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The choice is yours: Infants' expectations about an agent's future behavior based on taking and receiving actions

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Abstract

Our social world is rich with information about other people's choices, which subsequently inform our inferences about their future behavior. For individuals socialized within the American cultural context, which places a high value on autonomy and independence, outcomes that are the result of an agent's own choices may hold more predictive value than similar outcomes that are the result of another person's choices. Across two experiments we test the ontogeny of this phenomenon; that is, whether infants are sensitive to the causal history associated with an agent's acquisition of an object. We demonstrate that on average, 12.5-month-old American infants view taking actions as a better indication of an agent's future behavior than are receiving actions. Furthermore, there were significant individual differences in the extent to which infants perceived object receipt to be indicative of future behavior. Specifically, the less autonomous infants were perceived to be (by their parents), socialized to be, and behaved, the more they viewed object receipt as indicative of future behavior. The results are discussed in terms of the role of individual and cultural experience in early understanding of intentional action.

Keywords

Choice; Action Prediction; Individual Differences; Causal History

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> The line which separates a witness from an actor is a very thin line indeed; nevertheless, the line is real.
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> -James Baldwin

Imagine seeing your friend with a new car—a red sedan, for example. If you knew that she went to the dealership and chose the features of the car herself, you might infer that her car choice is a reflection of her underlying preference, say, for a particular make and model, or even a particular color. Understanding her behavior in this way allows you to not only explain her current choices, but also to predict her future choices; for example, that in a similar situation in the future she would likely choose the same car. But what if someone else chose the car specifics and she subsequently received the car after winning a raffle? In this case, you would certainly not explain the event as a preference-based choice, and consequently you would be reluctant to infer that she would choose the same car in the future. As the quote above suggests, although these situations are similar (i.e., the end states are the same), they have different causes and thus different consequences for the types of inferences you are willing to make. In other words, actions that result from someone's own choices are more diagnostic of that individual's future behavior compared to actions that resulted from someone else's choices. The goal of the current work is to understand the developmental origins of these differential inferences.

Much research has shown that infants do indeed use information about an agent's choices to make predictions about her future behavior. As early as 5 months of age infants interpret an agent's reaching behavior as goal directed, and expect the agent to continue to pursue the same goal under slightly different circumstances (Woodward, 1998; for a review see Woodward, 2009). Further, infants expect continuous actions to conclude after an agent completes their intention, as opposed to the agent's motion stopping prior to the completion of the intention (Baldwin, Baird, Saylor, & Clark, 2001). Moreover, the objects and events surrounding the action matter a great deal. Specifically, infants expect an agent to continue to pursue or prefer the same object, only when the agent's initial behavior clearly reflected an intentional choice. For example, this intentional choice can be conveyed by the presence of a second object as unchosen an alternative (Luo & Baillargeon, 2005; 2007) or by a statistically non-random action (vs. one that could have occurred by chance; Kushnir, Xu, & Wellman, 2010; Wellman, Kushnir, Xu, & Brink, 2016). Finally, infants infer that one agent's choices are subjective, and thus not generalizable to another (Buresh & Woodward, 2007). In principle these studies suggest that infants track some aspects of the causal history associated with object acquisition; that is, infants seem to be able to track not only information about what object is acquired but also information about the context in which the object is acquired. Specifically, they recognize that both alternative possible actions and the identity of the agent matter when deciding whether an action is or is not likely to happen again in the future. Further, infants even use this casual history information to guide their own behavior towards individuals (Gerson, Bekkering, & Hunnius, 2017; Kushnir et al., 2010; Ma & Xu, 2011). However, it remains to be directly tested whether infants appreciate that outcomes that are initiated by agent's own choices, and outcomes that are directed at an agent as a result of someone else's choices, may hold differential meaning.

Though our intuition is that there is a clear difference between making a choice oneself and being the recipient of another person's choice, it is worth noting that this distinction may reflect a Western cultural bias. On average Western cultures, in particular U.S. culture, places high value on individuality, autonomy, and self-reliance (Keller, 2012; LeVine & Norman, 2001; Markus & Kitayama, 1991; Vignoles et al., 2016) compared to Eastern

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cultures. For example, people socialized in the American cultural context (henceforth referred to as Americans) endorse the idea that behaviors are guided by one's own preferences, goals, intentions and motives are distinct from behaviors affected by or defined by others or external influences (Ross & Nisbett, 1991). As such, Americans' choices align with their preferences, and are more consistent across contexts than they are for people socialized in Eastern cultural contexts, such as Japan (Wilken, Miyamoto, & Uchida, 2011). Furthermore, Americans report liking objects that they freely choose more than those they are given; whereas, this pattern is not found with Indian individuals (Savani, Markus, & Connor, 2008). Finally, choices made by (Iyengar & Lepper, 1999) and on behalf of (Miller, Das, & Chakravarthy, 2011) trusted others are viewed as distinct from personal choices for American children and adults, but viewed in line with personal choices for Eastern (Asian American, Indian) children and adults. Taken together this work suggests a critical link between choice and individualistic cultural values (Iyengar, 2010). More specifically, it suggests that for Americans, actions that result from an individual's personal choices are more diagnostic of that person's future behavior compared to actions that result from choices made for them by another individual.

Although there are differences in the extent to which people from different cultures place value on personal choice and individuality, there also exists considerable variability with U.S. society in the extent to which individuals adopt and reinforce these values (e.g., Markus & Conner, 2013; Vignoles et al., 2016). In particular, due to moderating factors such as personality and socialization, cultural values are not deterministic of individuals' own values, and behavior. Instead, cultural values function more probabilistically to make some behaviors and ways of thinking about the world more likely than others (see Bronfenbrenner, 1979; Markus & Connors, 2013; Markus & Kitayama, 2010).

Perhaps most germane to our developmental investigation, caregivers socialize children to behave in line with their values (Kärtner, Keller, Chaudhary, & Yovsi, 2012; Keller, 2013; LeVine & Norman, 2001), which reinforces both mean-level culture specific behaviors as well as within culture, individual differences. Specifically, parental beliefs about infants, their behavior, and the optimal end state, affects parents' interactions with their infants, which ultimately scaffolds infant behavior (Keller & Kärtner, 2013). Thus, parents who place high value on individual autonomy provide opportunities for their infants to behave on their own, as opposed to guiding or controlling their infant's behavior (Kärtner, 2015; Yovsi, Kärtner, Keller, & Lohaus, 2009). As a consequence, these socialization experiences may lead infants to view others' personal choices as more diagnostic of their goals and motivations.

In the current paper, we focus on infants' perceptions of two types of actions, *taking* actions (where outcomes are the result of personal choice and behavior) and *receiving* actions (where outcomes are the result of someone else's choice and behavior). We asked whether, on average, American infants, like American adults, tend to see taking actions as more strongly diagnostic of future personal choices than receiving actions, or, in contrast, whether they see taking and receiving actions as equally diagnostic. Furthermore, we explore individual differences in infant's inferences—specifically, the role that autonomous socialization, as measured by parental report and also parent behavior in a simple choice task, plays in shaping infant's inferences.

Critically, studies suggest that by 12 months of age, infants appear to understand some information about simple actions that involve the transfer of resources between individuals. For instance, by 12 months of age, infants have first hand experience with both taking and receiving/giving resources (Hay, 1979; Hay & Murray, 1982; Rheingold, Hay, & West, 1976). In addition to direct experience with taking and receiving/giving, recent evidence suggests that infants appear to have expectations about giving and receiving behavior based on accompanying hand gestures: after seeing, "give-me" gestures (i.e., a cupped hand) infants expect the gesturer to receive resources, but not when infants see a similar, but inverted, cupped hand gesture (Elsner, Bakker, Rohlfing, & Gredebäck, 2014). Further, there is evidence that when watching third party interactions, infants understand the roles of giver and taker. Specifically, if Agent A gives an object to Agent B, infants expect Agent A to continue to give objects to Agent B, as opposed to subsequently taking objects from Agent B (and vice versa; Tatone, Geraci, & Csibra, 2014, Study 1). Together this suggests that 12-month-old infants are able to represent and attribute meaning to giving and taking events. Nonetheless, it is not yet clear whether infants of this age also view taking and receiving actions as differentially informative about an agent's future behavior.

