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Collaborative and competitive motivations uniquely impact infants' racial categorization

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ABSTRACT

Human history has been plagued by violent inter-group conflicts. Such conflicts are arguably grounded on group biases – particularly, a tendency to favor "ingroups" over "outgroups" – manifested in adults, children, and infants. A question these findings prompt is what *motivates* social categorization? Here it is shown that priming 14-month-old infants ($N = 144$) with collaborative or competitive interactions affects their capacity to form racial categories, and that this effect varies according to the gender of the exemplars being categorized. Specifically, whereas racial categorization of women was facilitated by collaboration, racial categorization of men was facilitated by competition. The presence of these differential effects in infancy is consistent with the idea that social categorization is driven by fundamental functions of group relations.

1. Introduction

Social group-based discrimination is a pervasive human phenomenon. Adults readily identify people's social group membership (Taylor, Fiske, Etcoff, & Ruderman, 1978), and manifest inter-group biases (Fiske & Tablante, 2015; Rudman, Greenwald, Mellott, & Schwartz, 1999). Social psychologists have proposed a variety of psychological mechanisms potentially explaining these phenomena, such as the centrality of groups to people's identity (Tajfel, 1982), and the importance of maintaining coherent beliefs about the social system (Jost, Banaji, & Nosek, 2004) or about one's status within dominance hierarchies (Sidanius & Pratto, 2001).

Lately, developmental studies revealed that even infants differentiate between people based on different social dimensions, such as age (Damon, Quinn, Heron-Delaney, Lee, & Pascalis, 2016), gender (Leinbach & Fagot, 1993; Quinn, Yahr, Kuhn, Slater, & Pascalis, 2002), or race (Anzures, Quinn, Pascalis, Slater, & Lee, 2010; Quinn, Lee, Pascalis, & Tanaka, 2016), and prefer those similar to them (Kinzler, Dupoux, & Spelke, 2007; Mahajan & Wynn, 2012; Pun, Ferera, Diesendruck, Hamlin, & Baron, 2017), intimating that social categorization emerges prior to the mature development of the mechanisms postulated by social psychologists as influencing this process. The question then, is what drives infants' social categorization? One option is that social categorization is an instance of a general categorization capacity, driven by a natural cognitive tendency to organize the world in a parsimonious fashion (Quinn, 2011). In this view, social categorization does not necessarily engage special mechanisms, but instead operates similar to the categorization of objects in other domains, i.e., infants detect statistical regularities in the environment, and group objects according to the presence of common and distinctive features. An alternative option is that social categorization engages further processes that are unique to the analyses of social stimuli. Drawing from evolutionary theory, we suggest that adaptive functions of social groups uniquely impact social categorization already in infants.

Evolutionary psychologists argue that the capacity to form social groups was a necessary adaptation for humans (Baumeister & Leary, 1995; Herrmann, Call, Hernández-Lloreda, Hare, & Tomasello, 2007; Kurzban, Tooby, & Cosmides, 2001). The argument is that in order to survive, humans had to respond to two recurrent social situations. Namely, they had to: a) affiliate with a large enough set of people willing to collaborate in hunting, gathering, and caring for their kin; and b) fight off – and assault – competing groups, so as to protect – and expand – their resources and mating possibilities. The recurrence of such situations throughout evolutionary time, and the fitness value of efficiently responding to such situations, arguably led to the selection of psychological machinery specialized in dealing with these situations; namely, machinery that would facilitate the identification of one's group. In particular, these psychological adaptations would respond to situations of affiliation and conflict by engaging processes of cue detection amongst individuals in one's environment, computation of cue similarity and distinctiveness, and grouping of people according to

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outcomes of such computations. These adaptations thus formed part of a so-called "coalitional psychology" (Kurzban et al., 2001; Pietraszewski, Cosmides, & Tooby, 2014), which allowed people to discriminate efficiently between groups of people with whom to affiliate from those with whom to compete (Choi & Bowles, 2007; De Dreu, 2012).

Arguably, one design feature of such cognitive adaptions is that it might have been sensitive to the sex of the individuals involved in the critical social encounters. In particular, the argument is that throughout evolution, males have been the primary agents of intergroup conflict and aggression, as they generated the most benefits from such encounters (e.g., in terms of mating possibilities, see, Geary, 2010; McDonald, Navarrete, & Van Vugt, 2012; Navarrete et al., 2009). In contrast, females have been primarily devoted to nurturing and caretaking, as means for guaranteeing the survival of their offspring (Benenson, 2014; Taylor et al., 2000). These differential functions of males and females led to the selection of gender-specific cognitive adaptations in the context of intergroup relations (Tooby & Cosmides, 1988). Specifically, whereas the recognition of the group membership of men became especially relevant in the context of competition and conflict, the recognition of the group membership of women became especially relevant in the context of collaboration and affiliation.

Various lines of work in adults corroborate this suggestion. For instance, Navarrete et al. (2009) found that whereas fear-extinction occurred in a similar fashion when the target was an outgroup woman vs. an ingroup woman, it was significantly more resistant when the target was an outgroup man compared to when it was an ingroup man. Similarly, in a punitive allocation task, male participants were aggressive towards outgroup men but not towards outgroup women (Navarrete, McDonald, Molina, & Sidanius, 2010). Moreover, it has been found that it is easier for adults to recognize a woman's gender when she is smiling than when she is frowning, but vice-versa for men (Hess, Adams, Grammer, & Kleck, 2009), and that perceptions of threat increased adults' attention to outgroup men but not to outgroup women (Maner & Miller, 2013). Lastly, situations of conflict have been found to make adults especially attentive to male facial features, and situations of collaborations to female facial features (Spisak, Dekker, Krüger, & van Vugt, 2012), thus indicating the gender-specific effects of such social interactions.

