# Is Schematic Biological Motion an Animacy Cue in Infancy?

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# Abstract

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The goal of the present research was to investigate whether schematic biological motion serves as a cue to the concept of animacy in infancy. In order to present motion cues in the absence of bodily form cues, Michotte's (1963) schematic biological motion stimuli (i.e., shape rhythmically expanding/contracting in the direction of movement) were used. The video animations displayed an amorphous shape moving in this way behind a screen (i.e., the shadow) and assessed looking patterns when the screen was removed to reveal either an animate or inanimate exemplar in the test phase. In Experiment 1, familiar exemplars of animate entities (i.e., dog, cow) were used as test items. In Experiment 2, the test objects were unfamiliar category exemplars associated with this type of motion (i.e., worm, caterpillar). Infants (10- and 18-months) looked longer when biological motion cues were congruent with the test items in Experiment 1, but 10-month-olds did not show differential looking across congruent and incongruent trials in Experiment 2. These findings suggest that the schematic biological motion stimulus does not serve as a primitive cue to the concept of animacy in infancy.

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# Table of Contents

Page

## List of Figures

# Is Schematic Biological Motion an Animacy Cue in Infancy?

The ability to recognize an object as either animate or inanimate is thought to be a critical step in human cognition and perception (Pavlova, 2012). Developmental research has revealed that this basic categorical distinction emerges within the first year of life (e.g., Rakison & Poulin-Dubois, 2001), and can serve as the building block for more complex abilities such as the interpretation of causal events, word learning, attribution of mental states and biological processes (Opfer & Gelman, 2010). Due to the central importance of this distinction, a large body of research has emerged with the aim of identifying the cues that lead infants to make the animate/inanimate categorization. The cues identified so far can be placed into two broad categories: static and dynamic.

The cues that fall under the static category are morphological, and include the presence of a face (Morton & Johnson, 1991; Johnson, Booth, & O'Hearn, 2001), eyes (Baron-Cohen, Campbell, Karmiloff-Smith, Grant & Walker, 1995; Carey & Spelke, 1994), asymmetry along a face-like axis (Premack, 1990), and human hands or legs (Slaughter & Corbett, 2007; Rakison, 2005). In the early months of life, faces appear to be especially compelling to infants, with infants paying more attention to a schematic face (two dark areas above a mouth shaped area), than to a scrambled version of the same image (Morton & Johnson, 1991). In the second year of life other cues become important. Rakison and Butterworth (Study 1, 1998) found that 14- and 18- month-olds differentiated between objects on the basis of wheels vs. legs, and at 22- months of age infants differentiated on the basis of category membership. In their second study, infants were tested with novel objects that were created by adding or removing legs or wheels from familiar objects. In this second study, infants failed to make a category-based distinction if shown an animal with wheels and vehicle with legs, and instead grouped objects with legs together and objects with wheels together. Although animals with wheels do not exist, there are many inanimate objects with legs (e.g., table), so it is likely that the presence of legs alone is not sufficient to identify an animal. Opfer and Gelman (2010) suggested that infants must be using additional properties such as texture, contour, and type of material to differentiate animates from inanimates. Smith and Heise (1992) reported that 12-month-olds used contour to distinguish between animate and inanimates, associating curvilinear forms with animacy. Findings from Pauen (2002) challenge the interpretation that infants make category based distinctions solely on the basis of shared features, and support a knowledge-based distinction. Pauen reported that when animal and furniture stimuli were matched for perceptual similarity (i.e., similar identifying features), 10- and 11- month-olds were able to make the superordinate category distinctions.

In addition to static cues, researchers have investigated the dynamic cues associated with animacy. In her theory of concept formation, Mandler (2004; 2012) proposed that an innate, domain-general mechanism of perceptual meaning analysis generates concepts from attended perceptual data (i.e., perceptual primitives). The perceptual primitives for dynamic entities are spatio-temporal in nature (Mandler, 2012), and are constituted into image schemas, which in turn can serve as the basis for the formation of more detailed concepts. Mandler (2004; 2012) argued that animates can be distinguished on the basis of a number of these spatio-temporal primitives, including being a bounded entity able to move without contact, able to move contingently with other entities, and able to initiate movement at a distance. Biological motion as such is not considered a perceptual primitive in this theory (Mandler, 2012), however, Mandler notes that further empirical work is needed to establish the fundamental cues used to form the categorical distinction between animates and inanimates early in infancy.

Historically, the majority of research on the role of dynamic cues in the perception of animacy has been done with adults. To investigate the primitive dynamic cues to animacy, researchers have isolated the spatio-temporal components of animate motion. Self-generated changes in direction and speed have been reported to lead to the attribution of animacy to a simple geometric shape, provided it had the appropriate orientation toward the direction of motion (Tremoulet & Feldman, 2000). Tremoulet and Feldman reported that adults attributed animacy to a simple geometric shape that accelerated or changed direction of movement. Both of these movement patterns (i.e., acceleration and change of direction) violate Newton's Third Law of Motion (i.e., conservation of momentum) when they occur for inanimate objects, which must be acted on by another object in order to initiate or change their path of motion. Thus, Scholl and Tremoulet (2000) suggest that violation of Newton's Third Law of Motion serves as a cue to animacy and forces an alternative interpretation to physical causality (i.e., the interpretation that the object moved because of agency). Scholl and Tremoulet (2000) set out to investigate the hypothesis that 'violations of Newtonian law' lead to animacy attribution, and found that only three motion styles consistently lead to inferences of animacy. These included starts from rest, changes in direction to avoid collision, and direct movement toward a goal.

The importance of these dynamic cues to animacy has not been extensively tested with infants. As previously noted, motion-based theories of early conceptual development propose that biological motion per se is not a primitive feature in building a concept of animacy (Mandler, 2004; 2012; Rakison & Poulin-Dubois, 2001). However, some aspects of motion have proven to be important to the development of the animate/inanimate distinction. Rakison and Poulin-Dubois (2001) review evidence to suggest that the conceptual system for animacy is initiated in infancy through primitives sensitive to five motion cues: a) *onset of motion* (self-propelled vs. caused motion), b) *type of causal role* (agent vs. recipient), c) *form of causal action* (action at a distance vs. action from contact), d) *pattern of interaction* (contingent vs. non-contingent), and e) *line of trajectory* (irregular vs. smooth).

Infant studies that directly assessed the importance of a self-generated motion cues to animacy report that from seven months of age, infants expect that animates are capable of self-generated motion, but inanimates are not (Poulin-Dubois, Lepage, & Ferland, 1996; Rakison & Poulin-Dubois, 2002; Spelke, Philips, & Woodward, 1995). An additional animate motion pattern that has been tested with infants is motion path (i.e., jumping vs. rebounding over an obstacle).  Baker, Pettigrew and Poulin-Dubois (2014) found that by 10-months of age, the non-linear motion of jumping was associated with animates (i.e., dog and cat), but not inanimates (i.e., vehicles and furniture).  In contrast, the linear motion pattern of rebounding off a barrier was associated with both animates and inanimates. These findings suggest that the expectations regarding motion paths for animates are less constrained than that for inanimate categories. As such, the findings support the view that motion cues may play an important role in infants' formation of the animate category (Mandler, 2012; Rakison & Poulin-Dubois, 2001).

Another type of dynamic animacy cue is goal-directed behavior, a behavioral pattern that is a characteristic of animate beings. In order to investigate goal perception in infancy, Gergely, Nádasdy, Csibra, and Biro (1995) presented infants with moving geometric figures using a visual habituation paradigm. The authors found that 12-month-olds (and nine-month-olds; Csibra, Gergeley, Biro, Koos, & Brockbank, 1999) saw the actions of these geometric figures as goal-directed. Participants were habituated to a small circle approaching a larger circle and then in a test phase the motion path of the figure changed.  The small circle now jumped over a barrier in its approach (rational) or followed this new jumping path in the absence of a barrier (non-rational). Infants dishabituated only to ‘non-rational’ paths to the goal, that is, when the circle appeared to jump over a nonexistent barrier to reach the large circle. In a related study, researchers reported that 20-months-olds’ (but not 16-month-olds’) expectations about rational paths of motion were stronger for animals than non-animals (Rakison, Cicchino, & Hahn, 2007).

