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Abstract: Adults' and 8-year-old children's perception of emotional faces is disrupted when faces are presented in the context of incongruent body postures (e.g., when a sad face is displayed on a fearful body) if the two emotions are highly similar (e.g., sad/fear) but not when if are highly dissimilar (e.g., sad/happy). The current research investigated the emergence of this adult-like pattern. Using a sorting task, we identified the youngest age at which children could accurately sort isolated facial expressions and body postures and then measured whether their accuracy was impaired in the incongruent condition. Six-year-old children showed congruency effects for sad/fear but even 4-year-old children did not for sad/happy. Early emergence of this adult-like pattern is consistent with the dimensional and emotional seed models of emotion perception and with evidence that by age 4 to 6 years children's representation of emotion is largely adult-like, although sensitivity to several categories continues to develop until middle childhood

1) Cover Letter

April 11, 2012

Dear Dr. Bjorklund,

We are submitting the attached manuscript, *Wide eyes and drooping arms: Adult-like congruency effects emerge early in the development of sensitivity to emotional faces and body postures,* for publication in the Journal of Experimental Child Psychology. Past research investigating the development of sensitivity to facial displays of emotion during childhood has been limited primarily to the presentation of isolated faces. During daily social interactions, however, children encounter facial expressions in the context of background scenes, body postures, gestures, etc. Recent research has shown that adults' perception of facial expressions is influenced by these contexts. When emotional faces are shown in incongruent contexts (e.g., when an angry face is presented in a context depicting fear) adults' accuracy decreases and their reaction times increase, although the magnitude of these effects varies across emotion pairs. I previously published a paper (in JECP) showing adult-like congruency effects in 8-year-old children.

Here we present two experiments that were designed to investigate the emergence of adult-like congruency effects. Adults and 8-year-olds show congruency effects for sad versus fearful faces, emotions that are negatively valenced but differ in arousal. They do not show congruency effects for sad versus happy faces, emotions that are opposites in both valence and arousal. We adapted the task for pre-school children and then determined the youngest age at which children could accurately sort both facial expressions and body postures presented in isolation. We then measured congruency effects at each age. Four-year-olds showed no congruency effects for sad/happy expressions, but 6-year-olds did show effects for sad/fear. We discuss these findings in light of two models of emotion perception and in light of what is already known about the development of sensitivity to emotion cues.

The data presented have not been reported elsewhere nor is this manuscript being considered for publication in another journal. Informed consent was obtained after the nature and possible consequences of the studies were explained. We thank you for considering this work for publication in the Journal of Experimental Child Psychology.

Sincerely,

Cathy Mondloch

Wide eyes and drooping arms: Adult-like congruency effects emerge early in the development of sensitivity to emotional faces and body postures

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Running head: Influence of body posture

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Wide eyes and drooping arms: Adult-like congruency effects emerge early in the development of sensitivity to emotional faces and body postures

Keywords: Emotion perception, Perceptual development, Congruency effects, Context effects, Circumplex model

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Abstract

Adults' and 8-year-old children's perception of emotional faces is disrupted when faces are presented in the context of incongruent body postures (e.g., when a sad face is displayed on a fearful body) if the two emotions are highly similar (e.g., sad/fear) but not when if are highly dissimilar (e.g., sad/happy). The current research investigated the emergence of this adult-like pattern. Using a sorting task, we identified the youngest age at which children could accurately sort isolated facial expressions and body postures and then measured whether their accuracy was impaired in the incongruent condition. Six-year-old children showed congruency effects for sad/fear but even 4-year-old children did not for sad/happy. Early emergence of this adult-like pattern is consistent with the dimensional and emotional seed models of emotion perception and with evidence that by age 4 to 6 years children's representation of emotion is largely adult-like, although sensitivity to several categories continues to develop until middle childhood.

