faces, female doll faces, toy cars, or real cars. Each category consisted of 6 different pictures, adding up to 24 pictures in total (Figure 1). Pictures were assigned to four paired categories for comparison: toy car versus female doll face, toy car versus real car, female doll face versus real female face, and real car versus real female face. To ensure the generalization of findings, multiple exemplars of each object type were included. Each paired category consisted of 6

pairs, and each pair included one of the 6 different images from the corresponding categories. Side presentation was counterbalanced, resulting in a total of 48 trials that included all relevant comparisons (4 pair types  $\times$  6 different pairs  $\times$  2 side orders = 48). The number of trials is larger than most previous studies (e.g., 2 trials in Alexander et al., 2009). The presentation order was randomized across trials. Picture size was approximately 12.0  $\times$  14.0 cm in height and width respectively, with an 11.4  $\times$  13.3° visual angle at infants' 60-cm viewing distance. The distance between the pictures of a pair was set as 3.0 cm (2.9°).

### *Apparatus and procedure*

A Tobii corneal reflection eye tracker (Model 1750, Tobii Technology) was used to record and measure infant gaze patterns. A standard 9-point calibration was used prior to the experiment. Stimuli were presented on a 27 cm height  $\times$  34 cm width Tobii screen via software E-Prime 2.0.

Each infant was tested individually. During the session, infants sat on caregivers' lap on a chair, while the eye tracker recorded infants' eye movements. Before each trial, an "attention-getter" (a short graphic clip with sound) appeared at the center of the screen. The experimenter sat in an adjacent room and initiated each trial when participants' attention was fixated on the attention-getter. The participant was presented with 48 trials of 5 s (4 min total). Parents were asked to close their eyes during calibration and were naive to the hypotheses until the study was completed. Each family received a toy for participation after the experiment.

### *Ethics*

The present study was conducted according to guidelines laid down in the Declaration of Helsinki, with written informed consent obtained from a parent or guardian for each child before any assessment or data collection. All procedures involving human subjects in this study were approved by the Human Ethics Committee at Western Sydney University.

## **1.1.2 | Results and discussion**

Analyses were conducted on each of the four pairs: toy car versus female doll face, toy car versus real car, female doll face versus real female face, and real female face versus real car. Preference scores were calculated based on accumulated fixations (i.e., dwell times) and were normalized for trial duration and number of trials. Infants did not provide usable data for all trials, but as noted in the participants' section, the number of trials in each condition was always above 4. A criterion of 4 or more trials per condition provided more reliable results than the criterion was 2 or more, although the overall pattern of results remained the same, replicating the previous study in terms of the number of trials shown (Escudero et al., 2013). Dwell time was calculated as the total fixation/number of 5 s trials for each item in a pair. The preference score was calculated as dwell time for an item in the pair (e.g., dolls in doll-car pairs) across repeats divided by the total dwell times  $\times$  100, such that no preference is 50% (cf., Escudero et al., 2013).

As age was a variable of primary interest, relations between age and infant preference scores were examined through the Pearson correlation coefficients for each gender (see Figure 2 and Table 1). For male infants, medium-sized significant correlations were found between age and preference for cars over faces (age and real female face-real car:  $r = -.521$ ,  $p = .009$ , age and female doll face-toy car:  $r = -.474$ ,  $p = .019$ ); however, these were smaller and not significant for female infants (age and real female face-real car:  $r = -.084$ ,  $p = .676$ , age and female doll face-toy car:  $r = -.308$ ,  $p = .118$ ). Even collapsed over gender to give more power, there were no significant correlations for the other

**TABLE 1**  $r$  and  $p$  values for correlations between age (in months) and infants' paired stimuli preferences in Experiment 1a

	Female doll face– toy car	Toy car–real car	Female doll face–real female face	Real female face–real car
Male infants ( $n = 24$ )	$r = -.474$ $p = .019$	$r = .048$ $p = .823$	$r = -.121$ $p = .574$	$r = -.521$ $p = .009$
Female infants ( $n = 27$ )	$r = -.308$ $p = .118$	$r = -.137$ $p = .496$	$r = -.112$ $p = .579$	$r = -.084$ $p = .676$
All infants ( $n = 51$ )	$r = -.411$ $p = .003$	$r = -.016$ $p = .913$	$r = -.112$ $p = .434$	$r = -.387$ $p = .005$

Note: A positive correlation corresponds to an increased preference for the first listed item in a pair with increasing age, whereas a negative correlation corresponds to an increased preference for the second item in a pair with increasing age.

**TABLE 2**  $t$  and  $p$  values of infant normalized fixation preference for each of the four pair types in Experiment 1a, compared with no preference (50%)

	Female doll face– toy car	Toy car–real car	Female doll face–real female face	Real female face–real car
Male infants	$t(23) = 0.975$ $p = .340$	$t(23) = 5.613$ $p < .001$	$t(23) = 4.268$ $p < .001$	$t(23) = 3.244$ $p = .004$
Female infants	$t(26) = 6.853$ $p < .001$	$t(26) = 8.693$ $p < .001$	$t(26) = 3.665$ $p = .001$	$t(26) = 8.927$ $p < .001$
All infants	$t(50) = 4.510$ $p < .001$	$t(50) = 9.724$ $p < .001$	$t(50) = 5.531$ $p < .001$	$t(50) = 7.368$ $p < .001$