Animacy attribution has also been extensively studied using the technique of point light displays. Point-light displays present patterns of motion with degraded object form cues by showing only points of light distributed throughout a moving body. Johannsen (1973) pioneered this work in experiments with adults, who are able to infer a wealth of socially relevant information from these simple displays (Rutherford & Kuhlmeier, 2013). The adult research has been followed up in studies with infants. Simion, Regolin, and Bulf (2008) found that two-day-old infants show a preference for biological motion over random motion in a point-light display. Newborn chicks also detect and prefer biological motion in point light displays, suggesting the operation of an evolutionary mechanism for the detection biological motion shared amongst vertebrates (Troje, 2013). It is important to note the ability to distinguish biological motion from random motion can be accomplished at the perceptual level, independent of any conceptual inference (Mandler, 2012). In order for perceptual information to be organized into conceptual knowledge it must be processed into an abstract representational format (i.e., image schemas). For Mandler, perceptual processes differ from conceptual knowledge primarily because knowledge can be represented in abstract form and can later be recalled.  This point is controversial, with a number of researchers claiming that some forms of knowledge, including animacy perception, are the products of perceptual processing (e.g., Kellman & Arterberry, 2000)

For example, researchers have suggested that the human visual system is able to quickly extract structure-from-motion information to infer the form that is depicted in point-light displays (Bertenthal & Pinto, 1994; Reid, Hoehl, Landt & Striano, 2008). In one study, Arterberry and Bornstein (2001) reported that three-month-old infants categorized animals as distinct from vehicles on the basis of point-light displays of their motion. The interesting theoretical question is how this perceptually based ability (i.e., encoding structure-from-motion) is related to the conceptual ability of using these motion cues to categorize animates and inanimates. There are at least two possibilities. Infants may directly recognize the motion as biological and form a category expectation 'animate' on that basis, or they may respond to the perception of form of the moving agent, and indirectly infer 'animate' from form cues.

In order to identify the primitive dynamic cues to animacy and disambiguate how infants make the inference of animacy from dynamic cues, it is important to investigate motion-based categorization of animacy with motion cues that do not contain form information (Mandler, 2012; Rakison & Poulin-Dubois, 2001). The current study begins to explore this theoretical question by utilizing schematic biological motion sequences as cues to animacy in two experiments with infants. Schematic biological motion sequences present biological motion without the implicit form information presented in point-light displays (Giese & Poggio, 2003). The foundational work on perception of causality using these cues was pioneered with adults by Michotte (1963), and has since been extended to studies of infants (e.g., Schlottmann & Ray, 2010). Michotte's (1963) stimulus involved a square that rhythmically expanded and contracted in the direction of its movement (i.e., 'caterpillar' stimulus). In their first study Schlottmann, Allen, Linderoth and Hesketh (2002) found that 3-year-olds verbally reported that this schematic motion sequence moved like an animal. In a later study, they assessed whether six-month-olds would attribute goals to this stimulus (Schlottmann & Ray, 2010). The authors felt that if infants did attribute goals to the Michotte stimulus, then it would suggest that early in infancy they are able to connect this motion style to mental state reasoning, and may use this route to infer a link to animacy. Six-month-olds did indeed attribute goals to the square moving in the non-rigid rhythmic manner of an animal (i.e., caterpillar motion) but not when it moved rigidly straight toward the target. Schlottmann and Ray were careful not to equate attribution of goal-directedness with animacy, especially given previous evidence that goal-directed behavior is itself a cue to animacy (Opfer & Gelman, 2010). These findings might be more prudently interpreted as indicating infants' burgeoning understanding of the relationship between multiple cues to animacy.

The theoretical perspective that an early animate-inanimate distinction is formed on the basis of primitive dynamic cues would gain further empirical support if infants were found to associate dynamic cues with exemplars of animates (Rakison & Poulin-Dubois, 2001). Arterberry and Bornstein (2002) investigated infants' understanding of the association between point-light motion and static images of animals and vehicles. Infants (6- and 9-month-olds) were habituated to point-light displays of biological or non-biological motion and then presented with static cues from the same or a different category (i.e., animal, vehicle) When nine-month-old infants (but not six-month-olds) were habituated to the motion of animal, they dishabituated to the static image of a vehicle, but not to the animal. Interestingly, this transfer did not occur at either six- or nine-months of age when participants were habituated to static exemplars, and then presented with dynamic ones. The authors concluded that because nine-month-olds were able to transfer category information from dynamic point-light displays to static images, their categorization was not dependent on the presence of particular stimulus attributes, and was therefore more conceptual than perceptual in nature.

Pauen and Träuble (2009) investigated the transfer of categorical information further by investigating seven-month-old infants' expectations about the behaviour of an animate being and an inanimate object. In this study, an unfamiliar toy animal and a ball were connected to one another and engaged in self-propelled motion as a unit. When both objects were later presented individually in separate locations, infants looked longer when the ball started moving but not the animal. These findings suggested that infants had attributed the self-initiated motion to the animal in the previous demonstration, and not the ball. In a second study, the researchers degraded the static features of the animals to determine whether infants continued to attribute agency to the degraded animal stimulus. They found that when the facial features of the animals were removed, or the fur was replaced with wire, infants no longer attributed agency to the animal. The authors concluded that seven-month-old infants formed category specific relations between static (i.e., pictures of objects) and dynamic attributes (i.e., motion patterns). However, these conclusions should be interpreted with caution. Although the initial finding is compelling (i.e., infants inferred that the self-initiated motion was caused by the animal and not the ball), by removing the static features of an animal (i.e., facial features, fur) the researchers introduced a strange new object in the place of the animal, which retained some morphological cues, but was missing others. It is possible that the oddity of the degraded animal resulted in no expectations being formed. Applying the morphological features that were removed from the animal to the ball could test this interpretation. If the role of agency were subsequently applied to the ball, then this interpretation would gain further empirical strength.

Träuble, Pauen, and Poulin-Dubois (2014) sought to directly investigate infants' understanding of the transfer of morphological and dynamic cues. The animacy cues in this study included the static images of animals and dynamic changes in speed and direction. These were contrasted with inanimate cues of static images of vehicles and rigid-linear motion. To test whether seven-month-old infants used motion information to categorize an entity as animate, a paradigm was developed that concealed the identity of the moving entity with a shadow. The goal of this paradigm was to make participants form expectations of the animacy status of a shadow on the basis of how it moved (i.e., to isolate motion cues from form cues). When the shadow moved with regular changes of speed and direction, infants looked longer when the shadow was later removed and revealed a vehicle, than when an animal was revealed. When the shadow moved rigidly across the screen, infants looked longer when the shadow was revealed to be an animal. The authors concluded that seven-month-old infants used motion information to form categorical expectations about the concealed entity. Specifically, infants expected animals to move with changes in speed and direction, while vehicles were expected to move in a rigid-linear fashion.

The present experiments employed the shadow paradigm to assess infants' expectations about dynamic animate and inanimate entities, and extends previous work (Träuble et al., 2014) by utilizing Michotte's (1963) schematic biological motion stimulus as a dynamic cue to animacy. The shadow paradigm presents infants with two entities casting identical shadows behind a screen in Phase 1. In Phase 2, one shadow moves with either animate or inanimate motion from a point midway between the two hidden entities. In Phase 3, the screen is removed to reveal one entity that is either congruent or incongruent with the motion presented in Phase 2, and infants' looking times are measured. In the current Experiment 1, 10- and 18-month-old infants were presented with Michotte's caterpillar motion or rigid non-biological motion, and either animal or vehicle target objects. Based on classic interpretations of the looking time patterns found in the violation of expectation paradigm (Baillargeon, 1987; 1993; Baillargeon, Spelke, & Wasserman, 1985), it was expected that infants would look longer when the motion of Phase 2 was incongruent with the category of the entity presented in Phase 3 (i.e., biological motion with an inanimate entity or rigid motion with an animate entity). In Experiment 2, 10-month-olds were presented with stimuli that were morphologically more similar to the natural entities that do produce Michotte's biological motion (i.e., caterpillar, worm) than those used in Experiment 1 (i.e., cow, dog) in order to assess whether infants' would be more likely to associate Michotte's motion to these new exemplars of the animate category.

## Experiment 1

Infants were presented with a series of videos depicting schematic biological motion as a cue to animacy in three phases (See Figure 1) using the shadow paradigm developed by Träuble et al. (2014). The first phase was designed to provide the impression that the two objects cast identical shadows, and that the target object could be represented by this ambiguous shadow. As a result, the impression during the motion phase was intended to be that the moving shadow was concealing the identity of one of the two objects that was introduced in Phase 1. Additionally, participants were expected to form an impression of which target object was making the motion based on the type of motion the shadow was exhibiting. When the screen opened in the final phase to reveal the target object, participants should already have had an expectation about what the object would be. The test object was either congruent (i.e., matching) or incongruent (i.e., mismatch) with the expectation formed. For example, biological motion was paired with an animal on congruent trials, and with a vehicle on incongruent trials. It was expected that infants would look longer at the test object for incongruent as compared to congruent trials.