Wide eyes and drooping arms: Adult-like congruency effects emerge early in the development of sensitivity to emotional faces and body postures

Emotional expressions provide important cues about the environment (e.g., an angry face indicates potential threat) and facilitate appropriate approach or avoidance behavior (Marsh, Ambady, & Kleck, 2005). Adults can detect the emotional status of other individuals using a variety of cues including facial expression (Izard, 1971; Russell, 1980), body posture (de Meijer, 1989; Hadjikhani & de Gelder, 2003; Schlindler, Van Gool & de Gelder, 2008; Sinke, Kret, & De Gelder, in press; Wallbot, 1998), and, to some extent, vocal intonation (e.g., Hawk, van Kleef, Fischer & van der Schalk, 2009; Nelson & Russell, 2011). Although adults are sensitive to each of these cues in isolation, their ability to accurately determine emotional status is enhanced when multiple cues are available (Van den Stock, Righart, & de Gelder, 2007; van de Riet & de Gelder, 2008). Conversely, their accuracy in recognizing facial displays of emotion is impaired when the facial display is incongruent with the other cues present (e.g., when a fearful face is presented in the context of disgust). Adults' accuracy decreases and their response times increase when asked to make a 2-alternative forced-choice judgment about angry/fearful faces presented on incongruent bodies (e.g., when a fearful face was presented on a body posing anger) relative to when the faces are presented on congruent bodies (e.g., when a fearful face was presented on a body posing fear; Meeren, van Heijnsbergen, & de Gelder, 2005). Body posture and background scenes influence adults' reaction times, the expression perceived, its valence (positive or negative), and its intensity (Aviezer, Hassin, Ryan, et al., 2008; Righart & de Gelder, 2008a; Righart & de Gelder, 2008b; reviewed in de Gelder et al., 2006; de Gelder & Van den Stock, 2011). Likewise, tone of voice and hand gestures both influenced adults' perception of facial expressions (de Gelder & Vroomen, 2000; Hietanen & Lappänen, 2008), body posture influenced adults' perception of emotional voices (Van den Stock, Righart & de Gelder, 2007), and the emotional content of music influenced adults' perception of body movements (Van den Stock, Peretz, Grezes, & de Gelder, 2009). Attention to adults' perception of emotions in multi-cue stimuli is quite recent; not surprisingly, then, very little is known about how the integration of multiple cues to emotion develops during childhood.

The time course over which children achieve adult-like proficiency in recognizing isolated facial expressions varies across emotions, with few age-related differences for happy facial expressions and gradual improvement for other expressions (e.g., Camras & Allison, 1985; Durand, Gallay, Seigneuric, Robichon, & Baudouin, 2007; Kolb, Wilson & Taylor, 1992; Vicari, Reilly, Pasqualetti, Vizzotto & Caltagrione, 2000; Widen & Russell, 2003). Only one previous study investigated whether young children benefit from multiple cues to emotion (Nelson & Russell, 2011). Preschool children (aged 3-5 years) viewed dynamic displays of four emotions (happy, sad, anger, fear) and were asked to provide a verbal label. Unlike adults, children's accuracy in the multi-cue condition (face + body + voice) was not higher than their accuracy in the face-only condition. Nelson and Russell (2011) concluded that preschool children may process faces and bodies less holistically than adults, raising the possibility that preschool children's perception of facial expressions may not be impaired by incongruent contexts.

Only one previous study investigated whether children show adult-like congruency effects and in that study the participants were 8-year-old children (Mondloch, 2012). Participants were asked to make two-alternative forced-choice judgments about facial expressions (e.g., sad/fearful) that were presented on congruent versus incongruent body postures. Stimuli were presented very briefly (600ms) so as to measure children's encoding of expressions in the context of congruent versus incongruent body postures, rather than their ability to reconcile conflicting cues, as measured in previous studies (Gnepp, 1983; Reichenbach & Masters, 1983). Like adults, these children showed large congruency effects when judging sad/fear stimuli but not when judging sad/happy stimuli.