The above theoretical argument and empirical findings imply that when involved in a competitive or conflictive context, humans might be especially sensitive to the group membership of men. Specifically, people will be keen in identifying the men who will stand by one's side in conflict, and in discriminating these men from those who will stand against one's side. In turn, when involved in a collaborative or affiliative context, humans might be especially sensitive to the group membership of women. Specifically, people will be especially attentive to which women can be trusted to help and cooperate, and which cannot. The latter might be especially true for young infants, for whom one's mothers' coalition may serve as an extended circle of attachment, composed of individuals willing to tend and nurture the infant (Taylor et al., 2000). The hypotheses we derived from this analysis, is that priming infants with a competitive situation might make them especially attentive to the features that distinguish between groups of men, whereas priming an affiliative situation might lead infants to invest in discriminating between groups of women.

Following previous adult work (e.g., Kurzban et al., 2001; Pietraszewski et al., 2014), we focused on a social dimension that arguably typifies coalitional alliances in modern times, and thus is most susceptible to the impact of the critical social situations, namely race. In fact, the above authors suggest that a further design feature of humans' coalitional psychology is a selectivity regarding the most relevant cues for discriminating between groups. Specifically, it is postulated that these cognitive adaptations were especially effective for identifying collections of people engaged in coalitional alliances, which in ancestral times were typically defined by cultural cues such as behavioral habits and dress code, and in more modern times by dimensions such as race and ethnicity (see Pietraszewski & Schwartz, 2014, for a discussion). Consistent with this argument, it was found that adults are especially sensitive to cues about inter-group collaboration (Pietraszewski et al., 2014) and competition (Kurzban et al., 2001), even when these were pitted against racial group markers that were not predictive of coalitions. Furthermore, competition between arbitrarily-defined groups was found to impact children's construal of the groups (Rhodes & Brickman, 2011), and infants' conceptualization of groups is responsive to coalitional properties, such as shared language and behaviors (Kinzler et al., 2007; Powell & Spelke, 2013).

In two experiments, we tested the above hypotheses regarding the differential effect of competitive vs. collaborative situations on infants' racial categorization of men vs. women targets (i.e., distinguishing between Black and White men, or between Black and White women). We presented 14-month-olds with different motivational primes and assessed the effect of these primes on infants' performance in a social (race, Experiment 1) and a non-social (animals, Experiment 2) categorization task.

2. General method

The categorization task employed here was an adaptation of a widely used paradigm in infant research (e.g., Althaus & Plunkett, 2015; Anzures et al., 2010; Balaban & Waxman, 1997; Damon et al., 2016; Erickson, Thiessen, & Estes, 2014; Ferry, Hespos, & Waxman, 2010; Ferry, Hespos, & Waxman, 2013; Fulkerson & Waxman, 2007; Quinn et al., 2002; Quinn, Lee, Pascalis, & Tanaka, 2016; Robinson & Sloutsky, 2007). The rationale for this measure is that in order to assess whether infants can form *categories*, one needs to expose infants to several different exemplars of a presumed category (habituation/familiarization phase), and assess whether they view an additional exemplar of the category as similar to the previous ones, but an exemplar from a presumed different category as distinct (test phase). Note that this capacity is different from a sheer *preference* for one exemplar over another, presented without any preliminary phases.

This discriminatory capacity can be measured either via habituation paradigms, whereby stimuli are presented until infants' looking time drops substantially and then a test trial follows (Leinbach & Fagot, 1993); or via familiarization paradigms, whereby stimuli are presented for a pre-determined fixed number of trials before a test trial is presented (Anzures et al., 2010; Damon et al., 2016; Quinn et al., 2002; Quinn et al., 2016). In both paradigms, infants' disproportionate looking at an exemplar from a different category at test is taken as an index that infants: a) recognized that the habituation/familiarization stimuli had some feature in common, and b) detected that only one of the test exemplars had that feature and the other did not. This is especially the case if one controls for possible a priori differences in preferences to the two kinds of stimuli (Robinson & Sloutsky, 2007).

Indeed, previous research suggests that by nine months of age, infants have an a priori preference for looking at other-race (compared to own-race) faces (Liu et al., 2015). We presumed that this preference also characterizes slightly older infants, and thus devised a measure that corrects for such a preference. Namely, we measured infants' baseline preference for looking at a Black vs. a White face, and then re-measured their looking time at these stimuli after infants had undergone the priming and familiarization trials. Our dependent measure was the *change* in the percentage of looking at the other-category exemplar from baseline to test. A positive change indicated that whatever infants' initial preferences were, their exposure to exemplars from a given category during familiarization caused a change in this preference. Namely, infants would have noticed that the exemplars share a certain cue, and possibly grown accustomed to it. Then, when on test, infants encountered one exemplar that shared that cue, and another that did not, the latter would become salient and attract infants' attention.

In addition, previous research showed that accompanying the familiarization exemplars with a common label helped infants represent objects categories, arguably by providing a strong social cue that various exemplars have something in common (e.g., Balaban & Waxman, 1997; Ferry et al., 2010; Fulkerson & Waxman, 2007). We assumed that forming a racial category could be as challenging, and therefore attempted to facilitate infants' performance by adhering closely to Balaban and Waxman's (1997) procedure.

Finally, the motivational manipulation employed here was an adaptation of a previously used paradigm (Over & Carpenter, 2009). Specifically, it was shown that priming eighteen-month-old infants with dolls in an affiliative display increased their helping behaviour. Here we primed infants with short videos depicting a scene of either a collaborative, neutral, or competitive interaction.