The Current Experiments

The aim of the current experiments was two-fold. First, at a group level, we sought to investigate whether 12-month-old infants see taking and receiving actions as differentially informative for an agent's future behavior. As such, infants watched events in which two agents and objects were present during a habituation phase. In Experiment 1, one of the agents either took one of the two objects (*Taking* condition), or received one of the two objects (*Receiving* condition). The critical question of interest is how infants expect the agent to behave, when alone, on test trials when the objects appear in reversed locations. Past work (Woodward, 1998) suggests that after seeing an agent reach for an object, infants expect her to pursue that same object even if it is in a new location (as evidenced by enhanced attention to events in which she pursued the new object). Thus, we predicted that infants in the *Taking* condition would expect the agent to continue to choose the same object (as evidenced by enhanced attention to events in which she pursued the new object), even though its location had changed. If infants, like adults, see receiving actions as less diagnostic of future object selections than taking actions, then we expected that infants in *Receiving* condition would either have no expectation that the agent would pursue the same object (as evidenced by equal attention to events in which she pursued the new and old object), or have a weaker expectation relative to infants in the *Taking* condition.

Experiment 2 was designed to investigate whether task demands could account for any potential differential results between conditions in Experiment 1. Specifically, infants in Experiment 2 witnessed an agent take one of two objects while the other agent observed. Then on test trials, the agent either received, from the observer, the previously taken object, or the other object. Positive findings in this condition would demonstrate that any failures in the receiving condition of Experiment 1 were not merely due to a difficulty or inability for infants to use information from one action sequence to make predictions about another, distinct action sequence.

Our second aim was to investigate individual differences in how infants perceived receiving actions as informative for predicting future behavior. Although on average Americans place high value on individual choice, there is considerable variability across individuals. Thus, we hypothesized that parental perception of infants' autonomy and scaffolding of infant choice-making, and infants own choice behavior would be related to infant's predictions about future behavior based on object receipt. Specifically, lower parental perceptions of infants' autonomy, and more scaffolding of infants' choice-making, would be associated with greater perceived diagnosticity of receiving actions.

Experiment 1

The goal of Experiment 1 was to explore infants' expectations about other's future behavior based on taking and receiving actions. We predicted that taking actions would serve as a strong predictor of an agent's future behavior, whereas on average, receiving actions would be a weaker predictor, if at all. Further, we hypothesized that there would be individual differences in perceptions of receiving actions, which would be uniquely captured by parental perceptions of infants' autonomy and scaffolding of infants' choice-making, as well as infant's own choice behavior.

Methods

Participants—Thirty-two infants, equally distributed across condition, participated in Experiment 1 (19 girls; M_{age}= 12 months, 17 days; Range: 12 months, 8 days to 13 months, 2 days). Of these infants, 25 were identified as Caucasian, 2 as Asian, 2 as Mixed Race, 2 as Hispanic, and 1 as Black. This sample size gave us the ability to detect large-sized effects (d = .75 and $|r|$ = .64) within each condition (for both Experiment 1 and 2), and a large-sized effect comparing the results of each condition ($\eta^2_{partial}$ = .12) with 80% power (Faul, Erdfelder, Lang, & Buchner, 2007). All infants were full term and typically developing. Participants were recruited from a database of parents who volunteered to participate in research at a large research institution in the Pacific Northwest. An additional 10 subjects were run, but excluded because they did not habituate (n_{taking} = 5; $n_{receiving}$ = 3), fussed out (n_{taking} = 1), or met our looking time exclusion criterion[1] (n_{taking} = 1). All studies in this manuscript received approval from University of Washington's Institutional Review Board (protocol number: 40481; name: Infants' Understanding of Social Interactions) and participants were treated in accordance to the approved protocol.

Procedure—Infants were sequentially assigned to the taking condition and the receiving condition. In other words, infants were not assigned to the receiving condition until the taking condition was completed. We first ran the taking condition, because had infants not

[1]The following looking time exclusion criterion was applied to all experiments. We totaled infants looking during all test trials, during only the new toy test trials, and during only the old toy test trials. If an infant's looking was more than 3 SD above the average on 2 or more of these indices they were excluded.

seen taking as an indication of future behavior, there would be significant trouble in interpreting the results of the receiving condition.

Habituation Paradigm

Habituation phase: Participants habituated to a short video of two women seated next to each other, facing forward (towards the infant) at a table. Centered between the women was a white plate, with two toys (a duck and a car).

Taking condition: During the video, infants in the taking condition saw one agent (henceforth referred to as: the Taker) reach towards and take one of the toys from the plate, hold it in front of her and smile, while the other agent (henceforth referred to as: the Observer) watched (and maintained a slightly positive, smiling facial expression). This action sequence lasted approximately 7 seconds. The video froze on a static image of the Taker smiling at the toy (see Figure 1).

Receiving condition: During the video, infants in the receiving condition saw one agent (henceforth referred to as: the Giver) reach towards and select one of the toys from the plate. The Giver then handed the toy to the other agent (henceforth referred to as: the Receiver). The Receiver then held the toy in front of her and smiled, while the Giver watched (and maintained a slightly positive, smiling facial expression). This action sequence lasted approximately 7 seconds. The video froze on a static image of the Receiver holding and smiling at the toy (see Figure 1).

Across both conditions the only difference in the habituation phase was how the individual acquired the toy (in the Taking condition the target agent took the toy themselves, whereas in the Receiving condition the target agent was given the toy). The final static image of the video was the identical across experiments.

Infants' looking time to the static image (of the Taker or Receiver, depending on condition, smiling at the toy in their hands) was measured until the infant looked away for 2 consecutive seconds. Infants viewed this short video repeatedly until they met the habituation criterion (when looking on 3 consecutive trials summed to less than 50% of looking on the first three habituation trials) or once a maximum of 14 habituation trials occurred.

Test phase: The test phase for infants in both conditions was identical.

Preview trial: After habituation, infants saw a still image of only the toys (the car and the duck) centered on the table on the white plate. The locations of the toys had switched sides from the habituation phase (e.g., if the duck was on the left during habituation it was now on the right). Infants' looking to the still image was measured until the infant looked away for 2 consecutive seconds.

Test trials: Infants then viewed a total of 6 test trials[2] in alternating order—three in which the same toy from habituation was selected (old toy test trials) and three in which the toy that was not selected during habituation was selected (new toy test trials). In both the new toy and old toy test trials, only the Taker/Receiver from the habituation phase was present; the Observer/Giver was not.

In the old toy test trials, the Taker (in the *Taking* condition) or the Receiver (in the *Receiving* condition) reached for the toy she previously acquired (i.e., took or received, respectively) during the habituation phase (which was in a new location), picked it up, and smiled at it. During the new toy test trials, the Taker (in the *Taking* condition) or the Receiver (in the *Receiving* condition) reached for the toy she had not previously acquired in the habituation phase, picked it up, and smiled at it (see Figure 1). Importantly, across both new toy and old toy test trials, the action itself was the same—reaching and taking an object—only the object that was acted on differed across trials.

Both the taking and receiving actions were a fluid, continuous, and uninterrupted sequence of events that lasted approximately 7 seconds. For each test trial (regardless of condition), the video froze once the Taker/Receiver held and smiled at the selected toy. As in habituation, infants' looking to the static images was measured until the infant looked away for 2 consecutive seconds. The toy chosen during habituation (duck or car), toy locations during habituation (right or left; and thus the toy locations during test—left or right), order of test trials (new toy or old toy test trials first), and the identity of the Taker/Receiver (and thus the Observer/Giver) were counterbalanced across infants.

Coding: The online coder, and an independent offline coder (who used video recordings) coded from another room infants' looking to the static freeze frame images shown during the habituation phase and test phase using a computer-based program (JHab; Casstevens, 2007). Both coders were unaware of the local factors of the stimuli (i.e., the identity of the agents, toy location, toy being selected) and the order of the test trials. Looking times from the online and offline coder were highly correlated in both conditions (taking condition: $r(234) = .99$, $p < .001$; receiving condition: $r(238) = .99$, $p < .001$). All subsequent analyses use the online coder's looking times, yet all results remain unchanged if using the reliability coder's data.