Differential patterns for sad/fear versus sad/happy judgments is consistent with two models of emotion perception, each of which predicts that the magnitude of congruency effects will be modulated by the similarity of the emotions displayed in the face and context. According to circumplex models of emotion perception (Abelson & Sermat, 1962; Bullock & Russell, 1984; Schlosberg, 1952; Widen & Russell, 2008a), context effects will be maximal when the two emotions are similar on two underlying dimensions, valence (pleasant vs. unpleasant) and arousal (low vs. high). For example, context effects will be large when one source (e.g., the face) displays anger and the other source (e.g., body posture) displays fear because both of these emotions are negatively valenced and high in arousal. Context effects will be smaller for emotions that differ on only one dimension, such as arousal (e.g., sad and fear), and negligible/absent for emotions that are opposite on both arousal and valence (e.g., sad and happy). According to the emotional seed model, context effects will be maximal when the *facial* display of the emotion conveyed by the context (e.g., fear) shares physical characteristics (emotional seeds) with the display of emotion in the face (e.g., sad; Aviezer, Hassin, Bentin, & Trope, 2008). Machines and human observers produce comparable similarity judgments (Susskind, Littleworth, Bartlett, Movellan, & Anderson, 2007), with sad and fear being more similar to each other than either is to happiness.

The purpose of the current study was to investigate the emergence of congruency effects. To do so we determined the youngest age at which children were able to accurately recognize facial expressions and body postures presented in isolation and then asked these children to categorize the facial expressions while ignoring body postures that were either congruent or incongruent with the emotion displayed in the face. Despite Nelson and Russell

(2011) not finding facilitation of emotion perception in their multi-cue condition, we reasoned that pre-school children may show an adult-like pattern of congruency effects given their sensitivity to valence, arousal and systematic differences in emotion similarity. Even 2-year-olds show sensitivity to valence. When asked to sort facial expressions into either a happy or an angry box, 2-year-old children placed anger, fear, and sad faces into the angry box while placing only happy faces into the happy box (Russell & Widen, 2002). Similarly, when asked to find all the angry faces from an array of photos, 2-year-old children rarely selected positive emotional facial expressions, but chose a variety of negative ones (Bullock & Russell, 1984; Denham & Couchoud, 1990). Thus, 2-year-old children live in a world in which people are happy or not happy; it is only when they become sensitive to the dimension of arousal that they differentiate among negatively valenced emotions (Widen & Russell, 2008b). That sensitivity emerges during the preschool years. When asked to sort a set of 20 facial expressions into a varying number (2 to 10) of piles in which everyone in the same pile felt alike, a measure of similarity suitable for testing 4- to 5-year-old children, preschoolers' representation of emotion was best characterized as a circumplex with two underlying axes: valence and arousal (Russell & Bullock, 1985; see also Russell & Widen, 2002; Wellman, Harris, Banerjee, & Sinclair, 1995; Widen & Russell, 2008a), like older children and adults (Gao, Maurer, & Nishimura, 2010), although sensitivity to arousal takes time to develop (Boyatzis, Chazan, & Ting, 1993; Camras & Allison, 1985; Widen & Russell, 2003).

Given that preschool children perceive systematic relationships among emotions, with some emotion pairs (e.g., fear and anger) being judged as more similar and more easily confused than others (e.g., fear and happy), we hypothesized that the youngest children who could reliably categorize emotional faces and body postures would show an adult-like pattern of congruency effects. In Experiment 1 we tested children with sad/fear stimuli for which we predicted large effects; in Experiment 2 we tested children with sad/happy stimuli for which we predicted no effect. In each experiment we began by testing 4-year-old children and adults. Because congruency effects can only be measured in participants who can accurately categorize both isolated facial expressions and isolated body postures, we tested a second group of children on each task, the age of which was determined by whether 4-year-olds were able to meet this criterion.

Experiment 1

Method

Participants. Three groups of 12 participants completed the study: undergraduate students (aged 18 to 23 years, *M* = 19.8), 6-year-old children (aged 5.5 to 6.5 years, *M* = 5.99), and 4-year-old children (aged 3.5 to 4.5, *M* = 3.93). Children were recruited from a community or a school database and were given a small toy as a reward for their participation. Adults received partial course credit or a small monetary reward for their participation. An additional six 6-year-old children were tested, but were excluded from final analysis for failing to pass criterion trials (see procedure for more details).

Materials. Photographs of eight different models (4 male) from the NimStim Face Stimulus Set (Tottenham et al., 2009) served as test stimuli. Half of the models (2 male) posed sad and half of the models posed fear. All face images were resized to approximately 2.2 cm horizontally x 2.8 cm vertically and cropped such that each model's hair and face contour were similar for each expression. Body postures were taken from Mondloch (2012); each of four models (two male) provided two sad and two fearful postures that were correctly labeled by over 80% of adult participants (see Mondloch, 2012 for validation details).