## Method

**Participants.** All participants were recruited (see Appendix A for recruitment letter) through birth lists obtained from the Régie Régionale de la Santé et des Services Sociaux de la Région de Montréal-Centre. A total of 34 10-month-old infants (*M* =10 months, 22 days; range = 9 months, 28 days to 11 months, 5 days), 20 females and 14 males were tested. Four participants were excluded due to fussiness, and 14 were excluded due to inattentiveness. Inattentiveness was operationally defined as not paying attention to the screen on both test phase trials that were preceded by the same motion pattern (e.g., bio/congruent and bio/incongruent, or rigid/congruent and rigid/incongruent). The final sample included 16 10-month-olds (*M* = 10 months, 15 days; range = 10 months, 2 days to 11 months, 4 days), 8 females and 8 males. A total of 36 18-month-old infants (*M* = 18 months, 22 days; range = 17 months, 27 days to 19 months, 14 days), 17 females and 19 males were tested. Three were excluded due to fussiness, and 19 were excluded due to inattentiveness. The final sample included 14 18-month-olds (*M* = 18 months, 17 days; range = 17 months, 27 days to 19 months, 14 days), 6 females and 8 males.

**Materials.** The stimuli included realistic color images of four objects; two animate beings (i.e., dog and cow) and two inanimate objects (i.e., truck and motorcycle). The objects were similar in complexity of features, matched for color, and could be covered by the same shadow. The objects that were paired with one another during the presentation (i.e., cow-motorcycle, dog-truck) were also matched for color. These images were included in computer-animated scenes created using Microsoft® Power Point®, and presented using a Tobii TX-300 eyetracker (TOBII Technology AB, Danderyd, Sweden).

**Design.** Each participant was presented with four trials that included both stimulus pairs, both types of motion (biological, rigid), and both types of trials (congruent, incongruent) in a within-subjects design. The stimuli were presented in two blocks of two trials each. The same pairs of stimuli (i.e., either dog-truck or cow-motorcycle) were presented twice in the first block of trials, and the alternate pair of stimuli was presented twice in the second block. Within each block, the type of motion was alternated. Thus, if biological motion was presented in the first trial, then rigid motion was presented in the second trial, and this pattern was repeated for the subsequent block. Finally, the target object during the test phase was always the same across both trials in the block, and the category of the target object (i.e., animal, vehicle) alternated across blocks. Therefore, if the target object were an animal in the first block, then it would be a vehicle in the second block. These pairings ensured that each participant saw two trials where the motion was congruent with the target object (i.e., biological-animal, rigid-vehicle) and two trials where the motion was incongruent with the target object (i.e., biological-vehicle, rigid-animal). The eight possible orders of these pairings were counterbalanced across participants (see Figure 2)

**Procedure.** The testing session lasted approximately 45 minutes. Upon arriving at the lab parents were debriefed on the procedure, and then provided with a consent form (see Appendix B) and demographics questionnaire (see Appendix C). The parents of all participants received a small financial compensation ($20) for their participation in the study. Participants were tested in a dimly lit room and sat in a high chair 70 cm from the screen in order to ensure maximum accuracy of eye tracking metrics (TOBII Technology AB, Danderyd, Sweden). Parents were asked not to interact with their infant during the experimental trials. The stimuli (approximately 7.36 x 4.91 visual degrees) were presented in computer-animated scenes (approximately 40.03 x

23.41 visual degrees) on a 23-inch screen (1920x1080) of a Tobii TX-300 eye tracker. Tobii Studio (3.1) was used to present the stimuli, as well as to extract the looking time data for each phase of the presentation. During the presentation of the computer-animations, the experimenter was located behind a barrier, where he monitored the fixations of the infant on a video monitor, and was able to control the progression of trials.

Immediately before each trial a visual attention-getter was presented in order to ensure that the participant's attention was oriented to the screen. The attention-getter was a circle that oscillated between expanding and contracting vertically and horizontally, while also cycling through a series of bright colors. This attention-getter was selected because it was both effective and, because it was stationary, did not contain any cues to animacy that have been reported in the literature. Visual fixation was not recorded during the presentation of the attention-getter. When the experimenter determined that participants had fixated on the attention-getter stimulus, the experimenter advanced to the experimental trials. Each trial presented one computer-animated scene containing three phases. The phases were presented continuously, with fluid transitions between phases. Each trial lasted for a total of 45 s, yielding a total presentation time for four trials of approximately 3.5 min, including presentation of the attention-getter.

During Phase 1, the stimulus pairs were presented in the left 25% portion of the display (10.41 x 23.41 visual degrees). At the beginning of the trial, the pair of stimuli were presented one on top of the other. The center of the top object had the pixel coordinates of 225 x 225 pixels and the object on the bottom 225 x 855 pixels (See Figure 1 for a visual representation of this configuration). During the first 15 s of this phase, these stimuli were covered and uncovered by a semi-lucent screen (rectangular grey field made to appear like a screen covering the objects) that emerged and then disappeared from the left side of the screen for a total of three covering events.

Each time the stimuli were covered, they were replaced by two identical shadows. After the stimuli had been covered three times, an additional semi-lucent screen came down to cover the middle 50% of the display and remained in place for the duration of the trial. Following this, an opaque screen came in from the right side of the screen covering the right 25% of the display. Finally, an opaque screen entered from the left of the screen covering the left 25% of the screen, leaving the entire scene, including the stimuli and their shadows, fully covered. The second part of Phase 1 lasted for 10 s, for a total duration of 25 s for Phase 1.

In Phase 2, biological or rigid motion of a single shadow was presented. This phase lasted for 10 s, during which the shadow emerged from behind the left opaque screen, midway between the two entities presented in Phase 1, and moved across the middle 50% of the display, finally disappearing behind the right opaque screen. The *biological motion* displayed by the shadow was Michotte's caterpillar stimuli. This motion style is characterized by expansion, where the front of the shadow moves forward while the back point remains stationary, and contraction, where the back of the shadow moves forward while the front point remains stationary. This motion style is one of the simplest forms of motion found in the natural world, being the result of the sequential forward motion of two points around a single axis. A familiar natural example would be the motion of an inchworm. In the current study, there were 4.5 cycles of expansion and contraction of the shadow during the 10 s motion phase, and the movement was from left to right. In the *rigid motion* display the shadow moved in a constant linear trajectory from left to right across the middle section of the display. It was important to ensure that infants were attentive to the style of motion during this phase in order to enable them to form an expectation about the identity of the test object. Trials for which participants did not look at the shadow motion for at least 2 s (i.e., the approximate duration of one cycle of expansion and contraction) were excluded from analyses.

Phase 3 (test phase) followed immediately after the shadow had disappeared behind the opaque screen on the right side of the display. At the beginning of Phase 3 the opaque screen opened to the right revealing a test stimulus. Depending on the trial order, the test stimulus could be either the animate or inanimate stimulus that had been introduced during Phase 1. The test stimulus was presented for 15 s (see Figure 1), and was either congruent or incongruent with the motion pattern that was shown in the Phase 2. For example, biological motion presented in Phase 2 was congruent with animals and incongruent with vehicles, and rigid motion was congruent with vehicles and incongruent with animals.

Eye Tracking metrics were recorded for each phase using Tobii Studio and a Tobii TX-300 eyetracker.  During Phase 1, an AOI encompassed the leftmost 25% of the display (10.41 x 23.41 visual degrees) where stimuli were presented, and was used to determine the amount of time that participants attended to the first 15 s of the trial.

During Phase 2, the AOI was defined along the path of motion followed by the moving shadow, forming a rectangle of 8.72 by 21.96 visual degrees. This AOI was selected instead of the area immediately surrounding the moving shadow because visual attention to a moving object often anticipates the objects' movement by looking ahead to where the object will appear, in addition to looking directly at the object. During Phase 3, the AOI surrounded the target stimulus (located at the coordinates 1695 X 640 pixels), with an additional error margin of 0.90 visual degrees to compensate for measurement error inherent in infant studies using eye-tracking data (Oakes, 2012).

The looking time metric that was used for all AOIs in this study was total dwell time (referred to as Total Visit Duration in Tobii Studio 3.1). This corresponds to the absolute time spent inside the AOI and in many cases included multiple fixations to the AOI. Total Visit Duration was selected over alternative metrics, such as number of fixations, because there is no agreed upon convention about what constitutes a visual fixation in infancy (Oakes, 2012).