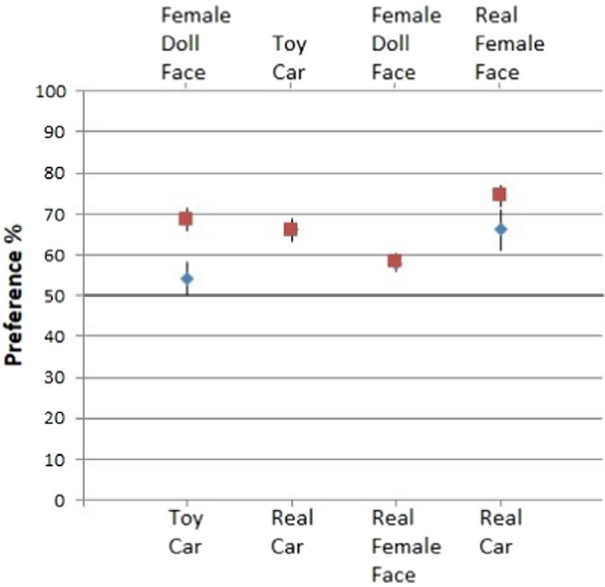
Note: The Bonferroni-corrected alpha  $p = .004$  (see also Figure 3).

pairs ( $ps > .433$ ; Table 2). Results suggested an increased preference toward cars with increasing age primarily for male infants.

To assess whether the current results replicated Escudero et al. (2013), preference scores were compared between males and female infants for each pair, and to 50% (no preference) for male and female infants via one-sample  $t$  tests (see Table 2). A significant difference was found between male and female preferences for toy cars versus female doll faces ( $t(49) = 3.011$ ,  $p = .004$ ; see Figure 3). However, preference did not differ between male infants and female infants for the other three pairs ( $ps \geq .139$ ). Importantly, when compared to 50% (no preference) results showed significant preferences in almost all pairs (after Bonferroni correction; see Table 3). These results replicate Escudero et al. (2013), in the current older infants, and with a wider age spread, but also show a significant preference for doll over real faces (the trend was in the same direction in Escudero et al., 2013). Interestingly, male infants' preference did not differ between toy cars and female doll faces when collapsed across ages, but female infants' preferences do, leading to a gender difference. Figure 3 illustrates these normalized total fixation preference scores.

To summarize, experimental results revealed three main patterns: (a) Collapsed across ages, infants exhibited general preference for faced stimuli over objects; (b) all infants preferred toy objects to real objects across age and gender; and (c) preferences for gendered toys changed with age, such that older male infants no longer had a preference for faces over cars, whereas female infants still did. In Experiment 1b, we tested whether findings in Experiment 1a would generalize to another set of faces and mechanical non-face objects. As in Escudero et al. (2013), we used stoves, which are mechanical





**FIGURE 3** Experiment 1a: Infant normalized fixation preference for each of the four pair types. Preference is shown as closer to one or other item, with 50% = no preference. Error bars =  $\pm 1$  SEM. Where male symbols (blue diamonds) are not visible, it is because males have an almost identical value to females (red squares)

**TABLE 3**  $r$  and  $p$  values for correlations between age and infants' paired stimuli preferences in Experiment 1b

	Male doll face–toy stove	Toy stove–real stove	Male doll face–real male face	Real male face–real stove
Male infants (n = 25)	$r = -.053$ $p = .801$	$r = -.213$ $p = .307$	$r = .092$ $p = .661$	$r = .002$ $p = .991$
Female infants (n = 29)	$r = -.073$ $p = .708$	$r = .199$ $p = .300$	$r = -.002$ $p = .991$	$r = .017$ $p = .931$
All infants (n = 54)	$r = -.068$ $p = .623$	$r = .016$ $p = .909$	$r = .055$ $p = .691$	$r = .026$ $p = .849$

*Note:* A positive correlation corresponds to an increased preference for the first listed item in a pair with increasing age, whereas a negative correlation corresponds to an increased preference for the second item in a pair with increasing age.

but might be considered “female”-gendered in terms of stereotypes, and male faces, which are less preferred by younger infants (Quinn, Yahr, Kuhn, Slater, & Pascalis, 2002).

1.2 | EXPERIMENT 1B: MALE FACES VERSUS STOVES

1.2.1 | Methods

Participants

The same recruitment and inclusion criteria as Experiment 1a were adopted. The final sample of participants comprised 54 infants from 6 to 20 months: 29 female and 25 male infants (see ages in Figure 5 scatterplot). The number of participants per gender satisfied G power analysis with a medium



**FIGURE 4** Stimuli for Experiment 1a. The four stimuli categories from top to bottom rows: Real male faces, male doll faces, toy stoves, and real stoves

effect size ( $f = 0.5$ ). An additional 11 infants were observed but not included in the final sample due to calibration failure ( $n = 3$ ), crying ( $n = 4$ ), experimental error ( $n = 1$ ), or less than 4 valid trials for infants in each condition (i.e., the criterion applied in Experiment 1a;  $n = 3$ ).

### *Stimuli and design*

The design was the same as Experiment 1a, with stimuli the same as in Escudero et al. (2013, Experiment 1b). Static pictures were from one of four categories: real male faces, male doll faces, toy stoves, or real stoves. As in Experiment 1a, each category consisted of 6 different pictures, adding up to 24 pictures in total (Figure 4). These pictures were further assigned to four paired categories for preference comparison: male doll face versus toy stove, toy stove versus real stove, male doll face versus real male face, and real male face versus real stove. Side presentation was counterbalanced, resulting in a total of 48 trials (4 pair types  $\times$  6 different pairs  $\times$  2 side orders = 48). The presentation order was randomized across trials. Picture size, visual angle, and viewing distance were the same as in Experiment 1a.