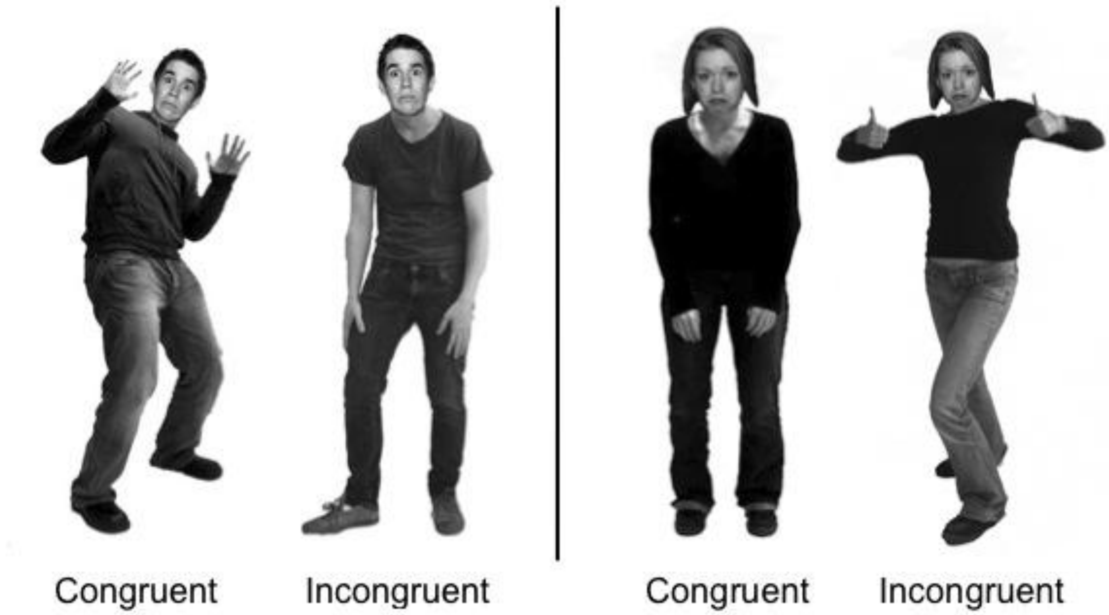

Figure 1. Examples of the congruent and incongruent stimuli shown during the test trials in Experiment 1 (sad/fear; left panel) and in Experiment 2 (sad/happy; right panel).

Using Adobe Photoshop (Version 8) each face stimulus was aligned with two same-sexed body postures (see Figure 1 for examples). One body was posing the congruent expression (e.g., sad for sad faces) and the other was posing the incongruent expression (e.g., sad for fear faces). The compound stimuli were realistically proportioned creating a face to body ratio of approximately 1:6 (see Meeren, van Heijnsbergen, & de Gelder, 2005).

Eight misaligned stimuli were created by shifting the head approximately 2 cm to the left of the body using the cut and lasso functions. Half of the misaligned stimuli were congruent (n = 2 sad faces) and half were incongruent (n = 2 sad faces). An isolated version of the eight faces used on misaligned trials and of eight of the 16 body postures (half male; half fear) were also created. All stimuli were presented on laminated cards[1].

Participants were asked to sort the stimuli into one of two houses made of shoeboxes. One house (the sad house) was decorated to look old and had a schematic picture of someone crying on it and the other (the fear house) was decorated so as to look haunted with eyes peering out of dark windows and bats and a ghost flying above. When testing child (but not adult) participants we used a hand puppet who was introduced as Officer Goodman, the sheriff of Scary/Sad Town.

Procedure. Written consent was obtained from adult participants or parents of the child participants prior to testing. Participants sat at a table across from a researcher in a quiet room in a laboratory at Brock University or at the child's school. This procedure and that of Experiment 2 received clearance from the Brock University Research Ethics Board.

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[1] Five of the faces (n = 2 fear) shown on misaligned trials were also used as test stimuli. We deemed it more important to present children with exemplars that adults could easily identify than to avoid repetition.