**A priori power analysis.** A priory power analysis was conducted with the results of Träuble et al. (2014) serving as input metrics for this calculation. The selection of Träuble et al. (2014) is justified by the fact that this is the only other study to use the shadow paradigm in infancy, because the current study uses a different motion pattern this might influence the accuracy of this power estimate. Using G*Power (Version 3.1), specifying a desired power level of .90, an effect size of $\eta^2$ =.50, which was converted into an effect size *f*=1.00. The a priori power analysis revealed that in order to achieve a power of .90, a sample size of 20 would be required in order to achieve statistically significant results at the $\alpha$=.05 level (*f*=3.24).

## Results

Due to the relatively high attrition rate in this study it was important to select a method of analysis that would retain a maximum number of cases and would not violate the assumptions of standard parametric tests (Kline, 2004). Two mean difference contrasts with confidence intervals were used to test the hypothesis that a congruency effect exists for each motion type. An effect size estimate using the metric Hedge's g was also used to determine the magnitude of the congruency effects that were found in these contrasts. Separate mean difference contrasts, and effect size estimates, were initially performed for 10- and 18-month-olds. These analyses revealed that the pattern and magnitude of differences was similar for both age groups. In order to increase sample size, the data were combined across ages and these analyses are reported below.

The first contrast was performed between biological congruent trials (*M* = 5.96 s, *SD* = 3.31, 95% CI [4.68, 7.25]) and biological incongruent trials (*M* = 4.53 s, *SD* = 2.97, 95% CI [3.27, 5.78]). The difference score of this contrast was found to be (*M* = 1.44 s, *SD* = 3.16, 95% CI [-.33, 3.20], *g* = .45). Therefore, a population mean contrast as low as -.33 s is just as consistent with the observed data as is a population mean contrast as high as 3.20 s with 95% confidence. The unbiased effect size obtained (*g* = .45) falls within the range of a medium effect. Although 0 is contained within the confidence interval, it would be premature to conclude that there is no substantive difference between these two trial types. Zero is one of a range of possible scores and should receive no special status (Kline, 2004). However, the fact that 0 is contained within the confidence interval for the difference score suggest that replication is needed to test the stability of this effect. The implication of these findings is that the difference between congruency types for biological motion results in a moderate effect.

The second contrast was performed between rigid congruent trials (*M* = 5.13 s, *SD* = 3.62, 95% CI [3.57, 6.70]) and rigid incongruent trials (*M* = 5.24 s, *SD* = 2.82, 95% CI [4.05, 6.43]). The difference score of this contrast was found to be (*M* = -.11 s, *SD* = 3.23, 95% CI [-2.10, 1.79], *g* = .03). Therefore, a population mean contrast as low as -2.10 s is just as consistent with the observed data as is a population mean contrast as high as 1.79 s with 95% confidence. The unbiased effect size obtained (*g* = .03) signifies a very small effect. In summary, the mean difference contrasts and effect size estimates revealed that the congruency effect for biological motion was moderate and the congruency effect for rigid motion was negligible.

## Discussion

The goal of Experiment 1 was to investigate whether schematic biological motion serves as a cue to the concept of animacy in infancy. It was hypothesized that infants would look longer at trials that paired biological motion with vehicles, as this pairing should violate the expectation that was created during Phases 1 and 2 each trial. The findings of Experiment 1 found a moderate effect, with infants looking longer on average at the congruent pairings of schematic biological motion with animals, than at the incongruent pairings of biological motion and vehicles. The prediction of a standard violation of expectation effect was based on the findings presented in Träuble et al. (2014). The major difference between this study and the current one was the motion style presented; schematic biological motion was used in the current study, and changes in speed and direction were presented in Träuble et al. (2014). Mandler (2004; 2012) and Rakison and Poulin-Dubois (2001) propose that changes in speed and direction constitute a motion pattern that serves as a primitive for an animacy concept early in development, whereas biological motion does not. Indeed, in a study with adults, Tremoulet and Feldman (2000) found that changes in speed and direction in simple geometric shapes were crucial for animacy attribution. Although our findings did not show the expected violation of expectation pattern (i.e., longer looking time for incongruent trials), the moderate effect for schematic biological motion is consistent with a congruency preference. The implications of this pattern will be discussed in the general discussion.

Experiment 1 presented infants with familiar exemplars of animates (i.e., dog, cow). It is possible that by 10- months of age infants may have had sufficient experience with the motion of these animals to know that they do not produce caterpillar-like motion, and this knowledge may have interfered with building an animacy expectation for this motion in Phase 2. If this interpretation is correct, then it is possible that an animacy expectation and looking patterns similar to Träuble et al. (2014) would be more likely to be observed with animate stimuli whose morphology is naturally conducive to this style of motion (i.e., animals without legs). In order to test this hypothesis, Experiment 2 used a worm and caterpillar as the animate exemplars with the same motion contrasts and shadow paradigm of Experiment 1.

## Experiment 2

The findings of Experiment 1 raised the question of whether infants may more readily build expectations for animacy when the particular animals used in testing are more naturally matched to the biological motion portrayed by the shadow. Although it is not clear how much real world experience may be needed with the motion of animals to impact infants' expectations, children as young as three years used the terms worm and caterpillar to describe Michotte's motion stimuli (Schlottmann et al., 2002). Thus, in Experiment 2 we tested whether 10-month-old infants would be more likely to show the congruency effect predicted in Experiment 1 when the animates were more natural exemplars of Michotte's biological motion (i.e., worm, caterpillar).

An important limitation of Experiment 1 was the high rate of attrition found in both age groups. Attrition is a significant problem in infancy research, especially in visually based studies such as the current one (Slaughter & Suddendorf, 2007). In order to reduce attrition as much as possible in Experiment 2, minor changes to the timing of the phases were introduced, along with auditory signals when the screens opened or closed.

### Method

**Participants.** A total of 33 10-month-old infants (*M* =10 months, 15 days; range = 9 months, 28 days to 10 months, 25 days), 20 females and 13 males were tested. Three were excluded due to fussiness, and seven were excluded due to inattentiveness. Inattentiveness was operationally defined the same way as Experiment 1. In order to be included, participants must have paid attention on the test and motion phases on a minimum of two trials with the same motion pattern.  The final sample included 23 10-month-olds (*M* =10 months, 13 days; range = 9 months, 28 days to 10 months, 25 days), 13 females and 10 males.

**Materials.** The materials used in Experiment 2 were the same as those of Experiment 1, with the exception that the animate exemplars were realistic images of a caterpillar and a worm instead of cow and dog. The inanimate exemplars were the same motorcycle and truck images from Experiment 1.

**Procedure.** All aspects of the procedure for Experiment 2 were identical to those of Experiment 1 with the following exceptions. To improve the attention of participants throughout the procedure, the speed of presentation of Phase 1 increased, resulting in the duration being shortened from 25 s to 15 s. Additionally, every time a screen opened or closed a brief chime sound was played to highlight the event. Although these minor changes would not allow a direct comparison of Experiment 2 findings to those of Experiment 1 or of Träuble et al. (2014), stemming the attrition rate of Experiment 1 was an important goal of Experiment 2.

### Results

There was also a high attrition rate in Experiment 2. Thus, mean difference contrasts with confidence intervals were used to test the hypothesis that a congruency effect existed for each motion type on test trials using the new stimuli. An effect size analysis using Hedge's g was also used to determine the magnitude of the congruency effects that were found in these contrasts.

The first contrast was performed between biological congruent trials (*M* = 5.77 s, *SD* = 3.59, 95% CI [4.09, 7.53]) and biological incongruent trials (*M* = 6.05 s, *SD* = 3.38, 95% CI

[4.46, 7.63]). The difference score of this contrast was found to be (*M* = -.28 s, *SD* = 3.49, 95% CI [-2.51, 1.95], *g* = .08). The results of this contrast suggest that a population mean contrast as low as -2.51 s is just as consistent with the observed data as is a population mean contrast as high as 1.95 s with 95% confidence. The unbiased effect size obtained (*g* = .08) falls within the range of range of a small effect. The implication of these findings is that the difference between congruency types for biological motion results in a small effect.

The second contrast was performed between rigid congruent trials (*M* = 5.63 s, *SD* = 3.30, 95% CI [4.04, 7.22]) and rigid incongruent trials (*M* = 5.26 s, *SD* = 4.24, 95% CI [3.28, 7.24]). The difference score of this contrast was found to be (*M* = .37 s, *SD* = 3.81, 95% CI [-2.10, 2.84], *g* = .10). Therefore, a population mean contrast as low as -2.10 s is just as consistent with the observed data as is a population mean contrast as high as 2.84 s with 95% confidence. The unbiased effect size obtained (*g* = .10) signifies a small effect. In summary, the mean difference contrasts and effect size estimates revealed that the congruency effects for both biological motion and rigid motion were small.