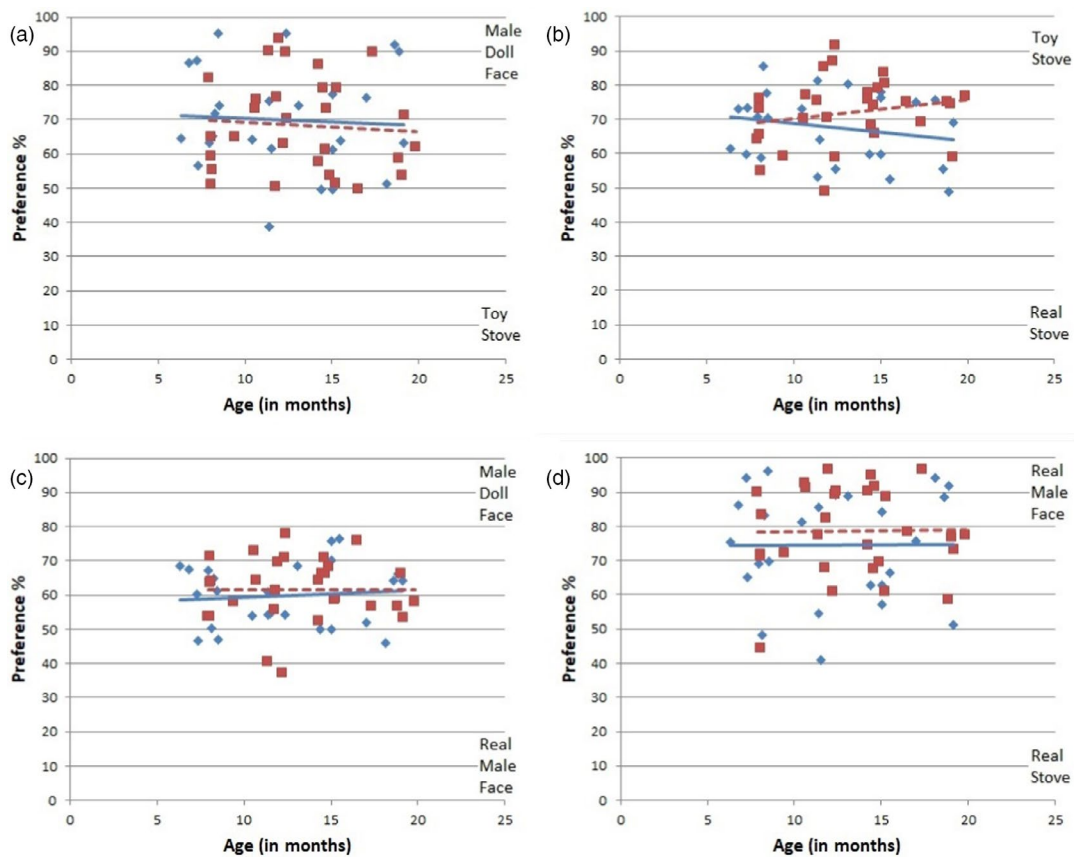
### *Apparatus and procedure*

The same apparatus and procedure as in Experiment 1a were used.

**TABLE 4** *t* and *p* values of infant normalized fixation preference for each of the four pair types in Experiment 1b

	Male doll face–toy stove	Toy stove–real stove	Male doll face–real male face	Real male face–real stove
Male infants	$t(24) = 6.529$ $p < .001$	$t(24) = 8.466$ $p < .001$	$t(24) = 5.376$ $p < .001$	$t(24) = 7.636$ $p < .001$
Female infants	$t(28) = 7.275$ $p < .001$	$t(28) = 12.126$ $p < .001$	$t(28) = 6.547$ $p < .001$	$t(28) = 11.709$ $p < .001$
All infants	$t(53) = 9.831$ $p < .001$	$t(53) = 14.356$ $p < .001$	$t(53) = 8.507$ $p < .001$	$t(53) = 13.469$ $p < .001$

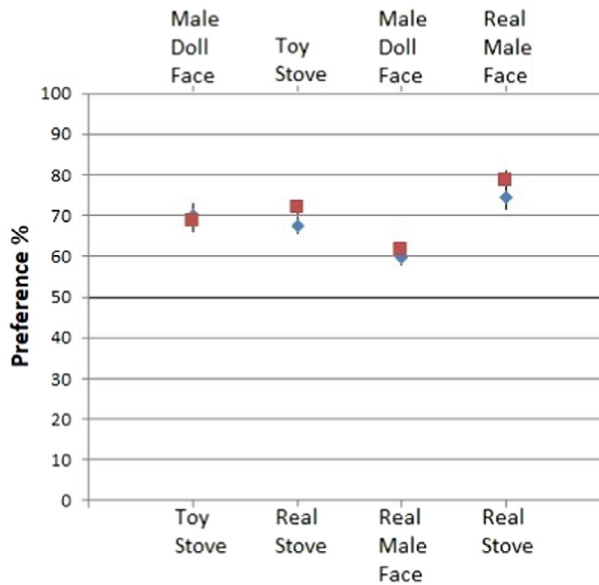
Note: The Bonferroni-corrected alpha  $p = .004$  (see also Figure 6).



**FIGURE 5** Scatterplot of male infants' (blue diamonds) and female infants' (red squares) age tested and looking time preferences in Experiment 1b for: (a) Male doll faces versus toy stoves; (b) toy stoves versus real stoves; (c) male doll faces versus real male faces; (d) Real male faces versus real stoves. In each case, 50% is no preference

### 1.2.2 | Results and discussion

Because the same questions applied as in Experiment 1a, the same statistics, figures, and tables as Experiment 1a were included. As age was a variable of primary interest, the effect of age on infant preference scores was also examined through the Pearson correlation coefficients for each gender (see



**FIGURE 6** Infant normalized fixation preference for each of the four pair types in Experiment 2. Preference is shown as closer to one or other item, with 50% = no preference. Error bars =  $\pm 1$  SEM. Where male symbols (blue diamonds) are not visible, it is because males have an almost identical value to female (red squares)

Figure 5 and Table 3). Unlike Experiment 1a, no significant correlations were observed ( $r_s < .199$ ,  $p_s > .300$ ). Preferences scores were compared with 50% (no preference) for male and female infants. Results showed significant preferences in all pairs after Bonferroni correction (see Figure 6 and Table 4).