3. Experiment 1: Social categorization

The general hypothesis was that motivational primes would impact infants' capacity to represent social groups, i.e., affect their capacity to detect features shared amongst exemplars of a certain category, and that distinguish them from a contrasting category. We chose to focus on skin-tone as the dimension for grouping, because as proxies for racial categories, this dimension is arguably a marker for coalitional alliances (Kurzban et al., 2001; Pietraszewski et al., 2014), and has been often used in infant research (Pauker, Williams, & Steele, 2016). In Experiment 1, infants watched one of three video primes - Collaboration, Neutral, or Competition - followed by a racial categorization task, in which they had to discriminate between Black and White women or between Black and White men (between-subjects). We hypothesized that there would be an interaction between the priming condition and the categorization targets' gender, such that collaboration would facilitate categorizing women into racial groups, whereas competition would facilitate categorizing men into racial groups.

3.1. Method

3.1.1. Participants

One hundred and twenty healthy 14-month-olds (59 girls; mean age = 14.2 months; range = 12.1 months to 17 months) constituted the final sample of participants. Thirty-nine additional infants were excluded due to fussiness (twenty-nine), parental interference (four), or experimenters' error (six). All families were White Israeli. The research was approved by the Institutional Review Board and conducted according to ethical standards. All participants' parents signed an informed consent. Families received a small gift in appreciation for their participation.

3.1.2. Design

Twenty infants were randomly assigned to each one of six conditions, resulting from the crossing of the two experimental variables: priming condition (Collaboration, Neutral, Competition) and targets' gender (women, men). This sample size and data-collection stopping rule were determined based on previous infant studies in the field (e.g., Anzures et al., 2010; Damon et al., 2016; Quinn et al., 2016), which assigned between nine to twenty participants to each condition.

3.1.3. Materials

3.1.3.1. Categorization task's stimuli. The task included a baseline trial, nine familiarization trials, and a test trial. Each of the nine familiarization trials presented a picture at the centre of the screen. Pictures were of a Black or White adult man or woman, between 15 and 18 cm wide and 22 cm high, presented on a grey background (see Fig. 1 for the complete set of familiarization pictures used in the experiments). The baseline and test trials were identical and presented a Black and a White adult (either both men, or both women) simultaneously, side by side, with approximately 27 cm space between them (see Fig. 3 for an example). Each of the eleven trials (one baseline, nine familiarization, and one test) was presented for ten seconds (with three seconds transitions between trials). Most of the pictures were taken from the NimStim data base.

3.1.3.2. Priming videos

The priming videos consisted of half-a-minute films depicting either a collaborative or a competitive social interaction between two White women, or a non-social, neutral, scene. In the Collaboration condition, one actress started assembling the pieces of a Lego train, and the other actress asked if she could join her (while picking a Lego piece from the floor), to which the first actress replied with a smiling, “yes!”. The two actresses continued playing together, smiling to each other, and offering Lego pieces to one another (with one of them saying a smiling, “thank you!”). Eventually, they built a complete train that they ran together on the carpet. In the Competition condition, one actress started assembling the pieces of the Lego train, and the other actress interfered, grabbing a Lego piece from her, to which the first actress replied with an angry, “no!”. The two actresses continued fighting over the pieces, frowning to each other, taking Lego pieces from one another (with one of them angrily exclaiming, “stop!”). Eventually, each of them had a stack of disorganized pieces behind her back. In the Neutral condition, no actresses appeared. Again, the scene started with the Lego parts randomly scattered on the carpet, only here the Lego parts were assembled by themselves (via an animation) to form a complete train. Following its assembly, the train appeared running by itself on the carpet. In the production of the two social conditions, we controlled for similar amounts of speech and similar body postures (see Fig. 2, and Videos 1–3 in the Supplementary material).

We chose to use “real” social interactions between real women for two main reasons: a) given that a variety of behaviors are presumably associated with the motivational needs we were hoping to manipulate (e.g., caretaking, helping, teaching, in the collaboration prime; threatening, hindering, hurting, in the competition prime), we attempted to pack the videos with various such behaviors, and b) following previous studies (e.g., Anzures et al., 2010; Kinzler et al., 2007; Kinzler, Dupoux, & Spelke, 2012; Over & Carpenter, 2009; Quinn et al., 2016), we exposed infants to social figures that had been shown to effectively elicit infants' social categorization and preferences, namely, those most familiar to infants, which in our case are White women. Moreover, a previous study that examined the effect of videos – depicting women – on infants' recognition capacity of still images – depicting men or women – found similar effects on both genders (Anzures et al., 2012).

3.1.4. Procedure

Fig. 3 illustrates the sequence of events infants underwent. Half of the infants were presented with women as targets, and the other half with men. The session started with the baseline trial of the categorization task. Then, a third of the infants were presented each with one of the three video primes: Collaboration, Neutral, or Competition. Immediately after the video, infants were presented with the familiarization trials of the categorization task. Half of the infants were familiarized to Black adults and the others to White adults. As was done in previous research using this paradigm (e.g., Balaban & Waxman, 1997), six of the familiarization exemplars were labelled with the same made-up label (“Look, Zergon”). Finally, infants were presented with the test trial.