## Discussion

Experiment 2 sought to investigate whether 10-month-old infants would expect that the schematic biological motion presented was made by animals that could move in this way. It was expected that congruency between the test objects (i.e., worm and caterpillar) and the biological motion cue in Experiment 2 would be an easier association for infants than that for the test objects presented in Experiment 1. This association can be made on the basis of perceptual cues, and does not require infants to extend the causal attribution of this motion pattern to animates in general. Experiment 2 found that 10-month-old infants did not readily associate the Michotte motion stimulus with the morphologically similar exemplars. One explanation of these findings is that in order to make the perceptual inference described above, infants would require experience with the motion of worms and caterpillars. This experience is almost certainly present for the 3-year-olds who labeled the stimuli as such (Schlottmann et al., 2002), but may not be typical for 10-month-olds. Thus, the younger infants in Experiment 2 may not have sufficient experience with the motion of worms and caterpillars to appreciate the natural congruence of these exemplars with the Michotte's motion stimulus.  This interpretation could be supported in future research by the addition parental questionnaires that assess participants' lifetime exposure the objects used as stimuli.

Although the worm and caterpillar stimuli do move in a similar fashion to the Michotte motion stimuli, there are other reasons that they may be more difficult to associate with animacy. From a cue-based approach to animacy attribution, it is clear that worms and caterpillars are lacking many morphological cues to animacy. Most importantly, these stimuli do not have faces, which have been reported to be strong static cues to animacy (Opfer & Gelman, 2010). Future research could assess the importance of these cues by including facial features on the worm and caterpillar stimuli. Additionally, the importance of these cues could be tested in combination with the dynamic cues of changes in speed and direction of the shadow stimuli, which have been shown to elicit category-based expectations by 7- months of age (Träuble et al., 2014).

## General Discussion

The current study investigated the effectiveness of schematic biological motion as a cue for animacy in 10- and 18-month-olds across two experiments.  Although a standard VOE pattern of looking (i.e., longer looking on incongruent trials) was expected based on previous findings using the shadow paradigm (Träuble et al., 2014), the results of Experiment 1 showed that infants looked longer during congruent trials for the biological motion condition. There was no differential looking on rigid motion trials in Experiment 1. When category exemplars were changed in Experiment 2 to be more compatible with schematic biological motion, infants did not look differentially across congruent vs. incongruent trials for either type of motion. The preference for congruent stimuli (e.g., dog ) with biological motion trials in Experiment 1 is an interesting effect that needs further discussion.

Interpretation of the findings from looking time experiments with infants has been the subject of debate for many years (Cohen, 2004; Munakata, 2000). The decision of whether longer looking time denotes a preference or a violation of expectation must be made in the context of the study design and the developmental trajectory (Houston-Price & Nakai, 2004). The dynamic model of attentional preference (Hunter & Ames, 1988) can inform this debate. This model predicts that there can be a shift in preference from familiar stimuli to novel stimuli with repeated exposure. This shift is thought to occur when encoding of the familiar stimulus is complete, or when there is no discrepancy between the internal representation of the stimulus and the stimulus input (Houston-Price & Nakai, 2004). Depending on the study design and the stimuli under investigation, preference shifts may occur over a relatively short (e.g., over a number of trials in an experiment), or long (i.e., over months of real world experience) period. From the perspective of the dynamic model of attentional preference, anomalous looking time findings may sometimes be due to such a shift of preference. As evidence for this position, it would be expected that individual looking time patterns should change according to the level of exposure to the stimuli. Likewise, looking time patterns should change as infants acquire real world experience with items that are related to the test stimuli. Although this account is plausible, it has rarely been tested using the longitudinal designs needed to evaluate the impact of repeated exposure (Roder, Bushnell, & Sasseville, 2000). While we did not provide extensive exposure within a longitudinal design in the present experiment, we did sample across two age groups (10- and 18-months). Infants at these ages would be expected to differ extensively in their real world perceptual experience with exemplars from the test categories (e.g., animals, vehicles). Contrary to the dynamic model of attentional preference model (Hunter & Ames, 1988), the pattern of findings was the same across age groups in Experiment 1.

There are a number of explanations for the prevalence of null results observed over Experiments 1 and 2. One possibility is that power was not sufficiently high to detect an effect of congruency that was present in the population. A priory power analysis revealed that a sample size of 20 would be sufficient to achieve statistically significant results, this sample size was achieved in both experiments therefore this is an unlikely explanation. A second explanation is that the shadow procedure failed to accurately assess infant's ability the form animacy expectations based on the motion of a morphologically ambiguous shadow. This explanation is also unlikely given the success of Träuble et al. (2014) using this design with the motion cue of changes in speed and direction. A final possibility is that schematic biological motion does not serve as a cue to animacy in infancy, a possibility that this discussion will be explored in detail.

Our findings contrast with those of Träuble et al. (2014), who employed the same shadow paradigm. The 7-month-old infants in Träuble et al. (2014) looked longer on incongruent than congruent trials for a different type of biological motion cue (i.e., changes in speed and direction) than the schematic motion used in the current studies. The fact that the animate motion cues were different between these two studies is the most plausible explanation for the difference in findings. Changes in speed and direction are well-established cues to animacy in infancy (Pauen & Träuble, 2009; Poulin-Dubois, et al., 1996), but when he association between Michotte's caterpillar stimuli and animacy is established in infancy remains an open question.

The only study to suggest that Michotte's (1963) motion stimulus may elicit the concept of animacy in infancy was that of Schlottmann and Ray (2010), who reported that 6-month-old infants attributed goals to a square that moved in this manner. As was discussed previously, goal attribution and animacy attribution are not equivalent. Schlottmann and Ray's findings would make a more compelling case for animacy attribution if not for the extensive research (Csibra et al., 1999; Gergely et al., 1995; Luo & Baillargeon, 2005; Shimizy & Johnson, 2004) that provides evidence that infants attribute goals to entities that do not exhibit any cues to animacy (e.g., rigidly moving geometric forms). Although it is possible that 6-month-old infants have formed an association between goal directedness and animacy, a more parsimonious interpretation of the evidence to date is that goals are initially attributed without association to animacy.

A recent study by Poulin-Dubois, Crivello, and Wright, (2014) provides additional and converging evidence about the effectiveness of schematic motion cues to animacy using a different task. These researchers investigated whether priming with biological motion, using either point-light displays or Michotte's schematic biological motion stimulus, improved 12-month-old infants' ability to subsequently categorize animals and vehicles in a sequential touching task. The sequential touching task has been used to assess categorization in infancy (Mareschal & Quinn, 2001). The order in which infants touch objects is recorded, and sequential touching of objects from the same category at levels above chance is considered to provide evidence of categorization. The first experiment in Poulin-Dubois et al. (2014) primed infants by exposing them to a point-light display of a human walking. Priming resulted in improved categorization of animals in a subsequent sequential touching task that contrasted animals vs. vehicles, but did not impact categorization of two inanimate categories (i.e., furniture and vehicles). In a second experiment, Michotte's (1963) stimulus was the biological motion prime. There were two separate exemplars of this motion pattern; a square identical to Michotte's original stimulus and a curvilinear shape similar to the shadow stimulus used in the present studies. Poulin-Dubois et al.'s second experiment found no priming effect for either exemplar. Taken together, these findings provide evidence that by the end of the first year, infants associate point light displays of a human walking to the domain general category of animates, but they do not yet incorporate Michotte's schematic motion stimulus to this conceptual framework.

Although we perceive biological motion from birth (Simion et al., 2008), the role it plays in building a concept of animacy remains unknown (Mandler, 2012). Motion-based theories of early conceptual development propose that unlike the motion cues identified by Rakison and Poulin-Dubois (2001), biological motion is not a primitive feature in building a concept of animacy (Mandler, 2004; 2012; Poulin-Dubois et al., 2014; Rakison & Poulin-Dubois, 2001). Perceptual associations between primitive movement cues (e.g., self-propelled movement) and objects can be learned without inferential thought (i.e., without engaging a conceptual process) (Mandler, 2012). If biological motion, in particular the schematic biological motion presented in the current studies, does not serve as an early primitive for animacy, then it may play an indirect role. Specifically, as a result of experience, biological motion may be associated with particular animals that have been categorized as animate on the basis of other motion primitives. Infants are not likely to have sufficient experience with animals that move like the caterpillar stimulus and thus may not make the link to animacy. This interpretation is suggesting that with such experience, infants would associate biological motion (including the Michotte stimulus) to animacy, but only for exemplars that have been previously associated with it. A training study would be useful to assess this interpretation. Exposing infants to videos of natural exemplars (e.g., caterpillars and worms) that move in this fashion may accelerate the process by which this motion becomes associated with animacy. Alternatively, infants could be trained with exposure to a shadow that moves with schematic biological motion, and other primitive motion cues (e.g., changes in speed and direction). If infants could be induced to associate schematic biological motion with other pre-existing (primitives) cues to animacy in the laboratory, this might provide insight into how this cue is naturally associated with animacy.