Children were invited to help Officer Goodman sort the people of Scary/Sad Town into their houses; adults performed the task without the use of a puppet. In the *isolated face* block, participants were presented with eight faces in isolation and asked to place each face into the scared house or the sad house. Each participant was required to place at least 6 faces in the correct house to be included in the final analysis. This criterion was set to ensure that each participant was able to recognize facial expressions in isolation, a prerequisite for measuring congruency effects. The isolated face block was followed by trials in which the misaligned stimuli were presented. Participants were told: "*A magician has come to town and he did a magic trick that made it look like people's heads are floating away from their bodies. We need to help the people get to their own house to end the magic trick. Being a police officer, I'm really big on following rules and the biggest rule is to ignore the body and only look at the face.*" All participants were asked to indicate whether each face was showing scared or sad by placing it in the corresponding house. The misaligned block was designed to help children to understand the importance of ignoring the body; no criterion was set for this block because both adults and 8-year-old children show a congruency effect for misaligned stimuli (Mondloch, 2012) and so excluding participants who made errors on misaligned trials may have inflated performance in the test trials (see Mondloch, Pathman, Maurer, Le Grand, & de Schonen, 2007 for a similar approach when testing children on the composite face task).

Participants then completed two blocks of test trials in which faces and bodies were aligned. Within each block half of the trials were congruent (n = 2 fear faces) and half were incongruent (n = 2 fear faces). Participants were asked to sort faces into the two houses based on the facial display while ignoring the body posture. Prior to each block of test trials all participants were told a story about a group of people in Scary/Sad Town; a puppet told the story to child participants. The story explained that the people they were about to see were either scared or sad because of events that happened to them at the zoo or circus. One story was as follows: *A big group of people that live in Scary/Sad town have just returned from their trip to the zoo! Some of the people went to see a great, big snake at the zoo and the snake was so big that when they saw it they were very scared. Other people went to see the baby monkeys, but the monkeys were sleeping and so the people didn't get to see them. These people are very sad because they didn't get to see the monkeys. Now that these people are back from the zoo, we need to make sure they get to the right houses! We need to look at these people's faces and decide if they go in the scared or sad house; and remember, the biggest rule is that you do not look at their bodies.* Within each block the stimuli were presented in one of two randomly determined orders to each participant; the order in which the two blocks were presented was counter-balanced across participants. Embedded within each block of test trials was a catch trial in which a picture of an object depicting fear (a ghost) or sadness (a broken bicycle) was shown. Participants were asked to place each object in either the sad or scared house. These were inserted to maintain children's interest.

After completing the test blocks, participants completed a final block of trials in which eight of the isolated body postures (half male; half sad) were presented (with the faces blurred) to verify that each participant was able to identify the emotional body postures. Prior to this block participants were told the following: *Ok, this is the last part of our game! It's really foggy out in Scary/Sad Town. You're going to see pictures of people, but because it's so foggy, you won't be able to see their faces. You'll have to decide if the person is scared or sad by looking at their body. If the body is showing scared, put it in the scared house; if the body is showing sad, put it in the sad house.* Participants were required to accurately identify six of the eight emotional body postures to be included in the final analysis because if participants were unable to correctly identify isolated bodies it would be impossible to interpret either the presence or absence of congruency effects. Child participants were given a sticker at the end of each set of trials and were invited to take a toy from our treasure chest at the end of the task.

Results

All participants correctly sorted the stimuli on the two catch trials. Every adult tested was correct on at least six isolated face trials (*M* = .94). They performed without error on the isolated body trials. Only three 4-year-olds met the inclusion criteria. The remaining children failed to pass the isolated faces (n = 7) and/or the isolated bodies (n = 5) criterion; three children failed both. We did not analyze 4-year-olds' performance on test trials. Six additional 6-year-olds were tested but excluded from final analysis because they failed to pass the isolated faces (n = 2) and/or isolated bodies (n = 5) criterion; one child failed both. The twelve 6-year-old children included in the final analysis had high accuracy on isolated face trials (*M* = .92) and on isolated body trials (*M* = .93).