As detailed in the General method section, our main dependent measure was the change from baseline to test, in looking time at the exemplar not from the familiarized category – the novel exemplar. In order to compensate for individual differences in infants' total looking time, we converted infants' raw looking time (in seconds, see Table A in the Supplementary material), both in the baseline and test trials, into percentages, by dividing looking time at the novel exemplar by total looking time at both novel and familiar exemplars. Thus, significant positive change scores indicated that infants had increased their

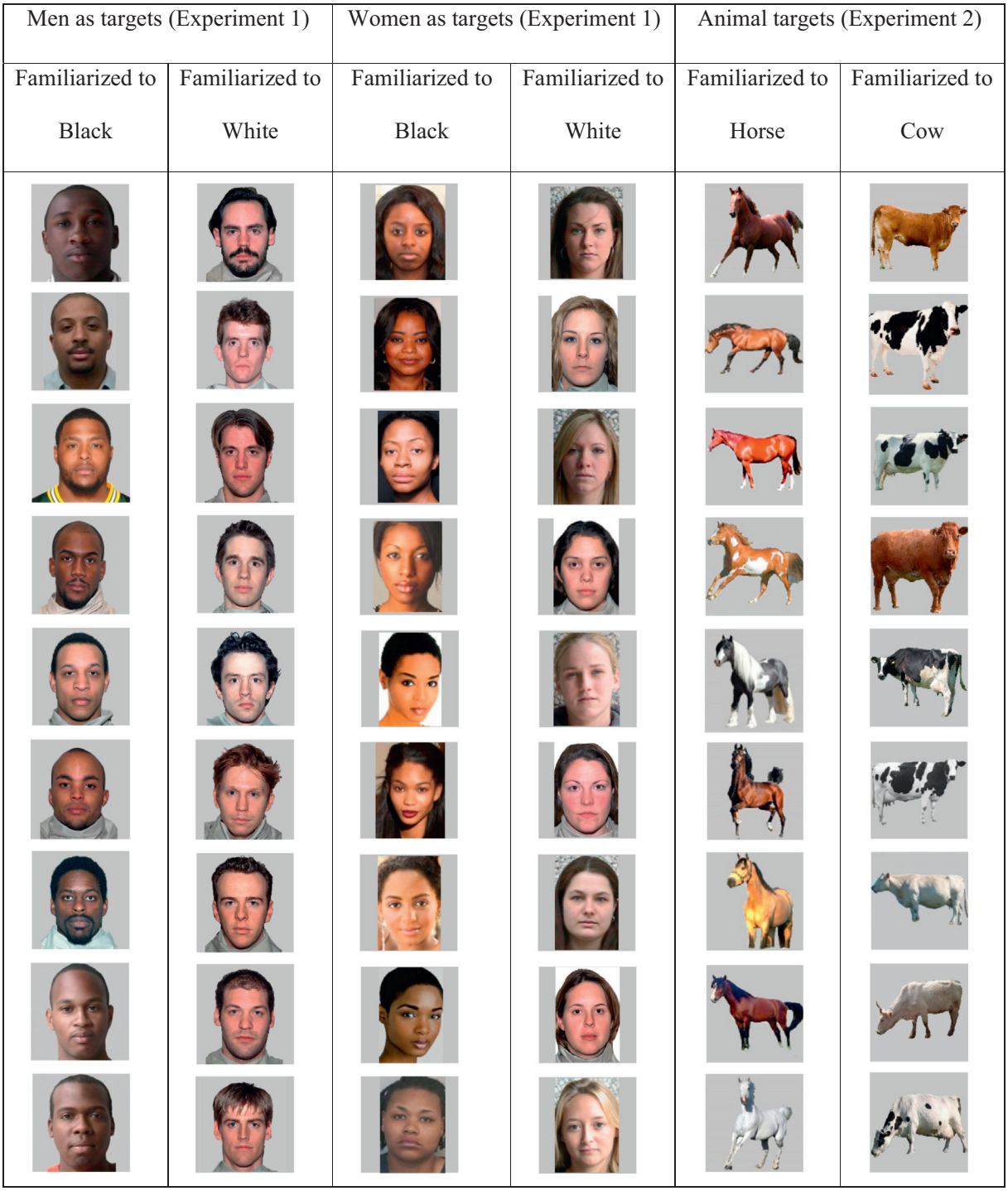

Fig. 1. Stimuli used as familiarization exemplars in the categorization task in Experiments 1–2. *Note*. Each of the six familiarization types above was presented to a different group of infants.

looking at the novel exemplar, from baseline to test; in other words, that categorization had occurred.

3.2. Results

Preliminary analyses revealed no differences between male and female participants in their categorization performances, we therefore did not include participants' sex in any of the further analyses. Preliminary analyses also did not reveal any effects related to the category infants were familiarized to (Black or White; see Supplementary material for the analyses).

Our main hypothesis was that there would be an interaction effect between targets' gender and priming condition on infants' racial categorization. To address this hypothesis, we first conducted an ANOVA, including the effects of targets' gender (women or men) and priming condition (Collaboration, Neutral, or Competition), using infants' change score as the dependent-variable. The ANOVA indeed revealed only a significant interaction between targets' gender and priming condition, indicating that the primes had a different effect in regard to women and men as targets, $F(2,114) = 4.473$, $p = 0.013$, $\eta^2 = 0.073$ (see Fig. 4).