The attrition rate of the current experiments (57.14% lost in Experiment 1; 30.30% lost in Experiment 2) is an important limitation. Slaughter and Suddendorf (2007) conducted a meta-analysis to investigate the attrition rate of infants in habituation and violation of expectation studies with infants under 12 months of age. The analysis included over one hundred articles published between 1987-2007, and identified the reasons for exclusion. On average, 13.7% (range 0 to 62%) of infants failed to complete the procedures in these studies due to ‘fussiness’. This attrition rate may underestimate the true rate of exclusion of participants in infancy research due to the ‘file drawer problem’, that is, the problem of underreporting of findings that are not statistically significant. The result of a truncated sample size is a decrease in power and likelihood of obtaining statistically significant results, which negatively impacts publication success (Kline, 2004).

Regardless of the true rate of attrition in infancy studies, loss of participants due to ‘fussiness’ is problematic because it might not be the result of random changes in temperamental state. Wachs and Smitherman (1985) reported a significant correlation between mother’s rating of temperament and infant attrition during a visual habituation paradigm. This suggests that experimenters may be unintentionally eliminating participants who have a temperamental disposition that is not suited to a procedure. If so, then the remaining sample of infants would no longer be representative of the population as a whole.

In the current studies relatively few infants (seven in Experiment 1, three in Experiment 2) were eliminated due to fussiness. The majority of exclusions in the present studies were based on inattentiveness, which was operationally defined as the failure of infants to attend to both the motion (for at least 2 s) and test phases of a trial. Although the objective nature of this criterion eliminates experimenter bias, it may still lead to systematic elimination of participants due to differences in attentional ability.

In the future, it will be imperative to modify the task to maximize the retention of participants to ensure the sample is representative of the population. Additionally, better retention of participants will enhance power and clarify whether the findings reported in the current studies accurately reflect infants' inability to utilize biological motion cues, or instead whether lack of power is masking the ability. The modifications to the procedure in Experiment 2 did result in a much lower attrition rate, though the percentage of participants who completed all four test trials was still relatively low (30.30%). One possible additional modification of the present task that might yield a higher retention rate would be to eliminate the introductory phase of each trial. Träuble et al. (2014) found that presenting the static images of test items in Phase 1 was not necessary in order to establish an animacy-specific relation between the dynamic (i.e., changes in speed and direction) and static images of cues to animacy (i.e., animals). They reported the same pattern of looking whether the introductory phase was present or absent. By eliminating the introductory phase, the attentional demands of the current task would be significantly improved, as the trial length would be reduced from 50 to 25 s.

## Conclusion

The current studies sought to investigate infants' ability to relate schematic biological motion cues to static images of animals. Although this relationship was not observed in either Experiment 1 or Experiment 2, the ontogenetic origin of the relationship between Michotte's motion stimuli and the concept of animacy remains an open and important question. The earliest demonstration of an explicit understanding that this motion pattern is animate or "animal like" came from the 3-year-old participants of Schlottman et al. (2002). There is also evidence of an association between schematic biological motion and goal attribution as early as 6- months-of-age (Schlottmann and Ray, 2010). However, the recent findings of Poulin-Dubois et al. (2014), along with the current results, challenge the suggestion that Michotte's schematic biological motion serves as a primitive cue to animacy in infancy.

The goal of future research will be to map out the developmental trajectory of schematic biological motion, and its role in animacy concept formation. Researchers will need to identify the processes that support the development of an animacy concept, and determine whether biological motion is initially associated to other animacy cues before infants then generalize it as a cue to animacy. Exactly how this associative process unfolds will be an important goal in future research. It will also be important to extend the age range to examine the development from early, implicit understanding and utilization of animacy cues to later, more explicit understanding that can be articulated in conscious thought. Schlottmann and Ray (2010) provided evidence that may be relevant to the potential onset and implicit use of biological motion cues in animacy attribution, and Schlottmann et al. (2002) presented findings relevant to the question of when such an understanding can be explicitly articulated. The findings from the present studies are inconclusive on the question of exactly how biological motion cues become associated with the concept of animacy over development, but have converged on the claim that biological motion is not likely a primitive cue early in infancy (Mandler, 2014; Rakison & Poulin-Dubois, 2001). The question of perceptual primitives remains vital to our understanding of the mechanisms that underlie early conceptual development in general and the core concept of animacy in particular.

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*Figure 1*. The phases for the animated scenes for the shadow paradigm.

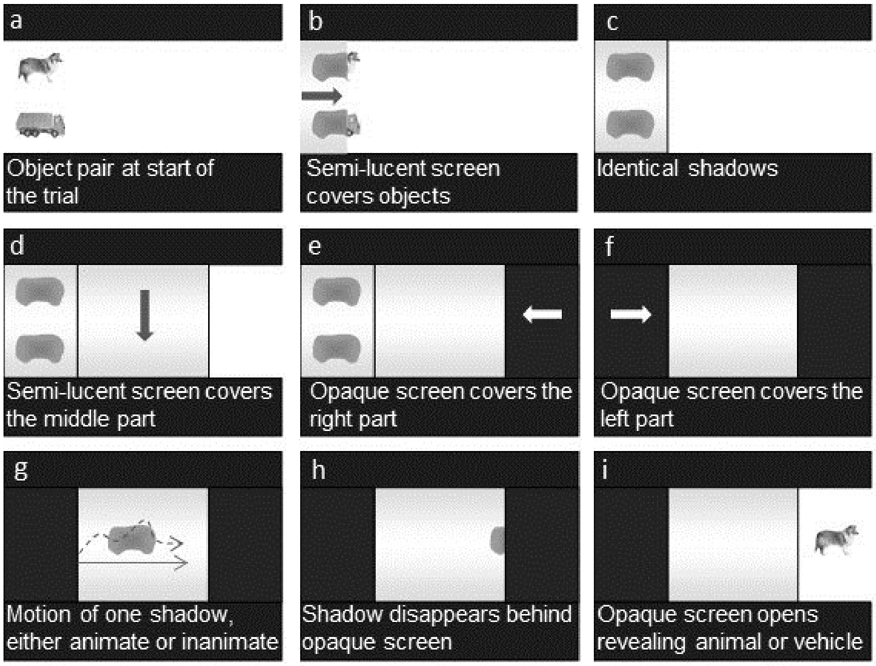


*Figure 2*. Object-pairs, motion patterns and test-outcomes presented on each trial.