In summary, experimental results revealed general preferences for faced stimuli over objects and for toys over real objects, similar to Experiment 1a. Unlike Experiment 1a, no gender-specific toy preference was observed, showing that male infants' emergent lack of preference between cars and faces does not apply to all mechanical toys, again replicating Escudero et al. (2013). Experiment 1 suggests that there may be differences in gendered toy preference depending on exactly what stimuli are used, but does not allow us to discern whether it is the characteristics inherent to the object, or something to do with the gendered nature of toys based on prior exposure. We explore these ideas in Experiment 2.

## 2 | EXPERIMENT 2. STIMULUS CHARACTERISTICS, PREVIOUS EXPOSURE, OVERALL ACTIVITY LEVELS, AND PARENTAL ATTITUDES

In Experiment 2, we explore the potential factors that may explain male infants' developmental decrease in preference for faces when compared to cars but not when compared to stoves. These factors include toy properties, infants' previous toy experience, infants' overall activity types, and parental attitudes toward gender-specific toys. First and foremost, although cars and stoves are mechanical objects that can be manipulated, cars are smaller and therefore more graspable. Further, cars have a locomotive aspect that may be appealing to male infants (Zosuls et al., 2009), and this may also relate to overall activity levels. In order to test whether other graspable and locomotive toys would yield similar effects as cars, we included tea sets and strollers in the stimuli, given that

strollers are locomotive but not as graspable to infants, whereas this is the opposite for tea sets. Experiment 2 thus tested toy preference in male and female infants for dolls, toy cars, strollers, and tea sets, including all possible pair comparisons. The choice of strollers and tea sets was also driven by stereotypical gender roles for these toys, as both might be considered more female-gendered by traditional parents. Whole dolls instead of doll heads were used to match many previous gender-specific toy preference studies and to resemble infants' actual experience. If stereotypical gender roles play a part in infant preference, we would expect female infants to prefer dolls, strollers, and tea sets over cars, while we would expect male infants to prefer cars over all other objects. If, however, male infants' preference for cars relates to their locomotive aspect, we would expect them to prefer cars or strollers over the other toys. If it is the graspability of toys that is appealing, strollers would be the least preferred objects. As Experiment 1a illustrated male infants' change in preference for cars versus dolls with age, we focused on testing a narrower age range (14–16 months) in Experiment 2. This age was also chosen to be consistent with previous work suggesting differences in gender preference at or after 12 months (Boe & Woods, 2018; Jadva et al., 2010; Lutchmaya & Baron-Cohen, 2002; Roopnarine, 1986).

A parental questionnaire was also included assessing infants' exposure to the various toys, activities they participated in, and parental attitudes to various gendered statements. Importantly, although observations and speculations have been provided (e.g., Zosuls et al., 2009) for the link between parental attitudes and toy preference among young infants, no previous study had directly measured this factor at the time the current study was conducted. However, many have found that parents illustrate stereotypical behaviors correspondent to their infants' gender during pregnancy and throughout childhood: Caretakers typically show enhanced physical relationship with male infants and more emotional relationship with female infants (Frisch, 1977; Kitamura & Burnham, 1998, 2003; Leaper, Anderson, & Sanders, 1998; Leaper, Leve, Strasser, & Schwartz, 1995; Pomerleau, Malcuit, Turgeon, & Cossette, 1997; Smith & Lloyd, 1978).

## 2.1 | Methods

### 2.1.1 | Participants

The same recruitment and inclusion criteria as Experiment 1 were adopted. The final sample of participants comprised 42 infants from 14 to 16 months: 22 female infants (mean age in months = 15.40,  $SD = 0.54$ ) and 20 male infants (mean = 15.40,  $SD = 0.48$ ). The number of participants per gender satisfied G power analysis with medium effect size ( $f = 0.5$ ). An additional 17 infants were observed but not included in the final sample due to crying ( $n = 2$ ), experimental error and calibration failure ( $n = 2$ ), or less than 4 valid trials for infants in each condition (i.e., the criterion applied in Experiment 1;  $n = 13$ ).

### 2.1.2 | Materials and design

For the preference task, the same design as in Experiment 1 was used with a different set of stimuli. Static pictures were from one of four categories: cars, dolls, strollers, or tea sets. As in Experiment 1, each category consisted of 6 different pictures, making a total of 24 images across categories (Figure 7). The car images were the same images as in Escudero et al. (2013), and the other pictures were chosen from the Internet to show a similar range of colors and shapes in each category.





**FIGURE 7** Experiment 2. Four stimuli categories from top to bottom rows: Dolls, cars, strollers, and tea sets. Numbers show which items were paired together (e.g., doll 1 with car 1 or stroller 1, etc.)

These pictures were further assigned to six paired categories for preference comparison: doll versus car, car versus stroller, car versus tea set, doll versus stroller, doll versus tea set, and tea set versus stroller, with each item from one category paired with one item from another to give 6 pairs for each comparison (e.g., doll 1–car 1; doll 2–car 2 ... car 1–stroller 1; doll 1–stroller 1 ... tea set 6–stroller 6). Side presentation was counterbalanced, resulting in a total of 72 trials (6 pair types  $\times$  6 different pairs  $\times$  2 side orders = 72). The presenting order was pseudo-randomized within each comparison (1–6) to ensure that the same pair of images did not appear one after another. Picture size, visual angle, and viewing distance were similar to Experiment 1. A parental questionnaire included some demographic information, followed by a list of activities that children might participate in and a time/week, as well as toys which parents were asked to say whether their child played with and approximately how long for per week. Finally, parents were asked to agree or disagree with 10 statements such as “Female infants are more social than male infants,” “Male infants like physical activities more than female infants,” and “Female infants prefer trucks to dolls” (see the full list in Table 7). The parental questionnaire was designed for this study (see Appendix S1 for the full questionnaire).