Influence of congruency on accuracy. A 2 (age: 6-year-olds and adults) x 2 (congruency: congruent and incongruent trials) mixed measures ANOVA was conducted to determine whether accuracy scores on aligned trials differed as a function of congruency and age. Both main effects were significant. Participants were more accurate on congruent than incongruent trials, $F(1, 22) = 17.00$, $p < .001$, $\eta^2 = .436$, and adults were more accurate than 6-year-olds, $F(1, 22) = 23.24$, $p < .001$, $\eta^2 = .514$. These main effects were qualified by a significant age x congruency interaction, $F(1, 22) = 4.77$, $p < .05$, $\eta^2 = .178$. As shown in Figure 2, the congruency effect was larger for 6-year-olds (*M* = .32) than for adults (*M* = .09).

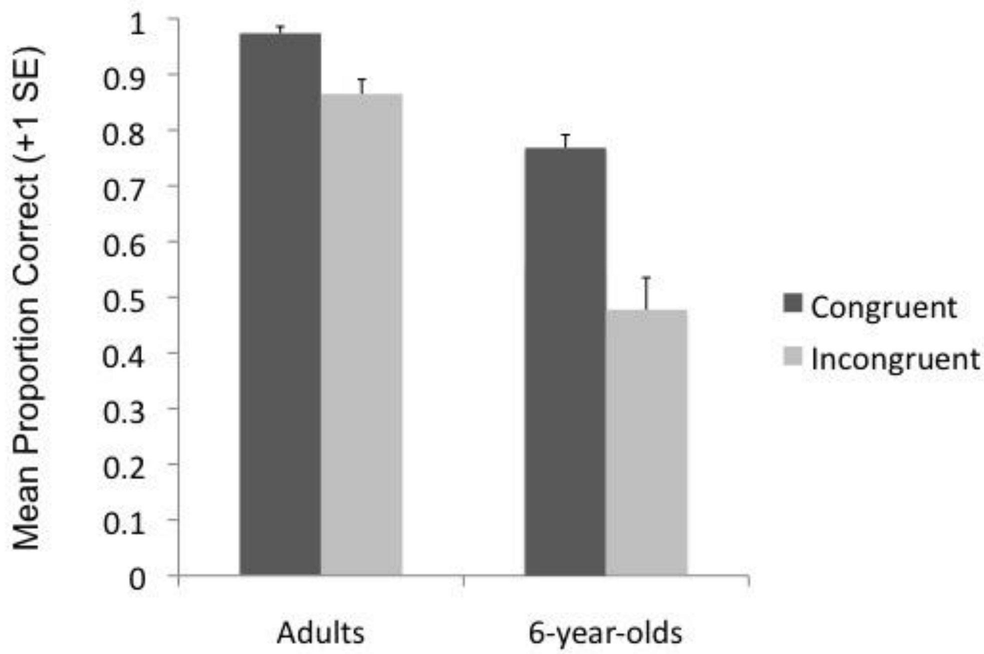

Figure 2. Adults' and 6-year-olds' mean proportion correct for congruent and incongruent trials in Experiment 1. Error bars indicate standard error of the mean.

To determine whether accuracy scores differed on congruent compared to incongruent trials for both adults and children, separate paired sample t-tests were conducted for each age group (2-tailed). Adults were more accurate on congruent trials (M = .95) than they were on incongruent trials (M = .86), t(11) = 2.35, p < .04, d = .34. Likewise, 6-year-old children were more accurate on congruent trials (M = .85) than they were on incongruent trials (M = .53), t(11) = 5.72, p < .001, d = .49. The four 6-year-olds who failed isolated bodies, but passed isolated faces were found to be no more accurate on congruent trials (M = .72) than they were on incongruent trials (M = .72).

Discussion

This study provides the first evidence that congruency effects are evident in the youngest children who can accurately categorize the individual cues in static multi-cue stimuli. Four-year-old children performed poorly when asked to categorize both isolated faces and isolated bodies, a result that is not surprising given evidence that sensitivity to these emotions is slow to develop (Widen & Russell, 2008b) and that precluded our ability to measure their congruency effects. Six-year-old children were able to accurately sort both isolated faces and isolated bodies and they showed a congruency effect, suggesting that congruency effects emerge early in the development of emotion perception. Interestingly, the subset (n = 4) of 6-year-olds who were unable to accurately sort isolated bodies did not show congruency effects, suggesting that it is the detection of incongruent emotional information in the body posture that drives congruency effects, rather than the mere presence of bodies distracting children's attention.