Individual Difference Measures

Toy choice task: Following all studies within our lab, infants are given a token of appreciation for participation. Given the relation between individualistic values and choice behavior (Iyengar, 2010; Savani et al., 2008; Wilken et al., 2010), we leveraged this aspect of our lab context to non-obtrusively measure infants' choice behavior and parental scaffolding of their choices. After the test phase of the experiment (purportedly after the study had concluded), infants were given the chance to pick a toy from a bowl. The experimenter held a bowl of toys in front of the infant and said they could have one as a prize to take home with them for participating in the study. This task was video recorded. A primary coder, unaware of infants' assigned condition, and hypotheses, coded from the video how long it took infants' to take a toy, and the number of verbal prompts that infants' were given by their parents[3]. A secondary coder, also blind to hypotheses and infants'

[2]In the taking condition, one infant only received 2 pairs of test trials, and one infant only received 1 pair of test trials before becoming too fussy to continue. All infants in the receiving condition received all 3 test trial pairs.

assigned condition, independently coded from video these variables. Infants' latency to take a toy was measured from the time the bowl of toys was held in front of the infants to the time when the infant or parent removed the final toy from the bowl. Parental prompts were coded as any verbal cue to the infant to choose a toy (e.g., "do you want one?"). Latencies from both coders were highly correlated in both conditions (Taking condition: $r(14) = 1.00$, $p < .001$; Receiving condition: $r(14) = .94$, $p < .001$), as were the number of parental prompts (Taking condition: $r(14) = .89$, $p < .001$; Receiving condition: $r(14) = .84$, $p < .001$). All subsequent analyses use the primary coder's data, yet all results remain unchanged if using the reliability coder's data.

Shorter latencies to choose a toy indicate more individual choices, and fewer parental prompts also indicate more support for their infants' individual choice, such that infant's own behavior was more self-guided as opposed to other-guided.

Further, to provide evidence of divergent validity between our measures of infants' choice behavior and parent scaffolding of choices, we also coded an aspect of infant temperament, shyness. This was done to ensure that parent and infant behaviors during the choice task were not solely driven by temperamental differences between infants. A primary coder, unaware of infants' condition and hypotheses, coded infants for actions indicative of shyness (e.g., leaning into the parent, or avoiding looking at the experimenter; Schmidt & Sommerville, 2011; Ziv & Sommerville, 2016), and gave a 1 (not shy at all) to 7 (very shy) Likert scale rating of the infants' behavior during the task[4]. A secondary coder also independently coded these behaviors and made a rating. Ratings from each coder were significantly correlated (Taking condition: $r(13) = .62$, $p = .017$; Receiving condition: $r(12) = .83$, $p < .001$). All subsequent analyses use the primary coder's data, yet all results remain unchanged if using the reliability coder's data.

Parental questionnaire: Before entering the testing room, participants' parents filled out the Infant Intentionality Interview Questions (Feldman & Reznick, 1996) that measured parents' views of their infants' perceptions of their own Self-Efficacy (e.g., When your infant reaches for a toy does it seem to you that he intends to get the toy?), Efficacy of Others (e.g., When your infant smiles, is it because he wants you to do something for him?), Awareness of Own States (e.g., Do you think your infant can feel joy?), Awareness of Others' States (e.g., Do you think your infant is aware of whether or not you had a bad day?). All responses were on a four-point Likert scale ranging from 1 (Definitely Not) to 4 (Definitely Yes).

Although parents took the entire Infant Intentionality Questionnaire, we focused on the Self-Efficacy subscale as a metric of parental perception of infant autonomy. In particular, this subscale primarily focused on whether parents perceive their infants as active agents, who intentionally seek to have their needs and wants met. Higher scores on this scale indicate greater parental perception of infant autonomy.

[3]We would like to thank reviewer 2 for a helpful suggestion to investigate whether there were differences in the types of prompts given (i.e., whether prompts were autonomy supporting, or controlling). Unfortunately, there was little variation in the content of parental prompts. Over 90% could be considered autonomy supporting. However, this is an interesting possibility for future research to consider.

[4]One infant in the *Taking* condition and 3 in the *Receiving* condition of Experiment 1 were not able to be coded for shyness due to the camera angle of the video. Therefore, the final sample in coded for each condition is as follows: $N_{taking} = 14$ and $N_{receiving} = 13$.

Results

Habituation Paradigm

Habituation phase: On average, infants took 7.97 trials to habituate (min = 6; max = 12; *SE* = .45), and this did not differ across conditions, $t(30) = .07$, $p = .946$, $d = .02$. There was a significant decrease in infants' mean looking time during the first three habituation outcomes ($M = 14.22$ seconds, $SE = 1.11$) compared to their mean looking to the last 3 habituation outcomes ($M = 5.45$ seconds, $SE = .42$), paired samples $t(31) = 10.82$, $p < .001$, $d = 1.91$, 95% CI of difference [7.12, 10.42]. For graphs of the habituation curves see Figure 2, Panel A and Panel B.

Preview Trial: On average, infants looked for 10.40 seconds to the preview trial ($SE = .88$), and this did not differ across conditions, $t(30) = .40$, $p = .695$, $d = .15$.

Test Phase: Of central interest was infants' average looking to the new toy test trials compared to their average looking to the old toy test trials as a function of condition. We predicted that infants in the *Taking* condition would look longer to the new toy test trials compared to the old toy test trials; whereas for infants in the *Receiving* condition, the difference in looking to the new toy and old toy test trials would be smaller, or non-significant. To investigate this question, we conducted a 2 (Condition: *Taking* vs. *Receiving*) × 2 (Test trial type: New Toy vs. Old Toy) Mixed Model Analysis of Variance (ANOVA), with the last factor within-subjects. There was a non-significant main effect of condition ($F(1, 30) = .71$, $p = .406$, $\eta^2 = .023$), and a significant main effect of Test trial type, $F(1, 30) = 19.69$, $p < .001$, $\eta^2 = .396$. Critically, however, there was a significant interaction between test trial type and condition, suggesting that indeed infant's pattern of looking in the *Taking* and *Receiving* conditions significantly differed, $F(1, 30) = 6.77$, $p = .014$, $\eta^2 = .184$.

Follow-up analyses revealed that, as expected, infants in the *Taking* condition looked significantly longer to the new toy test trials ($M = 8.95$, $SE = .61$), compared to the old toy test trials ($M = 5.40$, $SE = .73$), paired samples $t(15) = 5.52$, $p < .001$, $d = 1.38$, 95% CI of difference [2.18, 4.92] (see Figure 3 for condition averages, and Figure 4 for the results of each test trial pair). However, in the *Receiving* condition, infants' average looking to the new toy test trials ($M = 8.66$, $SE = 1.17$) compared to their average looking to the old toy test trials ($M = 7.73$, $SE = 1.07$) did not significantly differ, paired samples $t(15) = 1.19$, $p = .252$, $d = .30$, 95% CI of difference [-.73, 2.58] (see Figure 3 for condition averages, and Figure 4 for the results of each test trial pair).

To further investigate whether the pattern of results found in the *Taking* and *Receiving* conditions were driven by a subset of infants, we conducted the non-parametric equivalent of a dependent samples t-test, the Wilcoxon Signed Rank test for each condition. Convergent with its parametric equivalent, this analysis revealed that in the *Taking* condition looking to new toy test trials (*Mdn* = 9.15) was significantly longer than looking to old toy test trials (*Mdn* = 4.56), $Z = 3.46$, $p = .001$, $r = .61$. Similarly, in the *Receiving* condition, looking to the new toy test trials (*Mdn* =7.56) did not significantly differ from looking to the old toy test trials (*Mdn* = 6.66), $Z = 1.14$, $p = .26$, $r = .20$.

Taken together, these results are consistent with our predictions, taking actions served as a better inferential basis for predicting future behavior, than did receiving actions.

Individual Differences—Thus far we demonstrated that on average infants viewed taking actions as indicative of agents' future behavior, whereas receiving actions were not. Our next goal was to investigate individual differences in infants' perceptions of taking and receiving actions as indicative of future behavior. We predicted that for infants in the *Receiving* condition, lower levels of autonomy would be associated with perceiving object receipt as indicative of future behavior. However, due to the high level of diagnosticity of taking actions, we predicted that autonomy would be unrelated to infants' perceptions in the *Taking* condition. One infant in the *Taking* condition was excluded from analyses for being 3.4 SD above the mean on time it took to choose a toy and 2.9 SD above the mean on the number of parental prompts given during the toy choice task.