### 2.1.3 | Apparatus and procedure

Similar apparatus and procedure as in Experiment 1 were used with two differences. Participants were presented with 72 trials of 5 s in length (6 min total, compared with 48 trials and 4 min for each of Experiments 1a and 1b). Caregivers completed the parental questionnaire after the experiment.

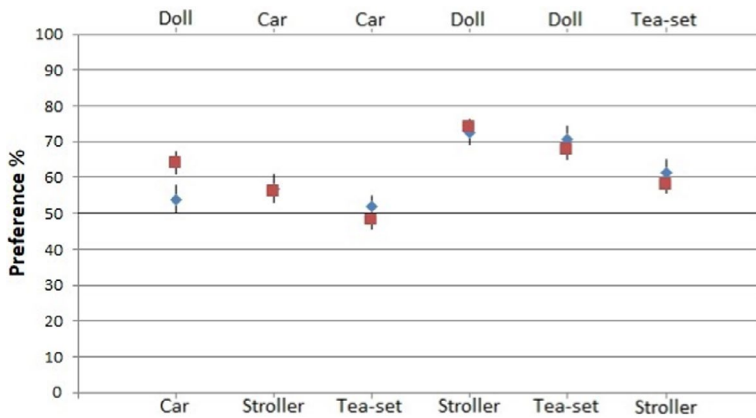
## 2.2 | Results and discussion

Analyses were conducted on each of the six pairs: doll versus car, car versus stroller, car versus tea set, doll versus stroller, doll versus tea set, and tea set versus stroller. The same preference score (dwell times) calculation method and infant trial selection criteria as in Experiment 1 were adopted. We first compared male infants and female infants' preferences within each pair using an independent-samples *t*-test with infants' preferential looking score as the test variable and gender (male vs. female) as the grouping variable. No significant gender difference was observed across pairs (*ts* (40) < 0.860, *ps* > .394) except for a marginal effect in the doll versus car comparison (*t* (40) = 1.981, *p* = .054): Female infants prefer dolls more than their male peers.

As in Experiment 1, all pair types were compared with 50% (no preference) via one-sample *t* tests. Results are presented both for males and female infants separately and for all infants combined (see Table 5). Results showed significant preferences for infants in almost all pairs. An evident trend was that both male and female infants appeared to prefer dolls over other toys, except for the doll–car pair for males, where they show no preference, replicating Experiment 1a. Interestingly, no preference between cars and tea sets was observed for either male or female infants. Figure 8 illustrates these normalized total fixation preference scores.

We further linked infants' preferential looking patterns with their motor activity, and toy experience collected through parental reports. Six motor activities were included in the questionnaire (dancing, running, swinging, sliding, swimming, and riding), but most participants only did some of these activities. To gain sufficient power for analysis, we coded the motor variable as having two levels, less than or more than three activities. This showed a significant interaction between gender and motor activity on infants' preference for cars over tea sets,  $F(1, 38) = 4.86$ ,  $p = .034$ ,  $\eta_p^2 = 0.113$ . Specifically, females participating in more types of motor-intensive activities showed increased attention to cars over tea sets and male infants revealed the same pattern if they engaged in fewer motor-intensive activities. The other interactions were not significant (*ps* > .195). We also looked at the correlation between the time (average minutes per week) infants spend on activities and their preferential patterns, altogether ( $N = 42$ ) and splitting by gender ( $N_{\text{male}} = 20$ ,  $N_{\text{female}} = 22$ ). Infants' time spent on motor-intensive activities appeared to be positively correlated with their preference for cars (car over doll:  $r = .323$ ,  $p = .037$ ; car over tea set:  $r = .341$ ,  $p = .027$ ). Although the sample size after splitting by gender is relatively small, significance was observed: Female infants who spent more time on motor activities showed increased attention to cars over tea sets ( $r = .587$ ,  $p = .004$ ), and male infants who spent more time on motor activities were more attentive to strollers than tea sets ( $r = .472$ ,  $p = .035$ ). The general trend seemed to suggest that infants' preferences for dynamic over static toys are positively correlated with their time spent on motor activities.

Regarding the factor of child toy exposure, there were many toys that very few infants had been exposed to (e.g.,  $N_{\text{action figure}} = 2$ ). To increase power, toys with similar properties were grouped (Table 6). That is, to examine the effect of locomotion we grouped walkers together with strollers, and cars with trucks. Similarly, for static toys, dolls and action figures were grouped, as were tea sets and stacking cups. Significant differences can be observed between male and female infants in their experience of cars + trucks,  $t = 3.27$ ,  $p = .002$ ,  $\eta_p^2 = 0.211$ , as well as tea sets + cups,  $t = 3.21$ ,  $p = .003$ ,  $\eta_p^2 = 0.205$ , but not of walkers + strollers,  $t = 1.19$ ,  $p = .241$ ,  $\eta_p^2 = 0.034$ , or dolls + action figures,  $t = 1.32$ ,  $p = .196$ ,  $\eta_p^2 = 0.041$ . When the presence or absence of each toy was then compared with the preference data, a significant interaction was observed between gender and the presence of walker/stroller on infants' preference for strollers over tea sets,  $F(1, 38) = 9.07$ ,  $p = .005$ ,  $\eta_p^2 = 0.193$ . Splitting gender, female infants with walker/stroller experience paid more attention to strollers than those without the experience,  $F(1, 20) = 7.39$ ,  $p = .013$ ,  $\eta_p^2 = 0.270$ , whereas this difference was not