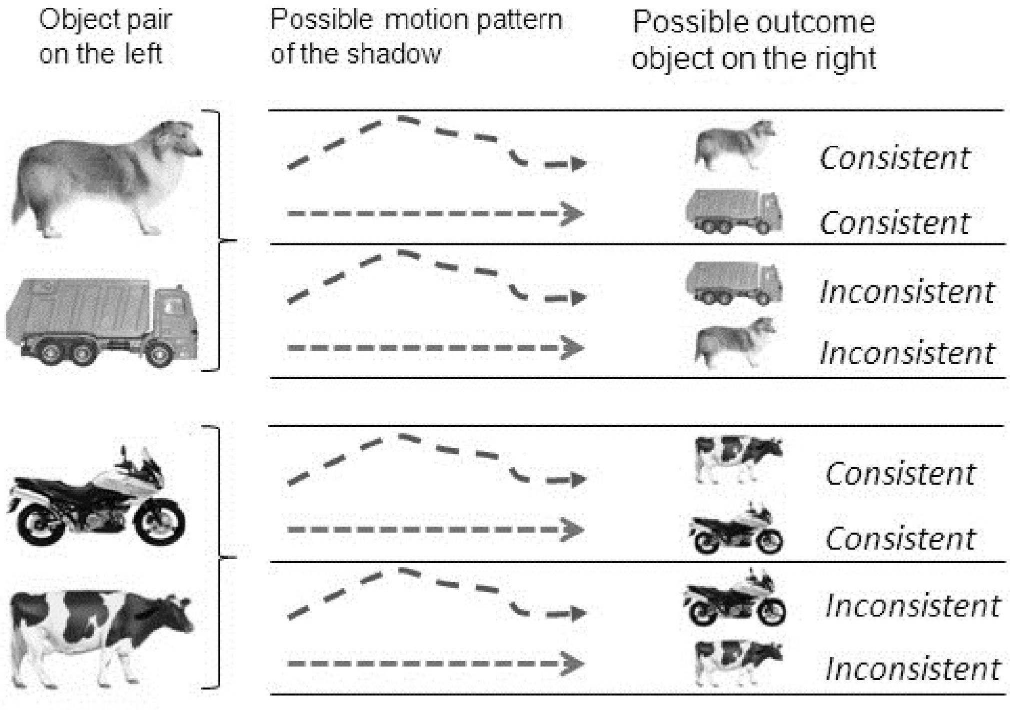


*Figure 3*. Total looking time during test phase in Experiment 1

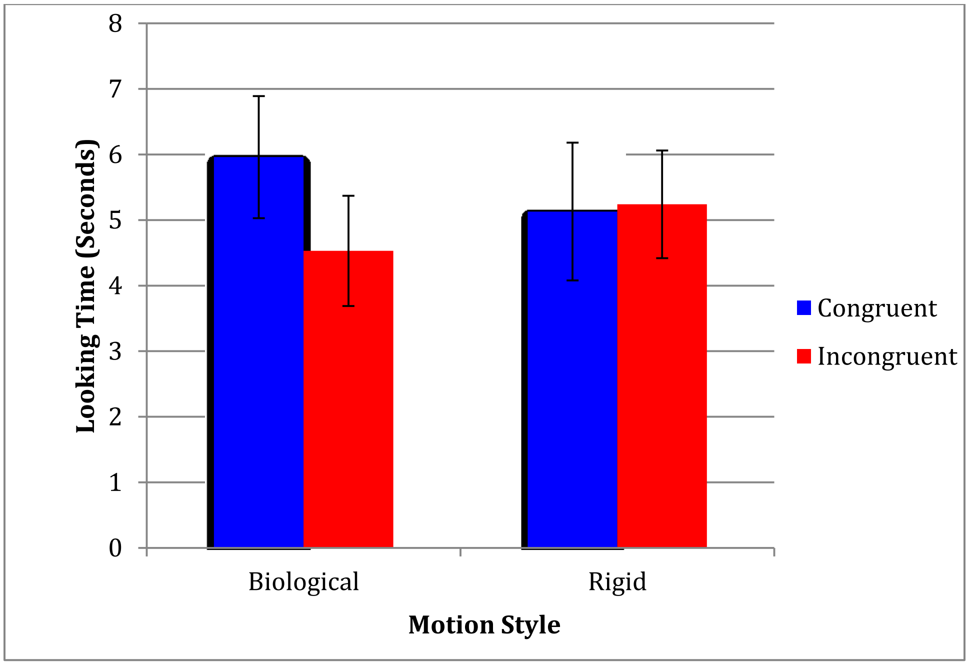
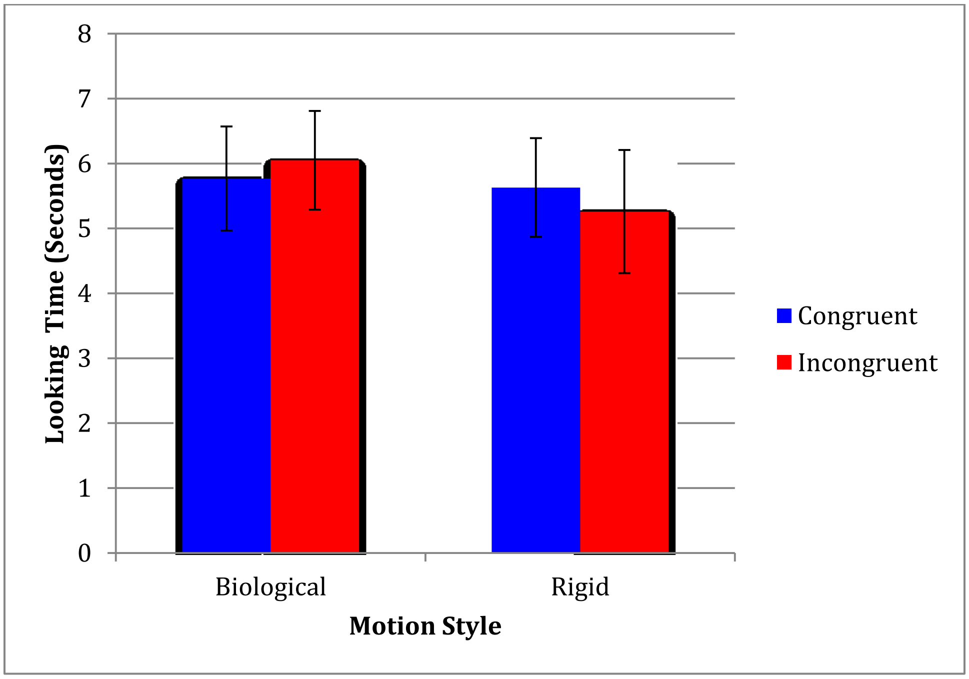


*Figure 4*. Experiment 2 looking time metrics for test phase



# Appendix A: Sample Recruitment Letter

Dear Parent(s),

The Cognitive and Language Development Laboratory, part of the Center for Research and Human Development at Concordia University, is presently involved in a study examining whether infants understand the link between motion and living versus nonliving objects. Our research has been funded by federal and provincial agencies for the past twenty-five years and our team is internationally recognized for its excellent work on early child development. Our articles are frequently published in prestigious journals such as "Infancy" and "Developmental Science". You might also have heard about our studies on national radio or on the *Discovery Health Channel*.

The Commission d'Accès à l'Information du Québec has kindly given us permission to consult birth lists provided by the Agence de la santé et des services sociaux de Montréal. Your name appears on the birth list of July 2012, which indicates that you have a child of an age appropriate for our study. We therefore invite you to participate in one of our new studies and have the unique experience of learning more about your child and child development, as well as contributing to research in this field!

Your child's participation in the study will involve watching a few computer animated video clip. They will see novel shapes, animals, and vehicles moving across a screen. We will be recording his or her eye gaze throughout these activities. During all tasks, your child will be seated on your lap or in a baby seat with you seated directly behind. We will videotape your child's responses and all tapes will be treated in the strictest of confidentiality.

Overall, your participation will involve approximately **one 45-minute visit** to our laboratory at the Loyola Campus of Concordia University, located at 7141 Sherbrooke Street West, in Notre-Dame-de-Grace. Appointments can be scheduled at a time which is convenient for you and your child, including weekends. Free parking is available on the campus and we offer babysitting for siblings who come to the appointment. Upon completion of the study, a Certificate of Merit for Contribution to Science will be given to your child, and you will be offered a financial compensation of 20$ for participating. A summary of the results of our study will be mailed to you once it is completed.

For the purposes of this study, we are looking for infants who are **10-18 months of age**, who have **English or French as a first language**, and who do not have any visual or hearing difficulties. If you are interested in having your child participate in this study, or would like any further information, please contact **Monyka Rodrigues at (514) 848-2424 ext. 2279**, or Dr. Diane Poulin-Dubois at (514) 848-2424 ext. 2219. For more information on our studies, please visit our website at http://crdh.concordia.ca/dpdlab/. We will try to contact you by telephone within a few days of receiving this letter.

We are looking forward to speaking with you in the near future.

Sincerely yours,

Diane Poulin-Dubois, Ph.D.
Professor
Department of Psychology

Monyka Rodrigues, B.A.
Laboratory Coordinator
Department of Psychology

John Corbit, B.A.
Master's Student
Department of Psychology

# Appendix B: Sample Parental Consent Form

## Parental Consent Form

This is to state that I agree to allow my child to participate in a research project being conducted by Dr. Diane Poulin-Dubois, in collaboration with graduate student John Corbit of Concordia University.

### A. PURPOSE

I have been informed that the purpose of the research is to examine children's understanding the distinction between living and nonliving objects as well as how infants process familiar and unfamiliar languages.

### B. PROCEDURES

Your child's participation in the study will involve watching a few video clips. Infants will see novel shapes, animals, and vehicles moving across a screen. They will also be given a series of toy animals, vehicles, and furniture and allowed to play with each toy for a brief period of time. In the final task, your child will be looking at a screen where faces speaking different languages will be presented. We want to know the part(s) of the faces your child will focus on. We will be recording his or her eye gaze throughout these activities. During all tasks, your child will be seated on your lap or in a baby seat with you seated directly behind. We will videotape your child's responses and all tapes will be treated in the strictest of confidentiality.