As expected, there were no significant differences condition differences on any of the three individual difference measures: 1) amount of time it took infants to chose a toy, $t(29) = 1.93$, $p = .063$, $d = .70$; 2) number of parental prompts given during the toy choice task, $t(29) = 1.19$, $p = .243$, $d = .43$; and 3) parental perceptions of infants' self-efficacy, $t(29) = 1.49$, $p = .142$, $d = .53$. Most importantly, the three individual difference measures – parents' perception of infants' autonomy, infant choice-making behavior, and parents' scaffolding of infants' choice significantly correlated with each other (see Table 1). This suggests that these measures may index a similar underlying construct, what we are referring to as Infant Autonomy. Given this, we created a composite measure by z-scoring for each measure (recoded so that high z-scores indicated high levels of autonomy), and averaging these z-scores together.

To test the relation between Infant Autonomy and infants' looking time within each condition, we conducted simple bivariate correlations between the looking time difference score (average looking to new toy trials minus average looking to old toy test trials) and the composite measure of Infant Autonomy. We report the correlations for the composite measure of Infant Autonomy, as well as the three measures of choice-making and perceived autonomy that comprise the composite measure.

As predicted, Infant Autonomy significantly correlated with infants' looking in the *Receiving* condition. Specifically less Infant Autonomy was related to larger differences in looking to new versus old test trials, $r(14) = -.67$, $p = .005$. These results are consistent for each measure that comprises the composite. Specifically, the lower parents' perceptions of infant autonomy, the larger infants' difference in looking to new versus old test trials, ($r(14) = -.51$, $p = .043$); infants whose behavior was more scaffolded by parents (as indexed by more parent prompts to take a toy) had larger differences in looking to new versus old toy test trials ($r(14) = .68$, $p = .004$); and infants whose choice-making behavior was more autonomous (as signified through slower time to choose a toy), also had larger differences in looking to new versus old toy test trials, $r(14) = .53$, $p = .033$. See Figure 5 for scatterplots of results. Thus, taken together, these results indicate that the less autonomous infants behaved, or were perceived to be, the more they saw object receipt as indicative of the Receiver's future behavior; whereas the more autonomous infants behaved or were perceived to be, the less they saw object receipt as indicative of the Receiver's future behavior (see Figure 5).

To test whether these individual difference results could instead be explained by infants' temperament, as opposed to our measures of choice-making and perceived autonomy, we investigated how infants' shy behavior during the toy choice task related to their looking in each condition. There were no significant differences in infants' shy behavior across conditions (Fishers' exact tests all *p*s > .209), or in the extent to which infants were perceived to be shy, $t(25) = 1.12$, $p = .273$. Infants who were rated to be more shy had larger differences in looking to new versus old test trials in the *Receiving* condition, although this correlation failed to reach traditional levels of significance, $r(11) = .52$, $p = .067$. Furthermore, when controlling for infants' shyness, medium to large sized effects of Infant Autonomy on infants' looking in the *Receiving* condition remained (Autonomy composite: $r_{partial}(10) = -.55$, $p = .062$; Self-efficacy partial correlation: $r_{partial}(10) = -.35$, $p = .266$; Parental Prompts: $r_{partial}(10) = .55$, $p = .062$; Time to choose a toy: $r_{partial}(10) = .50$, $p = .098$). However, due to reduced power, the partial correlations did not reach traditional levels of significance across all measures.

The measures of choice-making, perceived autonomy, and shyness were not significantly related to infants' looking in the *Taking* condition, all $|r|$s <.32 and all *p*s > .24.

Discussion

Our findings from Experiment 1 suggest that after viewing an individual choose one toy as opposed to another, infants expected an agent to continue to select that toy in the future—and thus showed enhanced attention when she selected a new toy on test trials. However, infants did not expect the recipient to continue to pursue the object she was previously given. Even though the end state was the same across both conditions—an agent had a toy, and was happy about it—how the agent acquired the toy (either by taking it or by receiving it from another agent) significantly affected infants' perceptions of the event. Thus, by at least 12.5 months of age, on average, American infants see taking actions as providing a stronger inferential basis for predicting an agent's future behavior than receiving actions.

Moreover, although the results of this experiment demonstrate that taking serves as stronger inferential base than receiving, there are individual differences in the extent to which 12.5-month-old infants viewed receiving as an indication of an agent's future behavior. These individual differences were better captured by infants' choice-making behavior and parent-infant interactions during choice making, rather than to their temperament. Specifically, infants who behave less autonomously in making their own choices are more likely to view choices made by another person on behalf of an agent as indicative of an agent's future behavior, compared to infants who behave more autonomously.

Experiment 2

Thus far we have demonstrated that infants appear to use information about the causal history associated with an agent's object acquisition – specifically whether it is chosen by the agent or received by that agent based on the choice of another person – to predict that agent's future actions. However, one possible alternative explanation of our findings is that the task in the *Taking* condition was simply easier than the task in the *Receiving* condition. Whereas the *Taking* condition of Experiment 1 required infants to map together actions that closely resembled each other at a perceptual level (reaching for and taking objects during habituation, to reaching for and taking objects in new locations during test), the *Receiving* condition of Experiment 1 required infants to integrate two types of actions with different perceptual properties. Specifically, infants in the *Receiving* condition view two disparate actions and thus had to integrate information about one agent reaching for and giving an object to a recipient, with information about the recipient reaching and taking objects (in a new locations) themselves during test trials. Thus, one could argue that the task for infants in the *Receiving* condition was simply more difficult than the task for infants in the *Taking* condition. Put another way, it is possible that the differential findings across conditions in Experiment 1 were due to differences in task difficulty.

Experiment 2 was designed to investigate this possibility. Specifically, infants saw an agent take an object during habituation trials while another individual observed the choice being made. On test trials, the objects were in new locations and the Observer either gave the Taker (from habituation) the same object that was selected in habituation trials, or gave her the new object. In this case, the Observer is privy to information about the Taker's past behavior, and thus her subsequent giving action is informed by the same causal history as the *Taking* condition in Experiment 1 (i.e., the Taker's past behavior). If infants' inferences are based on this common causal history—the Taker's initial choices—then they may appreciate the relation between initial taking and final receiving actions and show enhanced attention to the new toy test events relative to the old toy test events. However, like the *Receiving* condition of Experiment 1, this task required infants to map together two superficially different actions – taking and receiving. Thus, if differences in task demands are responsible for the differential findings between conditions in Experiment 1 then the results of this experiment should also be non-significant.

Methods

Participants—Sixteen infants participated in Experiment 2 (9 girls; M_{age}= 12 months, 13 days). Of these infants, 10 were identified as Caucasian, 3 as Mixed Race, and 2 as Hispanic; one participant's race was not reported. An additional 5 subjects were run, but excluded because they did not habituate (n = 3), fussed out (n = 1), or met our exclusion criterion (n = 1).

Materials—The materials and apparatus were identical to those of Experiment 1.

Procedure

Habituation Paradigm: The same actors and props from Experiment 1 were used in the video recordings of Experiment 2.

Habituation phase: Participants were habituated to the same short videos as the habituation videos in the *Taking* condition of Experiment 1. Specifically, two agents (the Taker and Observer) were seated next to each other facing forward (towards the infant) at a table.

Centered between the agents was a white plate, with two toys (a duck and a car). During the video, infants saw the Taker reach towards and take one of the toys from the plate, hold it in front of her and smile, while the Observer watched (and maintained a slightly positive, smiling facial expression). This action sequence lasted approximately 7 seconds. The video froze on a static image of the Taker smiling at the toy (see Figure 1).

Infants' looking time to the static image was measured until the infant looked away for 2 consecutive seconds. Infants viewed this video repeatedly until they met the habituation criterion (when looking on 3 consecutive trials summed to less than 50% of looking on the first three habituation trials) or once a maximum of 14 habituation trials occurred.

Test phase

Preview trials: The preview trial was identical to Experiment 1. Specifically, after habituation, infants saw a still image of only the toys (the car and the duck) centered on the table on the white plate. The locations of the toys switched sides from the habituation phase (e.g., if the duck was on the left during habituation it was now on the right). Infants' looking to the still image was measured until the infant looked away for 2 consecutive seconds.