**FIGURE 8** Experiment 2: Infant normalized fixation preference for each of the four pair types. Preference is shown as closer to one or other item, with 50% = no preference. Error bars =  $\pm 1$  SEM. Where male symbols (blue diamonds) are not visible, it is because males have an almost identical value to female (red squares)

**TABLE 5**  $t$  and  $p$  values of infant normalized fixation preference for each of the six pair types in Experiment 2, compared with no preference (50%)

	Doll-car	Car-stroller	Car-tea set	Doll-stroller	Doll-tea set	Tea set-stroller
Male infants ( $n = 20$ )	$t = 0.966$ $p = .346$	$t = 1.805$ $p = .087$	$t = 0.555$ $p = .585$	$t = 6.486$ $p < .001$	$t = 6.079$ $p < .001$	$t = 3.095$ $p = .006$
Female infants ( $n = 22$ )	$t = 4.308$ $p < .001$	$t = 2.812$ $p = .010$	$t = -0.669$ $p = .511$	$t = 11.582$ $p < .001$	$t = 7.452$ $p < .001$	$t = 3.523$ $p = .002$
All infants ( $n = 42$ )	$t = 3.469$ $p = .001$	$t = 3.067$ $p = .004$	$t = -0.033$ $p = .974$	$t = 11.919$ $p < .001$	$t = 9.382$ $p < .001$	$t = 4.575$ $p < .001$

Note: The Bonferroni-corrected alpha  $p = .003$  (see also Figure 8).

significant for male infants' preference,  $F(1, 18) = 3.36$ ,  $p = .085$ ,  $\eta_p^2 = 0.157$ . No other interactions reached statistical significance ( $ps > .187$ ). Motor-intensive activities and wheeled toy experiences appeared to have more effects on female than on male infants' toy preferences, though these effects do not seem to be large overall. It was not possible to look at the time spent playing with various toys compared to preferences, as there were generally too many infants with zero time for many of the toys.

Finally, we examined parental attitudes toward gender stereotypes. Group results showed that Australian parents seemed to provide generally non-stereotypical answers (Table 7). However, parental answers seemed to be more biased toward their own children's gender; that is, they were more likely to agree with a claim if it favors the gender of their own child as compared to when the claim favors the opposite gender (e.g., agree on girls are more social if they have a baby girl).

We also scored parental general attitudes across the claims to give a combined score where strongly agree = 1, agree = 2, disagree = 3, and strongly disagree = 4 for a typical claim, with 5 and 6 reverse-coded and 10 left out because it was a repeat. The lower the score, the stronger bias parents would have toward gender stereotypes. While no significant correlation was observed between the parental attitude score and overall infant looking preferences ( $rs < \pm .265$ ,  $ps > .089$ ) or those with male infants ( $rs < \pm .144$ ,  $ps > .544$ ), female infants' preferences for strollers over tea sets were negatively correlated with their parents' attitudes ( $r = -.641$ ,  $p = .001$ ). That is, preference for tea sets was even

**TABLE 6** Percentage of infants (14–16 months) reported as playing with each kind of toy

	Walkers + strollers	Cars + trucks	Dolls + action figures	Tea sets + cups
Female	73%	55%	50%	91%
Male	55%	95%	30%	50%

**TABLE 7** Parental responses toward gender-related questions along a 4-point scale from strongly disagree to strongly agree

Claim	Parents of male infants ( <i>n</i> = 20)	Parents of female infants ( <i>n</i> = 22)	All parents ( <i>n</i> = 42)
01 Girls are more social	25.00%	45.45%	35.70%
02 Boys are more active	45.00%	31.82%	38.10%
03 Girls engage more with language	30.00%	63.64%	47.62%
04 Boys like physical play more	45.00%	27.27%	35.71%
05 Girls prefer trucks to dolls	05.00%	31.82%	19.05%
06 Boys prefer dolls to trucks	10.00%	09.09%	09.52%
07 Girls prefer pink to blue	35.00%	27.27%	30.95%
08 Boys prefer blue to pink	20.00%	36.36%	28.57%
09 Girls have better imagination	00.00%	09.09%	04.76%
10 Boys have better imagination	20.00%	00.00%	09.52%

Note: The higher the percentage, the more parents agree or strongly agree with the claim.

stronger among female infants whose parents reported a less stereotypical view of gender specificity, possibly due to a novelty effect.

A reviewer questioned whether our results could be influenced by other-race effects, given that the faces in Experiment 1 were all Caucasian. Infants in our experiments were mostly, but not all, Caucasian growing up in a majority Caucasian country. More importantly, our task was to compare faces to other objects, not to compare faces from different groups. Results showed that faces or dolls were always preferred except in the case of faces/dolls for male infants with their age growth. As we replicate that lack of difference across two experiments with different sets of stimuli (including dolls with a range of skin tones), it seems unlikely that other-race effects could explain the results.

To summarize, dolls remained the primary toy of interest for all infants, followed by cars and tea sets, and strollers appear to be the least attractive across toys. The trend seemed to favor that infants prefer toys with strong graspability (e.g., toy cars over strollers). In terms of gender-specific differences, female infants appear to prefer dolls to cars, whereas male infants do not show this preference. Regarding the impact of nurture on toy preference, factors such as motor-intensive activities, wheeled toy experiences and parental attitudes all predicted infants' preferences for dynamic/wheeled toys over static toys, and such influence seemed to be overall stronger among female than male infants.

### 3 | DISCUSSION

The current study explored various factors that may play a role in infants' gender-specific toy preferences. Experiment 1 examined the age at which infants' gender-specific toy preference may emerge testing infants aged 6–20 months on dolls versus cars or stoves (cf. Escudero et al., 2013), and showed a change in preference such that male infants lose preference for dolls over cars as their age increases. Experiment 2 then tested infants at 14–16 months, examining stimuli characteristics of locomotion, graspability, children's participation in motor activities, their toy experience and parental attitudes to gendered statements. In general, infants again preferred dolls and then graspable toys (tea sets or cars) over strollers. The lack of preference between cars and dolls for males was replicated in this study. Experiment 2 also showed female infants' preferences for dynamic over static toys are positively associated with motor activities, wheeled toy experiences, and less stereotypical gender attitudes in parents.