We followed-up these analyses with one-sample *t*-tests, in order to

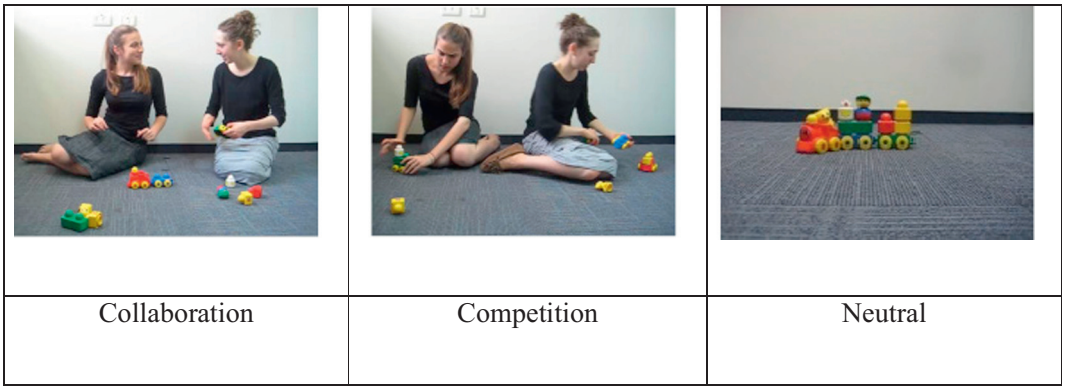

Fig. 2. Still images of video primes shown to infants in Experiments 1–2 (the Videos themselves are included as Videos 1–3 in the Supplementary material).

assess under what conditions infants evinced categorization; namely, under what conditions infants significantly *increased* their looking time at the novel exemplar from baseline to test. These tests revealed that when presented with women as targets, only in the Collaboration condition did infants significantly increase their looking time at the novel exemplar ($M_{collaboration}$ = 11.23%, $t(19) = 3.099$, $p < 0.005$, $r = 0.579$; $M_{neutral}$ = 5.14%, $t(19) = 1.759$, $p = 0.095$, $r = 0.374$; $M_{competition}$ = 4.62%, $t(19) = 1.602$, $p = 0.126$, $r = 0.344$). In contrast, when presented with men as targets, only in the Competition and Neutral conditions did infants significantly increase their looking time at the novel exemplar ($M_{collaboration}$ = 0.71%, $t(19) = 0.198$, $p = 0.845$, $r = 0.045$; $M_{neutral}$ = 7.99%, $t(19) = 2.667$, $p < 0.05$, $r = 0.521$; $M_{competition}$ = 13.64%, $t(19) = 3.483$, $p < 0.005$, $r = 0.624$). In other words, although even in a Neutral condition infants had some success at categorization (especially of men), clearly the effect sizes for their categorization performances in the theoretically central conditions (women & collaboration, men & competition) were the highest.

We conducted a further analysis in order to assess the potential direction of the effect of the motivational primes. In particular, we were interested in assessing whether the theoretically consistent motivational conditions (i.e., women & collaboration; men & competition) increased infants' default categorization capacity, and/or whether the inconsistent ones (i.e., women & competition; men & collaboration) decreased this capacity. To this end, we combined the two Consistent and the two Inconsistent conditions, and ran an analysis comparing them to the Neutral conditions. An ANOVA with this new condition variable (consistent, neutral, inconsistent; $n = 40$ per condition) revealed a main effect of condition, $F(2,117) = 4.401$, $p < 0.05$, $\eta^2 = 0.070$. LSD post hoc comparisons revealed that the effect derived from the change scores in the Consistent conditions being significantly higher than those in the Inconsistent ($p < 0.005$). The former was also close to being different from that in the Neutral conditions ($p = 0.07$). The scores in the Inconsistent and Neutral conditions were not significantly different ($p = 0.242$).

In a final parametric analysis, we looked at whether there were any general differences in infants' capacity to categorize women and men in the Neutral condition only. A two-tailed independent-samples *t*-test revealed no significant effect of targets' gender, $t(38) = 0.681$, $p = 0.5$, $r = 0.109$, indicating that without the motivational primes, infants were equally competent at categorizing women and men.

Lastly, we conducted non-parametric tests in order to assess whether the main interaction described above was not due to a few extreme participants. For these tests, we classified infants as “categorizers” and “non-categorizers” based respectively on whether or not their change score was positive. We found that the number of categorizers in the women & collaboration (16 of 20; $\chi^2 = 7.2$, $p < 0.01$) and the men & competition (15 of 20, $\chi^2 = 5.0$, $p < 0.05$) conditions, were significantly different from chance distribution, but this was not the case in the complementary motivational conditions. In the Neutral conditions, no differences were found in terms of categorizers' distribution regarding women and men as targets ($\chi^2 = 1.9$, $p = 0.168$), therefore we collapsed the two groups. We found that the number of categorizers in the Neutral conditions was significantly different from chance distribution (28 of 40, $\chi^2 = 6.4$, $p < 0.05$).

Taken together, these findings indicate that infants' social categorization is affected by social motivations. In particular, a collaborative prime substantially facilitated infants' tendency to look at women from an unfamiliarized category, and a competitive prime substantially facilitated infants' tendency to look at men from an unfamiliarized category. An alternative interpretation of these findings is that the results do not indicate anything specific to *social* categorization per se, but rather that following these motivational primes infants would be better at categorizing stimuli from *any* domain. If that is the case, then the priming videos might have similar effects on infants' categorization of non-social stimuli. Experiment 2 assessed this alternative hypothesis.

4. Experiment 2: Animal categorization

In Experiment 2, infants were primed with the same two motivational primes used in Experiment 1 (Collaboration and Competition), except that here these were followed by an animal (horses or cows) categorization task.

4.1. Method

4.1.1. Participants

Families' background, recruitment process, testing conditions, rewards for participation, and ethical precautions were as in Experiment 1. Infants in Experiment 2 were tested simultaneously to those tested in Experiment 1, based on random assignment to experiment and condition. Twenty-four healthy 14-month-olds (15 girls; mean age = 14.0 months; range = 12.3 months to 16.1 months) participated in Experiment 2. Seven additional infants were excluded due to fussiness.