Test trials: During the test trials, infants viewed a total of six videos (three new toy trials and three old toy trials) in alternating order.

During the old toy test trials, the Observer reached towards the toy that the Taker selected during habituation (which was in a new location). The Observer then gave the toy to the Taker, who held, and smiled at the toy. During the new toy test trials, the Observer reached towards the toy that the Taker had not selected during habituation. The Observer then gave the toy to the Taker, who held, and smiled at the toy. These were the same videos as those shown during the habituation phase of the *Receiving* condition of Experiment 1. For each test trial, the video froze on the Taker holding and smiling at the selected toy and infants' looking to the freeze frames was measured until they looked away for 2 consecutive seconds (see Figure 1 for a schematic of the methods).

Coding: The online coder, and an independent offline coder (who used video recordings) coded from another room infants' looking to the static freeze frame images shown during the habituation phase and test phase using a computer-based program (JHab; Casstevens, 2007). Both coders were unaware of the local factors of the stimuli (i.e., the identity of the agents, toy location, toy being selected) and the order of the test trials. Looking times from the online and offline coder were highly correlated, $r(256) = .98$, $p < .001$. All subsequent analyses use the online coder's looking times, yet all results remain unchanged if using the reliability coder's data.

<u>Individual Differences:</u> For consistency we measured the same individual difference variables as in Experiment 1. However, we did not have expectations about the role of infant autonomy in this experiment given that infant autonomy is not a feature of our experimental outcome as it was in Experiment 1, and because the question of this experiment is how other agents will act towards a taker (vs. how a agent will act themselves in the future).

Results

Habituation Paradigm

Habituation phase: On average, infants took 9.19 trials to habituate (min = 6; max = 14; *SE* = .68). There was a significant decrease in infants' mean looking time during the first three habituation outcomes ($M = 14.99$ seconds, $SE = 1.65$) compared to their mean looking to the last three habituation outcomes ($M = 5.76$ seconds, $SE = .65$), paired samples $t(15) = 8.43$, $p < .001$, $d = 2.11$, 95% CI of difference [6.90, 11.56] (see Figure 2, Panel C) .

Preview Trial: On average, infants looked for 11.39 seconds to the preview trial ($SE = 1.38$).

Test Phase: Of central interest was infants' average looking to the new toy test trials compared to their average looking to the old toy test trials. We predicted that if infants inferences are indeed based on the casual history associated with object acquisition (and thus that they recognize that the final giving action should be based on the observer's knowledge of the initial taking actions) then infants would look longer to new toy as compared to old toy test trials. However, if infants have difficulty using information from one type of action to inform their expectations about another type of action then we expect they would not differentially attend to the new toy and the old toy test trials.

In line with the first possibility, infants looked significantly longer to the new toy test trials ($M = 11.40$, $SE = 1.52$), compared to the old toy test trials ($M = 7.82$, $SE = .99$), paired-samples $t(15) = 2.99$, $p = .009$, $d = .67$, 95% CI of difference [1.03, 6.13][5] (see Figure 3 for condition averages, and Figure 4 for the results of each test trial pair). In addition, the results of the dependent *t*-test converge with those of a nonparametric Wilcoxon Signed Ranks test. Specifically, looking to the new toy test trials ($Mdn = 10.33$ seconds) was significantly longer than looking to the old toy test trials ($Mdn = 7.42$ seconds), $Z = 2.12$, $p = .034$, $r = .37$.

Individual Differences—The measures of infant autonomy in Experiment 2 did not significantly differ from those in Experiment 1, all $|t| < 1.70$ and all *p*s > .096. The measures of infant autonomy were not significantly related to infants' looking, all $|r|$s <.18 and all *p*s > .54. Furthermore, infants' shyness was not significantly related to infants' looking, $r(12) = .44$, $p = .115$.

Discussion

The findings from Experiment 2 help to rule out one possible alternative explanation for the results of Experiment 1. Specifically, Experiment 2 demonstrates that infants are indeed able to use information from one action sequence to make subsequent predictions about another distinct action sequence. In other words, infants are able to conceptually link taking and receiving actions together, despite their perceptual differences. This suggests that task demands or difficulty (i.e., needing to link both taking and giving actions together) cannot completely account for the condition differences found in Experiment 1 cannot be due to

[5]The achieved power for Experiment 3 given the effect size of our results and our final sample size was 71% (Faul et al., 2007).

task demands or difficulty. This finding adds to a rich body of literature on the circumstances under which infants link events that are potentially conceptually related, yet perceptually distinct (e.g., Hespos & Piccin, 2009; Hespos & Spelke, 2004).

The assertion that task demands or difficulty cannot account for condition differences found in Experiment 1 aligns with the individual difference result of the *Taking* condition of Experiment 1. In particular, one could construe infant autonomy (i.e., acting on ones' own, without parental interference) as being more developmentally advanced. If this were the case then we would expect that autonomy would have been positively correlated with the looking time difference score in the taking condition of Experiment 1; however, infant autonomy was negatively correlated. Taken together, these results support the hypothesis that infants see receiving actions as providing a weaker inferential basis for predicting an agent's future actions.

In addition to this, the results of Experiment 2 provide insight into infants' perception of prosocial giving. Our findings demonstrate that infants form expectations, not only about an agent's own subsequent choices, but also about how other people will act towards that agent on the basis of her choices. This adds to a growing body of work on infants' expectations about the norms of social interactions. For example, they expect others to distribute resources equally (vs. unequally) between two people (e.g., Geraci & Surian, 2011; Meristo, Strid, & Surian, 2016; Schmidt & Sommerville, 2011; Sloane, Baillargeon, & Premack, 2012; Sommerville, Schmidt, Yun, & Burns, 2013; Ziv & Sommerville, 2016), they expect an individual to approach someone who previously helped rather than hindered them (Kuhlmeier, Wynn, & Bloom, 2003), and they expect individuals to ignore those who they witness intentionally harm another person (Choi & Luo, 2015). Our results both converge with and extend beyond these findings, in several ways. First, they suggest that in absence of a clear valence associated with an agent's prior actions (harm/hindering = negative valence; helping = positive valence), infants can, and do, form expectations about how people will subsequently act towards an agent when the person has knowledge of the agent's past behavior. In particular, our study suggests that infants expect givers to perform actions consistent with a recipients' past behavior. Perhaps more speculatively, infants' expectations about giving actions suggest that notions of considerateness might be emerging alongside knowledge of norms such as fairness and harm. Whether infants' evaluations of the giving act are in line with their expectations that the act will occur is an interesting avenue to explore in future research.

General Discussion

The results of Experiment 1 demonstrated that on average, 12.5-month-old American infants perceive taking objects as a strong indication of an agent's future behavior, whereas receiving them is not. But also, there were individual differences in how infants viewed receiving events. These individual differences were better predicted by infants' choice-making behavior, and perceived autonomy as opposed to infants' temperament. Specifically, less autonomous infants perceived receiving as indicative of an agent's future behavior, whereas more autonomous infants perceived object receipt as non-indicative of an agent's future behavior. The results of Experiment 2, demonstrate that the differential diagnosticity of receiving actions, relative to taking actions, was not due to task difficulty. Specifically, infants were able to use information about agents' past behavior to form expectations about how others should subsequently act towards that agent: after viewing an agent choose an object, infants expect others to subsequently provide the chosen object to the agent, as opposed to another (previously unchosen) object.

Our findings speak to the importance of considering broader social contexts in research on infant understanding of intentional action. In line with recent work on early moral cognition (e.g., Hamlin, Mahajan, Liberman, & Wynn, 2013), we suggest that focusing narrowly on views of single agents (outside of social interactive contexts) does not address the scope of the evidence available to infants as they make sense of human behavior. We further highlight an open question about these broader social contexts, namely how infants evaluate recipients of other's actions. For example, there is evidence that American (and Canadian) infants evaluate helpers and hinderers (Hamlin, Wynn, & Bloom, 2007), but there has yet to be evidence that they also evaluate the recipients of helping or hindering actions. That is, even though, in these helping and hindering scenarios, infants have information about a helper and a hinderer, and subsequently prefer the helper to hinderer, they also have information about the individual who received help and the individual who received hindrance, yet do not seem to show a preference for either recipient. This suggests that infants are more prone to attributing the cause of the helping and hindering behaviors to the agents, as opposed to the recipients, of the actions. Moreover, infants evaluate fair and unfair resource distributors by 13 months of age (DesChamps, Eason, & Sommerville, 2016), but it is not until two months later that they evaluate the recipients of unfair resource distributions (Eason & Sommerville, 2017). Finally, infants also attend to information about agents but not recipients when making inferences about causal sequences (Cohen & Oakes, 1993).