Our finding larger congruency effects in 6-year-olds than in adults is consistent with the one previous study showing congruency effects in children (Mondloch, 2012). In that study, 8-year-old children showed larger congruency effects than adults for sad/fear stimuli in a speeded categorization task. Larger effects in children may be attributable to the slow development of adult-like sensitivity to sad and fear (Gao & Maurer, 2009; Kolb et al., 1992; Vicari et al., 2000), making their perception of these emotions in faces more susceptible to contextual influences.

The fact that 6-year-old children show congruency effects when tested with stimuli depicting sad/fear is consistent with evidence that children perceive these emotions to be relatively similar to each other (Gao et al., 2010; Russell & Bullock, 1985). Like adults, children's congruency effects may be influenced by the similarity of the emotions conveyed in the face and context. This interpretation of our results leads to the hypothesis that, like adults and 8-year-old children (Mondloch, 2012), preschool children will not show a congruency effect for a pair of highly dissimilar emotions (e.g., sad/happy). An alternative hypothesis, however, is that large congruency effects in very young children are attributable to their failing to allocate attention properly, a failure that is observed across a wide range of tasks (Choi, Lotto, Lewis, Hoover, & Stelmachowica, 2008; Irwin-Chase & Burns, 2000; Takio et al., 2009). According to this hypothesis, children's congruency effects may be ubiquitous and thus observed even for these highly dissimilar emotions. We tested these two alternative hypotheses in Experiment 2. Using the same procedure as in Experiment 1, we investigated whether young children would show congruency effects when asked to sort happy versus sad facial expressions placed on congruent and incongruent body postures. As noted above, happy and sad facial expressions are opposite one another on both the valence and the arousal dimensions (Russell, 1980), are maximally different in their physical characteristics (emotional seeds; Susskind et al., 2007) and are relatively easy for young children to recognize (Boyatzis, Chazan, & Ting, 1993; Camras & Allison, 1985; Russell & Widen, 2002; Widen & Russell, 2003).

Experiment 2

Method

Participants. Two groups of 12 participants completed the study: 4-year-old children (aged 3.5 to 4.5 years, *M* = 3.82), and 3-year-old children (aged 2.5 to 3.5, *M* = 3.08). Children were recruited from a community or a school database and were given a small toy as a reward for their participation. Adults were not tested because a previous study (Mondloch, 2012) already showed that adults do not show congruency effects for sad versus happy faces even when stimuli are presented for only 600ms.

Materials. The materials were similar to those used in Experiment 1 except that happy faces and bodies replaced the fearful faces and bodies. In addition, a happy house (brightly decorated with stars and a schematic happy face) replaced the fear house, and the picture of the ghost (presented during the sorting task) was replaced with a picture of candy. Four-year-old children were tested on four blocks of test trials; the ease with which they could discriminate happy versus sad faces allowed them to complete more trials than was possible in Experiment 1. We elected to present them with four blocks of trials to ensure that our method would be sensitive to very small congruency effects. Thus, 16 models (eight males) each posed either a happy or a sad facial expression and, across the four blocks, each expression was shown once on a congruent body posture and once on an incongruent body posture.

Procedure. The procedure was identical to Experiment 1 except that 4-year-old participants completed four blocks of test trials and all participants were asked to sort stimuli into a happy house or a sad house based on facial expression. Stories that explained why some people looked fearful in Experiment 1 were replaced with comparable stories that explained why some people looked happy (e.g., *Some of the people got to see a baby monkey at the zoo! The monkey was so cute and they were very happy because they got to see it.*)

Within each block of eight trials, half of the stimuli were congruent (n = 2 happy) and half of the stimuli were male. We added pictures of two more objects (a broken plate and an ice-cream cone) so that one object was presented within each block. Only two blocks were completed by 3-year-old children.