4.1.2. Design

Twelve infants were randomly assigned to each one of two conditions: Collaboration or Competition prime. This sample size and data-collection stopping rule were determined based on previous infant studies in the field (e.g., Anzures et al., 2010; Damon et al., 2016; Quinn et al., 2016), which assigned between nine to twenty participants to each condition. In Experiment 2 we decided on the lower end of this spectrum given that in this experiment we assessed infants' categorization in a domain in which these capacities have been extensively studied (e.g., Balaban & Waxman, 1997; Ferry et al., 2010; Fulkerson & Waxman, 2007).

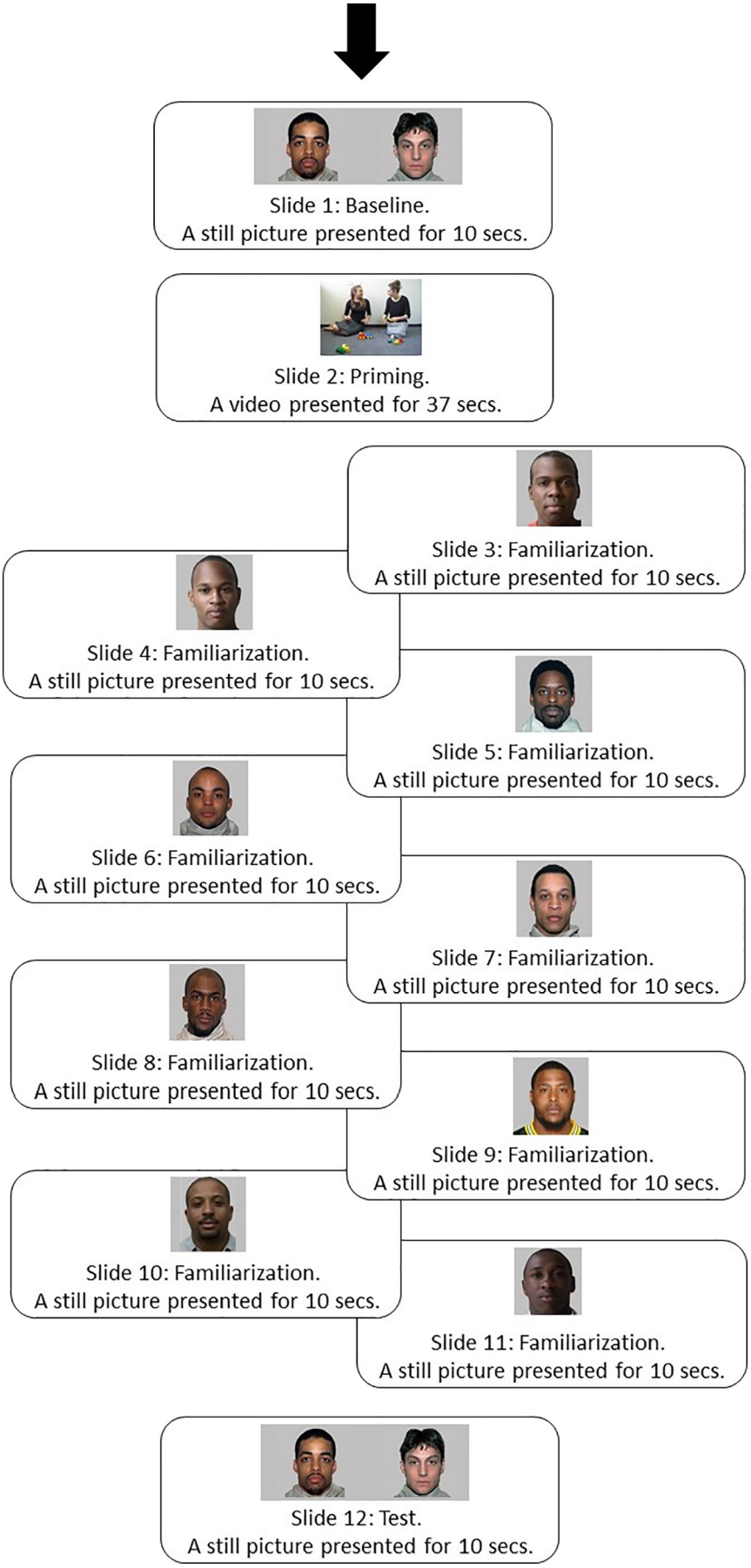

Fig. 3. Sequence of stimuli infants were presented with in Experiments 1–2 (an example of Men as targets, familiarized to Black, Collaboration prime condition).

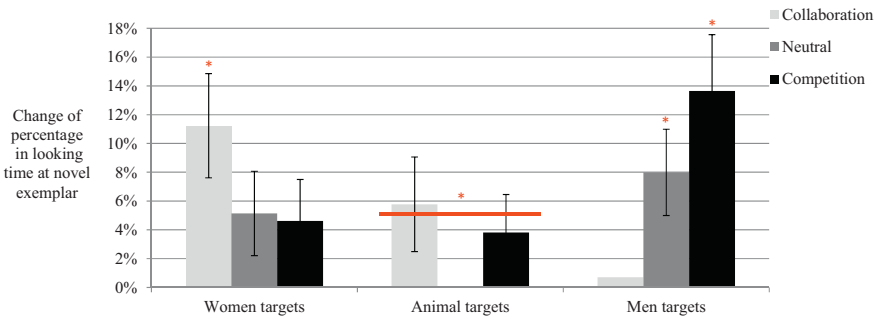

Fig. 4. Results of Experiments 1–2. Mean change in percentage of looking time at the novel exemplar from baseline trial to test trial across experiments. *Note.* *Comparison against no-change (i.e., zero), $p < 0.05$; for Animal targets the significant difference from no-change is across both conditions; Bars represent standard error of means. Data from Experiment 1: Collaboration, Neutral, and Competition conditions for Women and Men as targets. Data from Experiment 2: Collaboration and Competition conditions for Animal targets.