#### 3.1 | Preference for faces

Infants demonstrated striking preferential similarities across experiments and studies: Faces are typically preferred over other stimuli (Leo & Simion, 2009; Pascalis et al., 2002; Quinn et al., 2008). Recent evidence suggests that such tracking ability appears in prenatal period and therefore may be an innate mechanism: A recent experiment projecting patterned stimuli through maternal tissue to fetuses and detecting their reaction using 4D ultrasound shows that the third-trimester human fetuses actively look toward three dots configured like a face but not toward three inverted configuration dots (Reid, Dunn, Donovan, & Young, 2018; Reid et al., 2017). A similar trend continues upon birth (Farroni et al., 2005; Johnson et al., 1991; Mondloch et al., 1999) and at 5 months (Escudero et al., 2013). The current experiments extend such preference to 20 months after birth. Arguably, infants' attention to faces may indicate their preference for surrounding cues that are socially relevant. Parents use facial expressions to communicate with their children in addition to languages and gestures (Chong, Werker, Russell, & Carroll, 2003), and infants' attention to faces is crucial for their survival as caretakers' negative facial expression may indicate danger (Elfenbein & Ambady, 2002; Montague & Walker-Andrews, 2002). Infants' preference for face-like stimuli could fairly be described as innate given that it appears before birth.<sup>1</sup> Many previous studies on gendered toy preferences have chosen dolls as “female-typical” toys. In the current studies, we used both doll faces (Experiment 1) and whole dolls (Experiment 2), and found a general preference in all infants for dolls, except for males with age. An interesting extension to this might be that infants prefer faces on toys in general. We leave this open for future research.

#### 3.2 | Females prefer dolls, but what do males prefer?

A number of studies have argued that transitions in infant gender-related preferences occur between 14 and 21 months after birth during which self-awareness toward gender-specific toys also increases (Alexander & Saenz, 2012; Lauer & Yhang, 2016; Serbin et al., 2001; Zosuls et al., 2009). The previously reported developmental time window is in agreement with the outcomes of the current study,

<sup>1</sup>Note we are not interested in a debate of whether the preference is for a face per se; if humans have evolved to prefer shapes which, in a normal human environment, would direct their attention to faces more than other things, we consider that sufficient.



in which one of the main difference between male and female infants is that male infants around 15 months showed no preference for cars and dolls, unlike females who overall preferred dolls to cars.

Experiment 1 showed a developmental increase in male infants' preference for cars compared to dolls, consistent with the finding from the recent meta-analysis (Todd et al., 2018). In addition, Experiment 2 showed that male infants tended to prefer cars more than female infants when compared to dolls. This finding is in line with previous literature showing female infants' consistent preference for dolls (Bem, 1989; Blakemore, LaRue, & Olejnik, 1979; Connellan et al., 2000; Lutchmaya & Baron-Cohen, 2002; Serbin et al., 2001; Signorella, Bigler, & Liben, 1993; Thompson, 1975), as well as the meta-analysis (Lauer & Yhang, 2016) from which trends of stable gender-specific toy preferences for female infants and age-related development for male infants were shown. Possible explanations for this developmental difference in gender-specific preferences are discussed in the following sections.

### 3.3 | Locomotion and motor-intensive activities

Though under debate (Lutchmaya & Baron-Cohen, 2002), one explanation to account for male infants' shift toward a preference for cars may come from the locomotive status of the objects: Cars are generally associated with the movement or mechanical motion as compared to dolls, which has been argued to represent more social properties (Campbell, Shirley, Haywood, & Crook, 2000; Zosuls et al., 2009). Though lacking direct evidence, it has been hypothesized that male infants may have innate preferences for mechanical motion and female infants for social stimuli (Alexander & Hines, 2002; Campbell et al., 2000; Zosuls et al., 2009). Benenson, Tennyson and Wrangham (2011) observed that male infants are more likely to emulate propulsive movement than female infants at 6–9 months, and Todd et al. (2017) hypothesized that this may promote male infants' play styles that are associated with their attraction to toy features that allow them to move in space. Alexander and Hines (2002) argue that sexually dimorphic preferences for features like movement may evolve from differential selection pressures based on the different behavioral roles of males and females, and that evolved object feature preferences may contribute to gender-related toy preferences in children, and Alexander and Saenz (2012) further suggest that prenatal hormones play a role in such preference.

In Experiment 2, data were gathered from participating families regarding infants' typically attended activities, toy experiences and parental attitudes toward gender stereotypes. We found that infants' preferences for some dynamic over static toys appear to be positively correlated with their time spent on motor activities, leaning toward the hypothesis that children that spend more time in locomotive activities may have a stronger preference for the locomotive aspect of toys. In addition, female infants' preferences for wheeled toys appeared to be positively related to the type of motor-intensive activities and their previous experience with wheeled toys, but negatively correlated with parental gender stereotypes. Male infants, however, do not show an evident similar trend. Thus, if anything, our study supports the relationship of movement and locomotor aspects of female more than of male toy preferences. However, the overall correlation between infants' engagement with movement activities and their toy preferences suggests that individual experience rather than gender per se may play a role.