We will videotape your child's responses and all tapes will be treated in the strictest of confidentiality. That means that the researcher will not reveal your child's identity in any written or oral reports about the study. You and your child will be assigned a coded number, and that code will be used on all materials collected in this study. All materials and data will be stored in secure facilities in the Department of Psychology at Concordia University. Only members of the research team will have access to these facilities. Questionnaires and electronic datafiles will be identified by coded identification numbers, unique to each family. Information collected on paper (questionnaires) or videotapes (observed behaviours) will be entered into computer databases. Raw data will be kept for a minimum of 5 years. When it is time for disposal, papers will be shredded, heard-drives will be purged, and videotapes and computer disks will be magnetically erased.

As well, because we are only interested in comparing children's understanding as a function of age, no individual scores will be provided following participation. The whole session should last approximately 60 minutes. During all tasks, your child will be sitting in a child seat and you will be seated directly behind.

### C. RISKS AND BENEFITS

Your child will be given a certificate of merit at the end of the session as a thank-you for his/her participation. Also, you will be offered 20$ for your participation.

There are no procedures in this investigation that inquire about child maltreatment directly. However, by the laws of Québec and Canada, if the researchers discover information that indicates the possibility of child maltreatment, or that your child is at risk for imminent harm, they are required to disclose this information to the appropriate agencies. If this concern emerges, the lead researcher, Dr. Diane Poulin-Dubois, will discuss the reasons for this concern with you and will advise you of what steps will have to be taken.

### D. CONDITIONS OF PARTICIPATION

- I understand that I am free to withdraw my consent and discontinue my participation at any time without negative consequences, and that the experimenter will gladly answer any questions that might arise during the course of the research.
- I understand that my participation in this study is confidential (i.e. the researchers will know, but will not disclose my identity).
- I understand that the data from this study may be published, though no individual scores will be reported.

I would be interested in participating in other studies with my child in the future (yes/no): ______

I HAVE CAREFULLY STUDIED THE ABOVE AND UNDERSTAND THIS AGREEMENT. I FREELY CONSENT AND VOUNTARILY AGREE TO HAVE MY CHILD PARTICIPATE IN THIS STUDY.

MY CHILD'S NAME (please print) ________________________________

MY NAME (please print) ______________________________________

SIGNATURE ________________________ DATE _________________

WITNESSED BY _____________________ DATE _________________

If at any time you have questions about your rights as a research participant, you are free to contact the Research Ethics and Compliance Officer of Concordia University, at (514) 848-2424 ext 7481 or by email at ethics@alcor.concordia.ca.

| | |
|---|---|
| _______________________ | _______________________ |
| Diane Poulin-Dubois, Ph.D. | John Corbit, Bsc. |
| Professor | M.A. Candidate |
| Department of Psychology | Department of Psychology |
| 848-2424 ext. 2219 | 848-2424 ext. 2279 |
| diane.poulindubois@concordia.ca | johncorbit@gmail.com |

Participant # ___________

Researcher: ________________

# Appendix C: Demographics Questionnaire

## Cognitive and Language Development Laboratory Participant Information

**Child's Name:** ______________________________
First Last

**Child's Date of Birth:** ________________ **Child's Gender:** ☐**M** ☐**F**
MM / DD / YY

### Basic Family Information

Parent A's Full Name: ______________________________ ☐**M** ☐**F**
First Last

Parent B's Full Name: ______________________________ ☐**M** ☐**F**
First Last

Address (including **postal code**):

______________________________

______________________________

| **Phone numbers** | **Where?** (e.g. home, Mom work, Dad cell) |
|---|---|
| 1. | |
| 2. | |
| 3. | |
| 4. | |
| 5. | |

**E-mail**: ______________________________

Does your child have any siblings?

| **Name of Sibling** | **Date of Birth** | **Gender** | **Can we contact you for future studies for this child?** |
|---|---|---|---|
| | | **M F** | ☐**Yes** ☐**No** |
| | | **M F** | ☐**Yes** ☐**No** |
| | | **M F** | ☐**Yes** ☐**No** |

### Languages Spoken in the Home and at Childcare

What percent of the time does your baby hear **English**? _________ **%**

What percent of the time does your baby hear **French?** _________ **%**

What percent of the time does your baby hear **another language**? _________ **%**
Please specify this language**:**________________________

Has the child lived/vacationed in any country **where s/he would hear a language other than English or French**? ☐**Yes** ☐ **No**
If yes, please detail (when, where, and for how long?) _________________________________

## Health History

Parent A age: ____________ Parent B age: ____________

What was your child's birth weight? __ __ **lbs** __ __ **oz** OR __ __ __ __ **grams**

How many weeks was your pregnancy? ____________**weeks**

Were there any **complications** during the pregnancy? ☐**Yes** ☐ **No**
If yes please detail ________________________________________________________

Has your child had any major **medical problems**?
If yes please detail_________________________________________________________

Does your child have any **hearing or vision problems**?
If yes please detail_________________________________________________________

Does your child **currently** have an ear infection? ☐**Yes** ☐ **No**

Has your child had any ear infections **in the past**? ☐**Yes** ☐ **No**
If yes at which ages_________________________________________________________

Does your child have a **cold** today? ☐**Yes** ☐ **No**

If yes, does he/she have pressure/pain in ears (if known)? ☐**Yes** ☐ **No**

Is there any other relevant information we should know (health or language-related)?

---

Has another university contacted you to participate in one of their studies? ☐**Yes** ☐ **No**
If yes, which university? _________________________________

## Family and Child Background Information (optional)

Parent A marital status:____________________Parent B marital status:_______________

**Parent A's Current Level of Education**
Check any/all that apply:

☐ Primary School
☐ Some High School
☐ High School
☐ Some College/University
☐ College Certificate/Diploma
☐ Trade School Diploma
☐ Bachelor's Degree
☐ Master's Degree
☐ Doctoral Degree
☐ Professional Degree
☐ Not Applicable/Unknown
☐ Other (please specify):
_____________________________________
_____________________________

**Parent B's Current Level of Education**
Check any/all that apply:

☐ Primary School
☐ Some High School
☐ High School
☐ Some College/University
☐ College Certificate/Diploma
☐ Trade School Diploma
☐ Bachelor's Degree
☐ Master's Degree
☐ Doctoral Degree
☐ Professional Degree
☐ Not Applicable/Unknown
☐ Other (please specify):
_____________________________________
_____________________________

**Parent A's Occupational Status** (optional)
Check any/all that apply:

☐ Employed Full-Time
☐ Employed Part-Time
☐ Stay-at-Home-Parent
☐ Student
☐ Unemployed
☐ Not Applicable/Unknown
☐ On Temporary Leave (e.g., maternity, paternity, sick, etc.; **please also check status when *not* on leave**)
☐ Other (please specify):
____________________________
☐ Occupation
____________________________

**Parent B's Occupational Status** (optional)
Check any/all that apply:

☐ Employed Full-Time
☐ Employed Part-Time
☐ Stay-at-Home-Parent
☐ Student
☐ Unemployed
☐ Not Applicable/Unknown
☐ On Temporary Leave (e.g., maternity, paternity, sick, etc.; **please also check status when *not* on leave**)
☐ Other (please specify):
_________________________
☐ Occupation

Income bracket for the entire household (per year/before tax):
☐ < $22 000
☐ Between $22 000 and $35 000
☐ Between $35 000 and $50 000
☐ Between $50 000 and $75 000
☐ Between $75 000 and $100 000
☐ Between $100 000 and $150 000
☐ > $150 000

What language community do you (and your partner) identify with?
Check any/all that apply:

☐ Anglophone
☐ Francophone
☐ Allophone
☐ Other (please specify): ____________________________________________

What are your child's ethnic origins?
Check any/all that apply:

☐ Aboriginal
☐ African
☐ Arab
☐ West Asian
☐ South Asian
☐ East and Southeast Asian
☐ Caribbean
☐ European
☐ Latin/Central/South American
☐ Pacific Islands
☐ Not Applicable/Unknown
☐ Other (please specify):
____________________________________________

What culture do you (and your partner) identify with?
Check any/all that apply:

☐ Aboriginal
☐ African
☐ Arab
☐ West Asian
☐ South Asian
☐ East and Southeast Asian
☐ Caribbean
☐ European
☐ Latin/Central/South American
☐ Pacific Islands
☐ Not Applicable/Unknown
☐ Other (please specify):
____________________________________________