4.1.3. Materials and procedure

Priming videos, the structure of the categorization task, and the procedure (including labeling) were all identical to Experiment 1. The only difference between the experiments was that instead of pictures of people, in Experiment 2 infants saw pictures of animals (horses and cows). Half of the infants were familiarized to horses and the others to cows (see Fig. 1).

4.2. Results

First, a two-tailed independent-samples *t*-test revealed no significant effect of priming condition, $t(22) = 0.466$, $p = 0.646$, $r = 0.098$ (see Fig. 4), and there were also no differences between conditions in terms of categorizers' distribution ($\chi^2 = 0.178$, $p = 0.673$). These results indicate that the motivations did not affect infants' categorization of non-social stimuli. To assess the robustness of this result, we performed a bootstrap analysis, which revealed that the resulting mean difference between the two conditions fell well within the C.I. of the bootstrap analysis (see Supplementary material). Second, across conditions, the change in the percentage of looking time at the novel exemplar was significantly *larger* than zero ($M = 4.79\%$, $t(23) = 2.315$, $p < 0.05$, $r = 0.434$), indicating that infants evinced categorization of animals. This finding is consistent with previous work showing that infants' animal categorization capacity is well established by this age (Balaban & Waxman, 1997; Ferry et al., 2010; Fulkerson & Waxman, 2007). Third and finally, infants' performance in the animal conditions was not different from infants' performance in the neutral social conditions of Experiment 1, $t(62) = 0.321$, $p = 0.573$, $r = 0.040$), but was significantly worse than infants' performance in the "consistent" social conditions of Experiment 1 ($p < 0.05$, LSD post-hoc). In other words, when motivations were aligned with people's gender, infants became especially proficient categorizers.

5. General discussion

Various mechanisms have been proposed as potentially driving adults' intergroup cognition; e.g., the centrality of groups to people's identity (Tajfel, 1982), beliefs about the social system (Jost et al., 2004), or one's status within dominance hierarchies (Sidanius & Pratto, 2001). The present experiments reveal that already by 1-year of age – arguably an age at which the above mechanisms have not yet fully matured – infants' social categorization is affected by collaborative and competitive motivations, suggesting that such basic motivations might be involved in the emergence of children's representation of social group categories. Two additional findings are important for the full interpretation of the results. First, the effects of the collaborative and competitive primes were specific to the categorization of people, not of animals. Second, the effects varied according to the sex of the target people being categorized, with collaboration facilitating racial categorization of women, and competition that of men.

This overall pattern of findings is consistent with the notion that humans' processing of group information is driven by cognitive adaptations that provided fitness advantages in light of social situations recurrent in ancestral conditions. Namely, recurrent situations of conflict – in which males were predominant – and recurrent situations of affiliation – in which females were predominant (Benenson, 2014; Geary, 2010; McDonald et al., 2012; Taylor et al., 2000). These regularities arguably provided selection pressures for the emergence of cognitive adaptations specific to social categorization. Specifically, a pull towards identifying the group membership of men when involved in a conflictive situation, and that of women when involved in an affiliative situation. As described by Tooby and Cosmides (1990), once the situation triggered the pertinent cognitive adaptation, it led to the engagement of other cognitive mechanisms that boosted the overall fitness outcome. In the present case, for instance, it engaged infants' "perceptual systems" by focusing them on people's features, it directed infants' "attention" towards common features across the target stimuli, and it shaped infants' "information-gathering motivations" by driving them to compute the similarities and differences across targets.

The above description of the process via which the situations of competition and collaboration shaped infants' processing of the stimuli highlights the complexity of the processes involved in categorization. For instance, it was not simply the case that these motivations increased infants' overall attention to particular faces. First, in principle, an overall increase in attention to the faces would not have necessarily boosted infants' looking at the novel face at test. This is so because the increase in attention to the familiarization faces could have led infants to detect the *individuating* features of the faces, rather than their *common* features – in which case, there would be no reason for the novel test face to be especially salient. In other words, under the critical conditions of women & collaboration and men & competition, infants' attention was *selectively* directed to certain kinds of features. Moreover, even when attention was directed to certain kinds of features, *computations* had to operate to assess the degrees of similarity and difference between the features of the faces. Finally, de facto, at least one of our findings indeed indicates that sheer amount of attention was not conducive to better categorization performance. Namely, as reported in the Supplementary material, during familiarization infants looked significantly longer at the faces of women than those of men; yet, as reported in the Results section, there was no overall difference in infants' racial categorization of women vs. men. In sum, the competition and collaboration primes drove the deployment of a series of cognitive processes, which combined allowed infants to detect similarities across faces, thus forming rough representations of racial groups.

Note that these general processes engaging perception, attention, and computation, are likely not specialized for the formation of *social* categories. Rather, they are also involved in the formation of categories in other domains (see for instance, Quinn, 2011). In other words, it might be the case that these processes are not modular components of an adaptation designed to pick out social groups in situations of conflict and affiliation. Having said that, it might also be the case that the cognitive adaptations that constitute our coalitional psychology involve unique parameters, specifically regarding the range of social categories governed by these adaptations. In particular, on the one hand, infants'

social group concepts and intergroup biases have been manifested with respect to arbitrary categories (e.g., food-preferences, Mahajan & Wynn, 2012; Powell & Spelke, 2013), and up to 19-months of age, infants are similarly capable of representing categories based on conventional (e.g., race) as well as arbitrary (e.g., shirt-color) group-markers (Diesendruck & Deblinger-Tangi, 2014). On the other hand, a coalitional psychology account predicts that the adaptations would have been selected for privileging certain dimensions of human variability that had ecological and fitness relevance in ancestral times (e.g., gender, age, and possibly accent, see Pietraszewski et al., 2014; Pietraszewski & Schwartz, 2014, for a discussion). Future studies could address these alternative possibilities by investigating the impact of the different motivational primes on the formation of a variety of social categories.