### 3.4 | Graspability

Male infants' emergent preference for cars over faces does not apply to all mechanical toys; that is, they prefer cars but not stoves. However, male infants, as well as female infants, also prefer cars and

tea sets over strollers but show no preference between cars and tea sets. Linking the two experiments in the current study, graspability seems to play a larger role than gender. Although it is difficult to interpret null results, if something linked to gender was the primary reason for a preference then we would expect male infants to prefer cars to tea sets, and female infants, the reverse. Toy cars, dolls, and tea sets may be more graspable for 15-month-olds than stoves and strollers due to their sizes and shapes. It must be noted that examining and interpreting preferences based on specific toy characteristics is challenging because it is difficult to adequately control the numerous lower-level variables and differences that may be driving category-level preferences. Our speculation with graspability needs to be treated with caution and further examined in future research.

### 3.5 | Parental attitude and familiarity

The establishment of gender-specific toy preferences has also been argued to be largely dependent on postnatal influences from the ambient environment (Bandura, 1977; Ehrhardt & Meyer-Bahlburg, 1981; Fagot & Hagan, 1991; Langlois & Downs, 1990; Martin, 1999; Martin et al., 1990). Experiment 2 reported a small but not robust correlation between parental attitudes and infants' gender-specific toy preferences. As Table 7 illustrates, parents appear to be generally aware of gender stereo-typicality. For instance, the majority of parents disagree with the claim that male infants are more physically active than female infants or that male infants like blue and female infants like pink. However, these responses do not necessarily guide parental actions and choices for their infants in real-life settings, as shown by infants' actual toy experience in Table 7: Male and female 14- to 16-month-old infants have a clear difference in their experience with cars and trucks (95% vs. 55%). One possibility is that parents were aware of the gendered issue and provided responses that are socially desirable, irrespective of their actual toy choices for their children (which appears to be fairly gender-specific), and thus conforming to the claim that parents contribute to their infants' gender-specific socialization (Boe & Woods, 2018; Roopnarine, 1986; Weinraub et al., 1984; Weisgram & Bruun, 2018), even though they may be unaware of their choices. Note that the current study is unable to tell which of these may be true.

Infant preferences for toys, or at least those of female infants as observed in the current study, appear to be influenced by parents' selection, which is often "gendered" from the beginning of life. Children's physical and social environments are typically gender-congruent as they engage in corresponding conducts and activities (Blakemore et al., 1979). Playing with socially defined gender-congruent toys, for instance, may be rewarding to infants through shared attention with significant others (Alexander et al., 2009). It should also be noted that the majority of parental responses were from mothers. As they are the primary caregivers of participants, it is likely that they were also responsible for selecting the toys for their children. There may be differences between male and female caretakers on their attitudes to toys and gender. We leave these potential factors for future research, but encourage greater diversity in children's toy play to promote a reduction in gender stereotypes (Dinella & Weisgram, 2018; Joel et al., 2015; Kollmayer et al., 2018; Spinner, Cameron, & Calogero, 2018).

### 3.6 | Methodological considerations

Our study had several methodological strengths: Besides examining the effect of age in a large cohort of infants between 6 and 20 months, the range of individual differences in infants' preference was also examined at a smaller time window. In addition, the current design directly measured infants'

preferences between two items, addressing the limitations of previous studies looking at one item at a time (cf. Alexander et al., 2009). In addition, a substantial number of trials per pair were included to improve validity. Furthermore, we used a range of items with a range of colors as gender-typed colors have been shown to affect preschool children's toy preferences (Weisgram, Fulcher, & Dinella, 2014; Yeung & Wong, 2018), thus improving the generalizability of results.

It is, however, important to consider the inclusion of observational and behavioral measures in future research as infant looking preferences may not accurately represent or translate to actual behavior. It would be interesting to examine whether looking preferences at around 15 months predict actual play/behavior using a grasping task or a longitudinal design. Controlling for gender, a recent study by Lauer, Ilksoy, and Lourenco (2018) showed a positive correlation between infants' gender-specific toy preference at 6–13 months and their gender-typed play preferences at age 4. Findings indicate children's gender-specific toy preferences may have a long-lasting effect along their developmental trajectory.

## 4 | CONCLUSION

The gradual trend between 6 and 20 months and the evident display of gender-specific toy preference at 14–16 months in the current study conform to social cognitive theories on infant emerging understanding of gender (Bussey & Bandura, 1999; Martin, Ruble, & Szkrybalo, 2002). Rather than during the phallic stage (Freud, 1963), conceptual gender categories and gender identification begin in infancy (Chodorow, 1978; Courage & Howe, 2002; Poulin-Dubois, Serbin, Eichstedt, Sen, & Beissel, 2002; Poulin-Dubois, Serbin, Kenyon, & Derbyshire, 1994) and continue to develop in the second year after birth.

The current study provides interesting and relevant contributions to the literature by examining the relationship between looking preferences to gendered toys, objects, and faces and parents' attitudes, as well as children's toy exposure. It is among the first to study toy preferences at a range of ages in infancy and suggests 15 months to be the time window around which gender-specific toy differences may emerge. Further, it investigates the relationship between prior exposure and toy preferences. The study contributes knowledge to theoretical approaches regarding the development of gender-typed preferences, which may be restricted and related to specific toys under investigation. Although human evolution provides biological potentialities, the conceptions and roles of gender may be the product of a broad network of social influences (Bussey & Bandura, 1999). The development of gender-specific toy preference may be a result of biological, cognitive, and socialization factors (Alexander & Hines, 2002; Fausto-Sterling, 1992; Hines, 2010; Martin et al., 2002; Ruble, Martin, & Berenbaum, 1998) working together for children to reach the patterns observed in adulthood (Alexander & Hines, 2002; Fausto-Sterling, 1992; Hines, 2010). In conclusion, our study illustrated gender-specific toy preference among infants aged 6 to 20 months, with a gender difference emerging at around 15 months. Age, stimuli characteristics, infant daily motor activities, experience with toys, and parental attitudes all appear to play a role in the developmental trajectory of such preference, shaping the current and future perception and cognition across infants.

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## SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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