Our findings add to this body of work and offer insight into one potential reason why information about agents may be more readily used compared to information about recipients—infants' own choice-making behavior, parents' scaffolding of infants' choices, and parents' perceptions of infant autonomy. Specifically, we show that all three are negatively related to perceiving object receipt as diagnostic of future behavior. Moreover, these results suggest the role of particular socialization experiences in perception of others' choices, which requires further investigation. Although untested within our experiment, these results also make interesting predictions about cultural differences; namely, they suggest that in cultures that place greater value on interdependence and choices made with and on behalf of others, infants may view outcomes of dyadic interactions as more diagnostic of individual agents' future behaviors. This would parallel cultural differences found in older children's beliefs about preferences and choice (Chernyak, Kushnir, Sullivan, & Wang, 2013; Iyengar & Lepper, 1999; Miller, Das, & Chakravarthy, 2011) and suggest that these differences begin to emerge early in infancy, even prior to children's explicit understanding of social and personal causes for behavior (Kushnir, forthcoming; Kushnir, Gopnik, Chernyak, Seiver, & Wellman, 2015; Lagattuda, Nucci, & Bosacki, 2010; Nucci & Weber, 1995).

Second, setting aside potential cultural learning to focus more squarely on socialization, these results beg the question of precisely how socialization of individual autonomy may matter. For example, is direct experience making choices on one's own required, or is observational experience sufficient? If direct experience is necessary, then early in life, when infants have less experience with their own agency infants may not differentiate taking and receiving. Prior work on infant's understanding of goal-directed action suggests that direct experience, as opposed to observational experience, might be most important for infants' developing understanding of others' actions (Sommerville, Woodward, & Needham, 2005). However, if observational experience is sufficient, then throughout development the difference in prioritization of agents over recipients should remain constant (all else being equal).

Whether infants' inferences in this study were about goals or preferences remains an open question. Specifically, infants may see the initial action, make a goal inference and then use that to predict a subsequent action (e.g., Woodward, 1998), or infants may see the initial action, make a preference inference and then use that to predict a subsequent action (Luo & Baillargeon, 2005; 2007). While both goals and preferences are seen as subjective (i.e., the goal or preference of one individual does not extend to another individual; Buresh & Woodward, 2007) preferences, unlike goals are viewed as more enduring across contexts (Martin, Shelton, & Sommerville, 2017). Therefore, if infants made an initial preference inference, we might expect infants to infer that the individual would continue to pursue the same object, even in a new context (such as a new room), whereas if infants' made an initial goal inference this would not be the case. Nonetheless, future work will need to disentangle the precise psychological mechanisms by which infants arrive at their predictions about future behavior.

This work contributes broadly to theories of development and individual differences, while also suggesting interesting future directions for theories of cross-cultural development. As there have been recent calls within developmental psychology (and psychology more generally) to broaden our populations of investigation (e.g., Fernald, 2010), particularly focusing on cross-cultural comparison (e.g., Henrich, Heine, Norenzayan, 2010; Lancy, 2010), this work demonstrates that researchers should also consider investigating and attempting to explain the variability within cultures (see also: Fernald, 2010; Martin, Ziv, & Sommerville, 2016). In particular, we demonstrate that the individual differences in our task are predictable (as opposed to random noise) and hold important information about developmental processes (Martin et al., 2016). Investigations into cross-cultural variability and within-culture variability inform each other, and set the stage for making more refined and accurate theories of psychological functioning. For example, work on cross-cultural variation informed our predictions for this study, and our results have in turn made predictions about cross-cultural variation. Therefore, future work should consider understanding not only group-level differences, but also individual differences.

Overall, our results indicate that for 12.5-month-old American infants, the line between actor and witness is thin yet important—choosing for oneself holds more meaning than the same outcome which resulted from someone else's choice.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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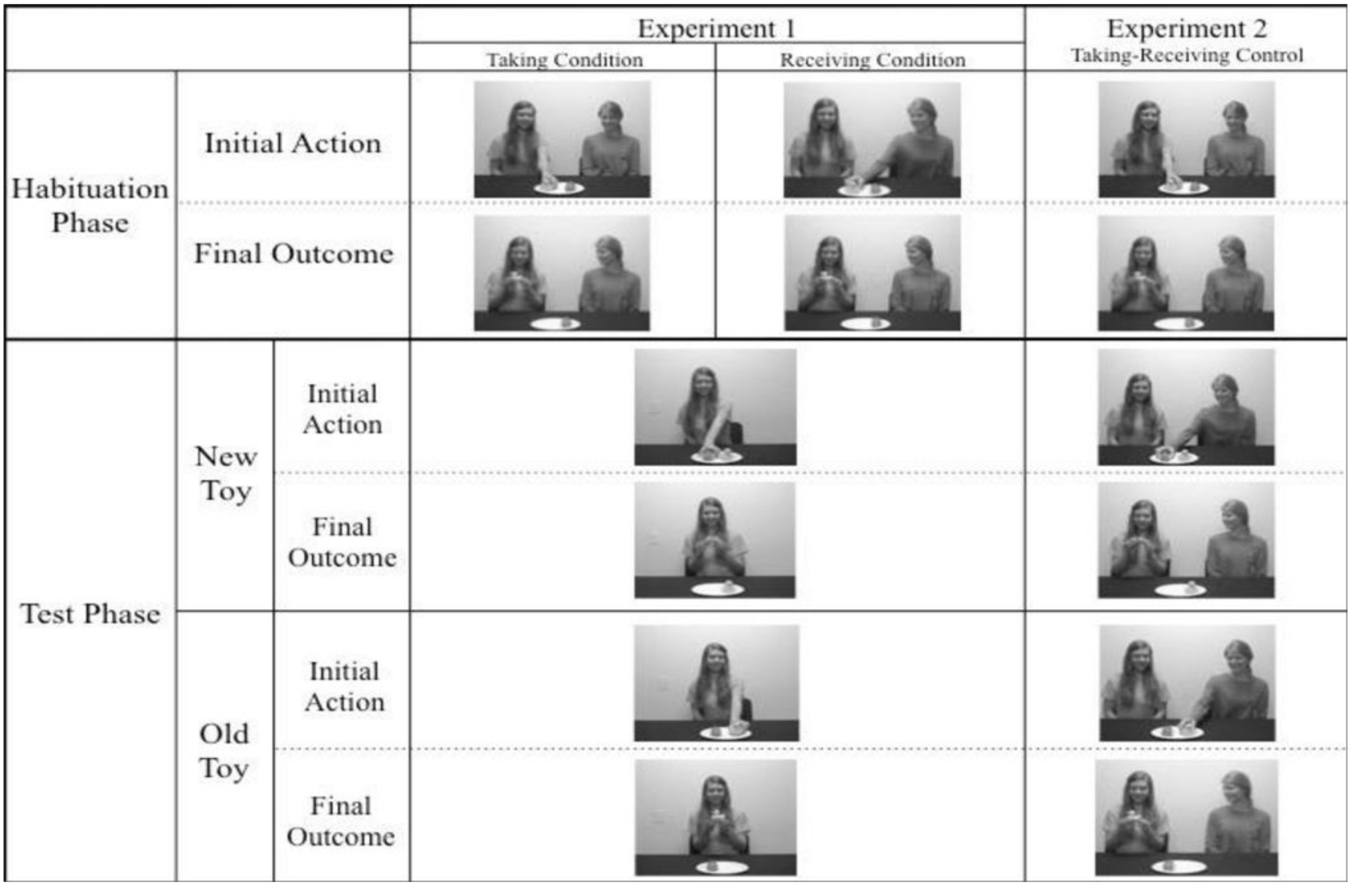

Figure 1.

Schematic of the experimental methods. Participants saw short videos and the actions from those videos are depicted in the still frame images above. The still image from the preview trial is not shown in this schematic. The individuals in this figure, and in the video stimuli, have provided the authors signed consent to publish their likeliness in this manuscript. Note: Across all participants the person doing the action, which toy was selected, and the location of the toys were counterbalanced. Furthermore, in the test phase, the order of the New Toy and Old Toy trials were counterbalanced across participants.