Our interpretation thus far, is that by showing that already by 1-year of age, human infants' attention to the common features of men and women is variably directed by distinct motivations, the studies support an adaptationist account of such a linkage. Importantly, this postulation could be falsifiable, for instance, if the correspondence of these social motivations to the categorization of men and women by racial groups would have been acquired by infants via their cultural experiences in their modern ecologies. Evidently, such an account could explain previous findings with adults, showing linkages between women as caregivers and men as warriors (Hess et al., 2009; Maner & Miller, 2013; Palgi, Klein, & Shamay-Tsoory, 2015). And there are examples in the infant social cognition literature of the tenability of such an account (see Lee, Quinn, & Pascalis, 2017, for a review). For instance, infants' preference for looking at female over male faces seems to derive from the fact that infants' primary caregivers tend to be women – the preference is reversed for those primarily tendered by men (Quinn et al., 2002). Similarly, infants' preference for looking at White vs. Black people is a function of the relative frequencies of White and Black people in their ecologies (Bar-Haim, Ziv, Lamy, & Hodes, 2006). In other words, certain socio-cognitive biases found in young infants seem to be the product of their capacities to detect regularities in their upbringing social environment, not a priori manifestations of presumed innate predispositions.

Nevertheless, we believe that such an experience-based account is unlikely to explain the present findings. As just noted, by detecting a regularity that women tend to be their primary caregivers, infants could develop the expectation that women are better targets of affiliation or collaboration. However, it is unclear how such expectation would then affect infants' *racial categorization* of women. Moreover, such an experience-based account would be hard-pressed to explain the findings regarding the impact of conflict on infants' racial categorization of men, as it is unlikely that by 1-year-old infants encounter many instances of men in conflict.

One important question the above conclusion raises is why would such gendered group cognitions be already manifest in 1-year-old infants? Given that they are not actively involved in inter-group interactions, why would such biased cognitive machinery manifest at this young age? We offer two speculative answers to this question. The first answer derives from a life history perspective, according to which an ability will emerge when it becomes relevant to the behavior for which it was selected, and given that the benefits out-score the costs. Drawing an analogy from another aspect of social cognition – namely, moral evaluations (Sheskin, Chevallier, Lambert, & Baumard, 2014) – we posit that an infant's ability to correctly categorize a person is, a) not so costly, because it only requires observation and no manifest behavior, and b) highly beneficial both for the long run – identifying who one should affiliate with or avoid in future interactions – and the short run – directing one's attention to interact with collaborative partners. A second, related, answer stems from the idea that infants have to be ready for potential intergroup encounters, not as agents but as patients. Infants need to be capable of recognizing whether an approaching adult is someone to be trusted or to be avoided, and group membership is a strong cue for these decisions. Both of these reasons may partly explain why we found no effects of infants' own sex in their categorization performance. Namely, what is critical for infants is how to *respond* to encounters with men or women of theirs, or another group – not how to *initiate* such encounters.

A potential methodological concern regarding our interpretation is that the effects obtained in the present studies might have been due to the particular social group used as primes (i.e., White women). For instance, it could be that priming infants with men collaborating or competing, or even a-gendered characters (e.g., puppets), would differently affect infants' categorization ability. Indeed, future research could explore these possibilities. Nonetheless, we believe a number of findings argue against this possibility. First, Anzures et al. (2012) showed that using women as video primes similarly affected infants' recognition ability of both women and men targets. Second, recall that in the current study there was no main effect of targets' gender on infants' categorization performance. In other words, being primed with women, did not enhance infants' racial categorization of women relative to men. Third, although infants exhibited longer looking time at women as targets during familiarization (see analysis in Supplementary material), this effect did not interact with the priming conditions. That is, it was not the case that a collaborative prime involving women drew infants' attention to the stimuli more than a competitive prime involving women, and yet infants' categorization performance in these two conditions was significantly different. Finally, the fact that we found an *interaction* between priming condition and targets' gender on infants' categorization performance cannot be explained by the specific social group used in the primes. After all, what needs to be explained is why seeing women from their familiar social group collaborating, enhanced infants' racial categorization of women, but not of men; and seeing women from their familiar social group competing, enhanced infants' racial categorization of men, but not of women.

To end on a practical note, the conclusion that motivations impact social categorization from early in development may carry significant implications. Much attention has been devoted to means for remedying group-based discriminatory attitudes and behaviors – most of it, based on the social psychological accounts of the underlying causes of these phenomena (e.g., Gonzalez, Steele, & Baron, 2017; Lai et al., 2014). At a minimum, the present findings offer a further remedy to that catalogue. More promisingly, the proposed remedy may be especially effective. It may not be trivial to change children's – and certainly adults' – perceptions of status-differences in their social system, or the importance of group membership to their identity. However, re-defining and/or highlighting coalitional alliances may be an easier intervention objective, and one that can start being targeted very early on in life.

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Author contributions

M. Ferera, A. S. Baron, and G. Diesendruck conceived the initial idea. M. Ferera and G. Diesendruck designed the experiments. M. Ferera was in charge of running and coding all experiments. M. Ferera and G. Diesendruck analyzed the data, and wrote the paper together. A. S. Baron commented on drafts of the paper. All authors approved the final version of the manuscript for submission.

Data availability

The data associated with this research are available at [https://faculty.biu.ac.il/~dieseng/publications.html].

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