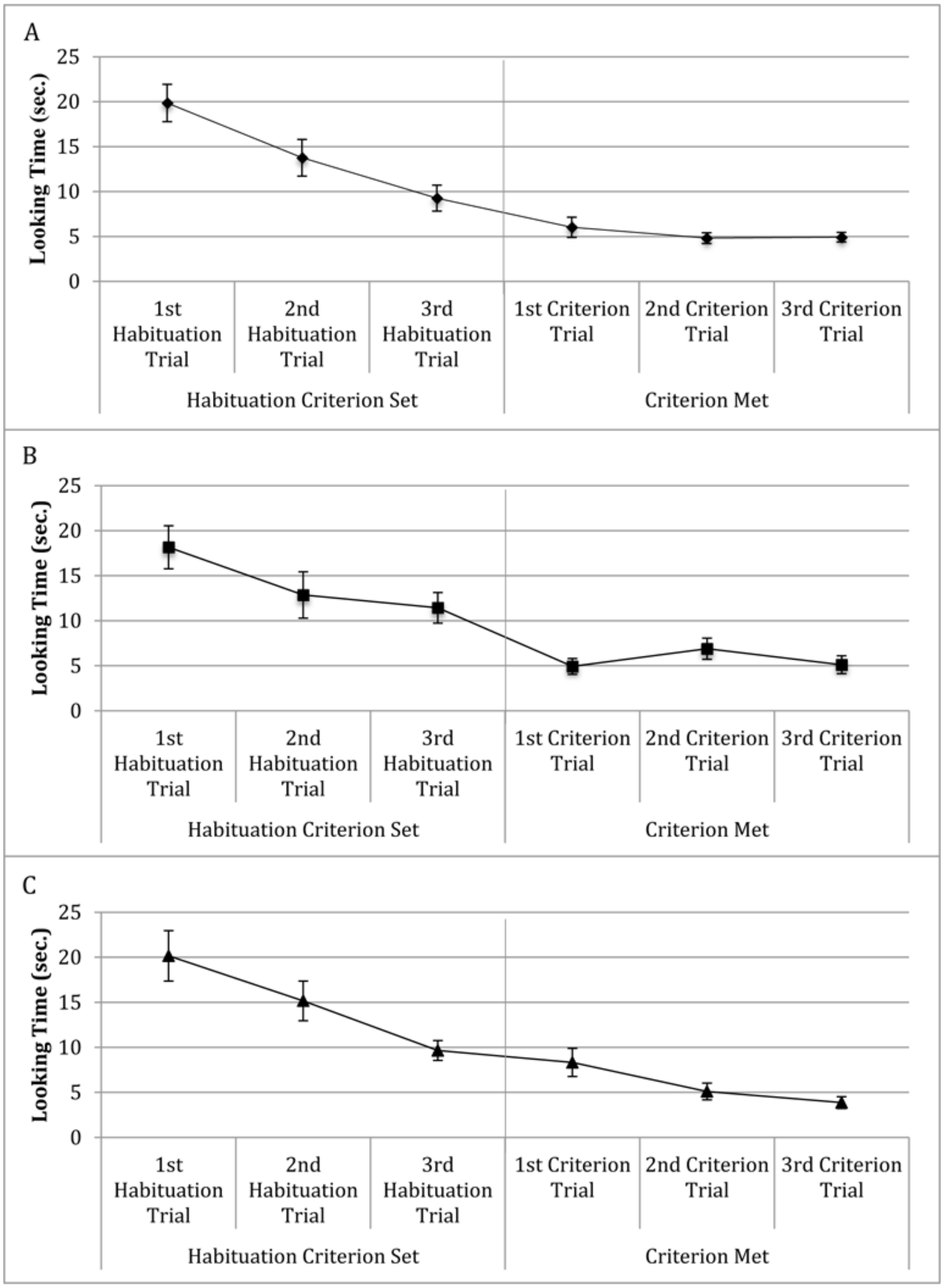

Figure 2.

Habituation curves for infants across all experiments. Error bars represent ±1 standard error. Panel A: Experiment 1, Taking Condition; Panel B: Experiment 1, Receiving Condition; Panel C: Experiment 2, Taking-Receiving Control Condition. Note: Additional trials could occur between the 3rd habituation trial and the 1st criterion trial.

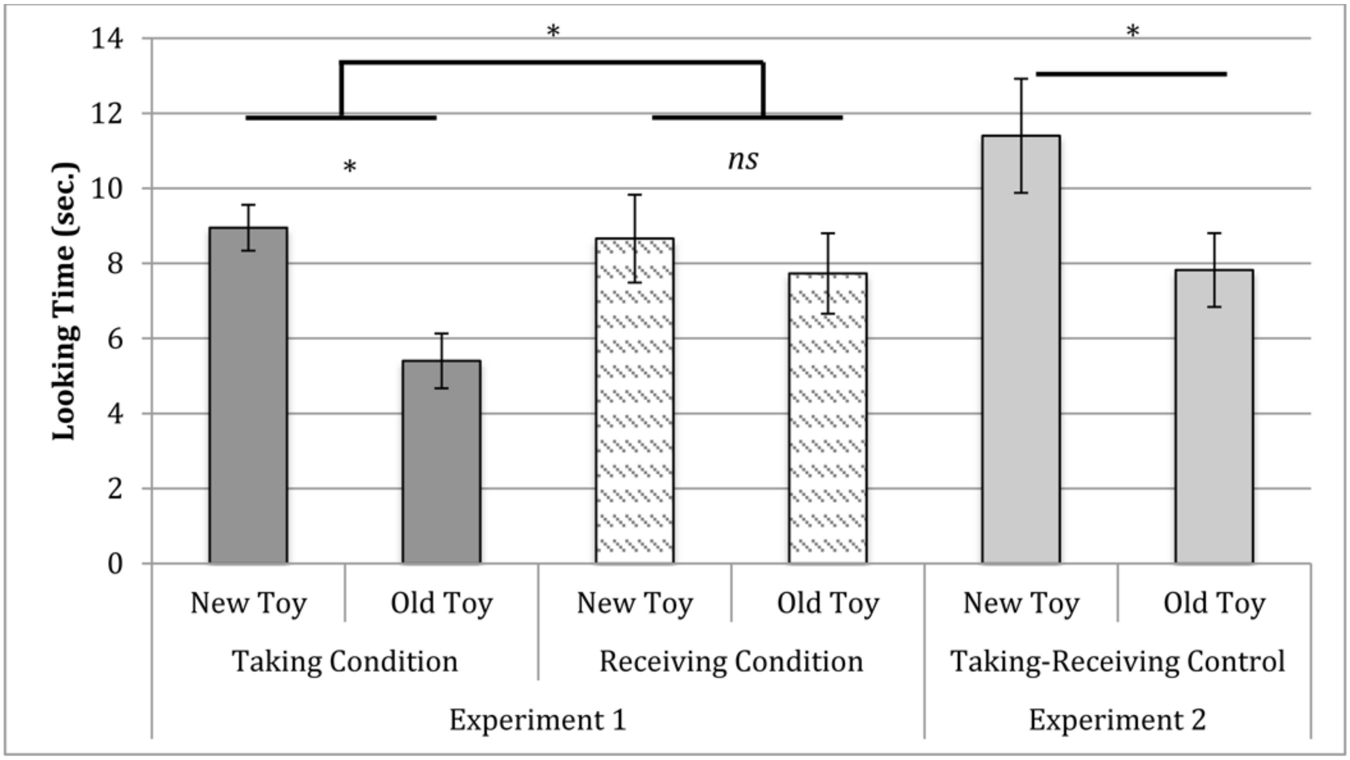

Figure 3.
Mean looking times to each test trial type. Error bars that represent ±1 standard error. * $p < .05$

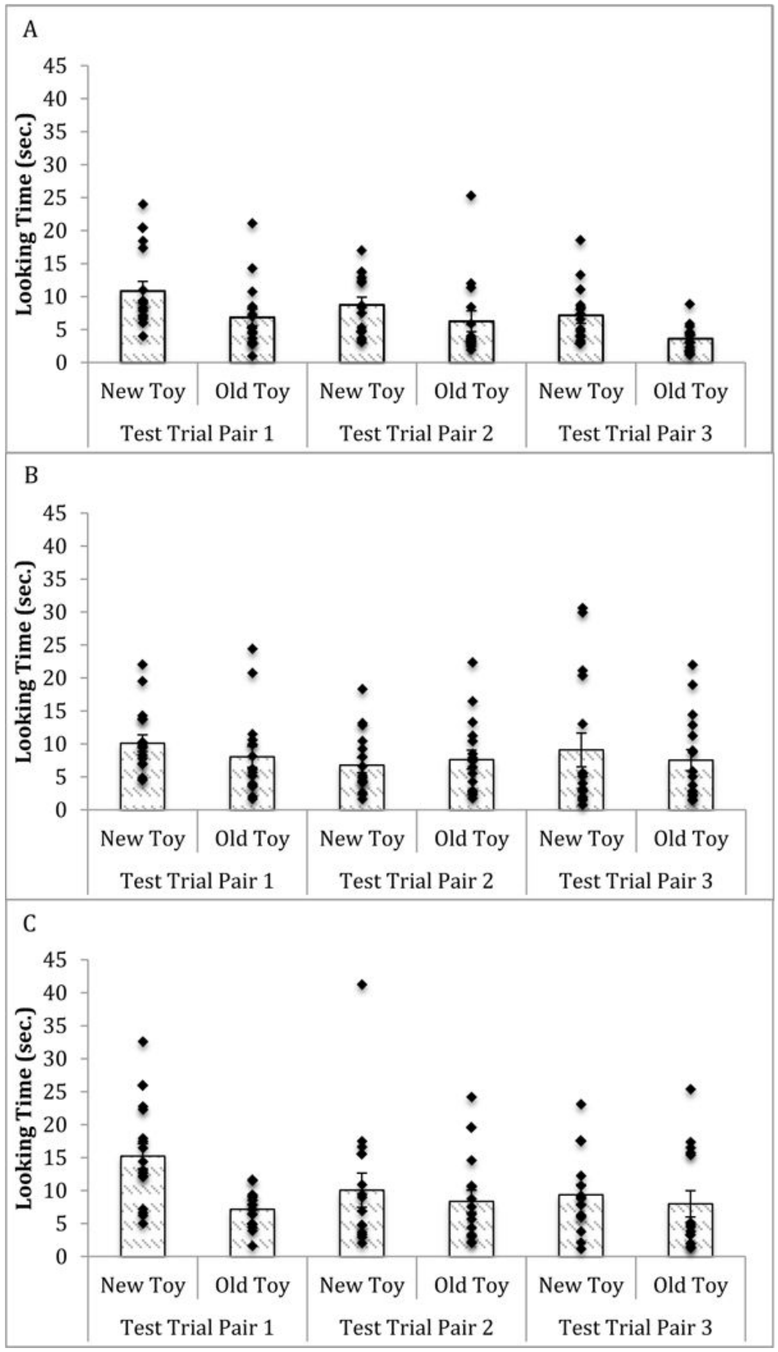

Figure 4.

Looking times for each test trial pair. Bars represent mean looking time with error bars that represent ±1 standard error. Overlaid on the bar graph is a scatterplot of the looking time of each individual participant. Panel A: Experiment 1, Taking Condition; Panel B: Experiment 1, Receiving Condition; Panel C: Experiment 2, Taking-Receiving Control Condition.

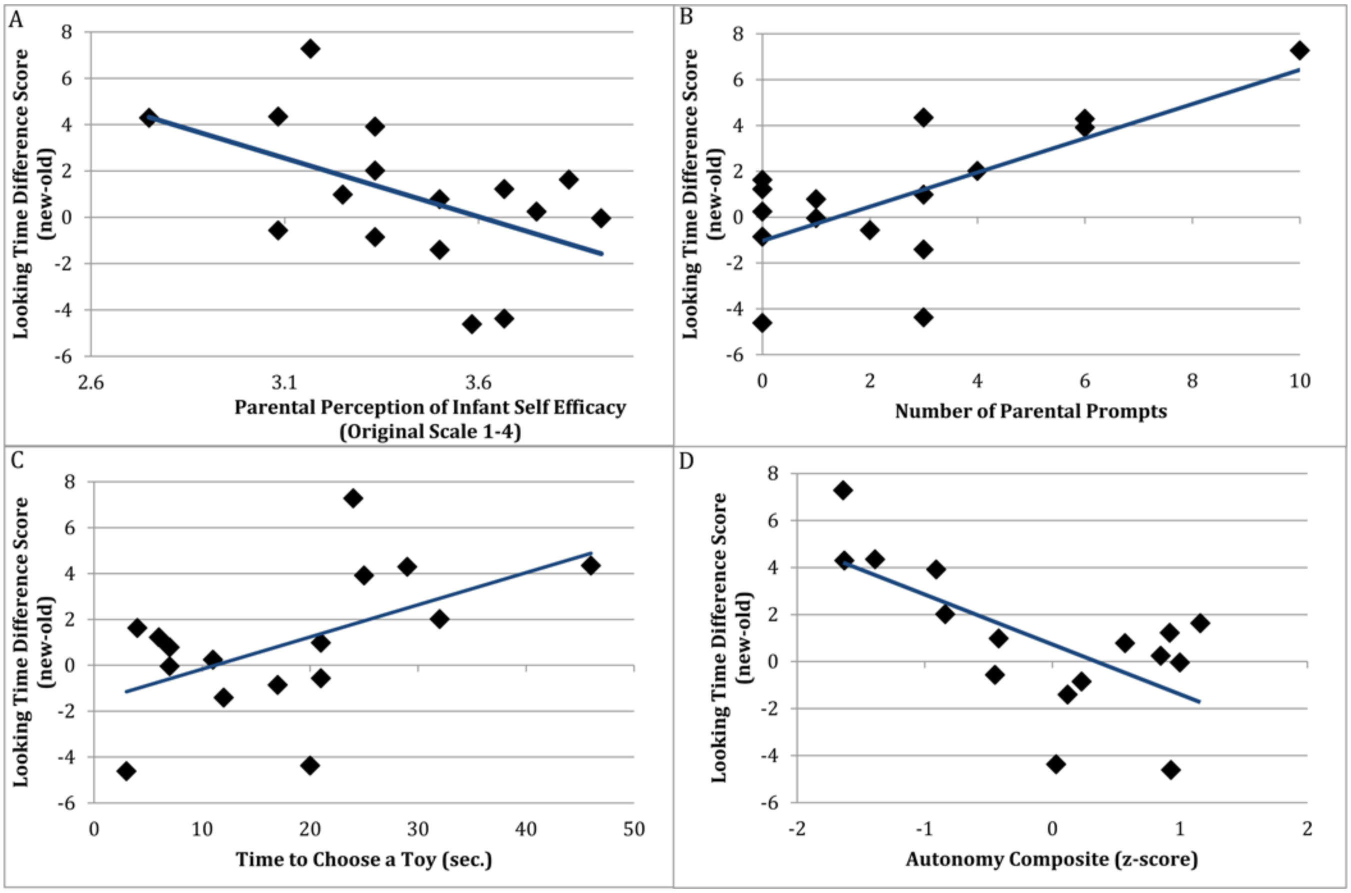

Figure 5.

Correlations between looking time difference score and 3 individual difference measures. Panel A: Self-Efficacy correlation within the *Receiving* condition; Panel B: Number of parental prompts within the *Receiving* condition; Panel C: Time to choose a toy within the *Receiving* condition; Panel D: Autonomy composite score within the *Receiving* condition.

Table 1

Experiment 1 correlations descriptives and correlations between individual difference measures.

Measure	Mean (SD)	Infant Self Efficacy Rating	Number of Parent Prompts	Time to take a Toy
Looking time difference	2.17 (3.14)	–	–	–
Parent Rated Infant Self Efficacy	3.34 (.33)	–	–	–
Number of Parent Prompts	2.16 (2.25)	−.34†	–	–
Time to take a Toy (seconds)	14.45 (10.45)	−.45*	.57*	–

† $p = .061$,

* $p < .05$

Note: One infant in the taking condition was excluded from the correlational analyses because their time to take a toy was more than 4SD above the average.