Results

Criteria trials: Isolated face and isolated body trials. All 4-year-old participants performed without error on isolated face trials, successfully sorted stimuli presented on each of the four catch trials, and were extremely accurate on isolated body trials (*M* = .86). Similarly, all 3-year-old children passed our criteria for isolated faces; three children made one mistake and the rest performed without error. All 3-year-old participants successfully sorted stimuli presented on the two catch trials. However, only two 3-year-olds met the criterion on isolated body trials (*M* correct = .55) and so no further analyses were conducted for this age group.

Influence of congruency on accuracy. A paired samples t-test revealed that 4-year-old children were no more accurate on congruent test trials (M = .96) than they were on incongruent trials (M = .94), $t(11) = 1.08$, $p > .30$. When only the first two blocks were analyzed the same pattern of results was obtained (*M* correct = .95 on congruent trials and .94 on incongruent trials).

Discussion

Unlike 6-year-olds tested with sad/fear stimuli (Experiment 1), 4-year-old children showed no evidence of congruency effects when tested with happy/sad expressions. Because our goal was to measure congruency effects in the youngest children who could reliably categorize our static facial expressions and body postures, we were motivated to test 3-year-old children after 4-year-olds completed the task successfully. Three-year-olds were unable to accurately sort happy versus sad body postures and so the lack of congruency effects observed in 4-year-old children indicates that the absence of congruency effects for sad/happy expressions in older children and adults (Mondloch, 2012) does not represent a loss of an effect that was evident early in development. Rather it appears as though the effect is absent at the youngest age at which children are able to reliably recognize both happy and sad expressions in both the face and body. This is in contrast to the congruency effect observed for sad/fearful expression, an effect that was present at the youngest age at which children could reliably categorize sad versus fear in both faces and body postures. Thus, children appear to integrate the emotional information conveyed by facial expressions and body postures at about the same time at which they acquire sensitivity to each cue in isolation and, like adults and older children, congruency effects are dependent on the similarity of the emotions conveyed by conflicting cues.

General Discussion

We identified the youngest children who could reliably categorize sad/fear and sad/happy expressions in both faces and body postures and then demonstrated an adult-like pattern of congruency effects in those children. Four-year-olds, but not 3-year-olds, accurately categorized sad/happy stimuli and, like adults and 8-year-old children (Mondloch, 2012), did not show any evidence of congruency effects. Six-year-olds, but not 4-year-olds, accurately categorized sad/fearful stimuli and, like adults and 8-year-old children (Mondloch, 2012), made more errors on incongruent than on congruent trials. The pattern of congruency effects is robust in adults; they showed the same pattern of results in the current study in which there were very few trials and an unlimited presentation time as in a previous study in which there were 96 test trials and in which stimuli were presented for only 600ms (Mondloch, 2012). In the current study we used a child-friendly version of this method and provided the first evidence that these perceptual congruency effects emerge very early in development, just as children can reliably use information from both faces and body postures.

Previous research had demonstrated that children's attribution of emotional states is influenced by context; they can predict facial expressions based on situational contexts (Saarni, 1979), although when facial expressions and contextual cues are conflicting, preschool children usually indicate that the protagonist's feelings match those of the facial expression whereas older children (aged 12 years) and adults indicate that the protagonist's feelings match those of the story (e.g., Gnepp, 1983; Reichenbach & Masters, 1983). In each of these studies, however, researchers were examining participants' attribution of emotion in the context of conflicting cues rather than the influence of context on the perception of emotional facial expressions per se. Children in these studies accurately perceived the emotion conveyed by both the facial expression and the story and then used one of several strategies (e.g., elaborating on the story) to reconcile conflicting cues (Reichenbach & Masters, 1983). The two-alternative forced-choice method used in the current study may reduce the influence of cognitive processes (e.g., emotion attribution) and thus tap perceptual processes better than other paradigms (Van den Stock et al., 2009).

The lack of congruency effects observed in 4-year-old children judging sad/happy stimuli verifies that children understood the task demands (i.e., that they were to ignore the body) and that preschool children are able to selectively attend to facial displays of emotion under some conditions. If children had failed to understand task instructions (i.e., that they were to ignore body posture and attend only to the face) or were unable to selectively attend to faces, then congruency effects should have been observed in Experiment 2.

Likewise, it is unlikely that congruency effects for sad/fear stimuli can be attributed to low–level perceptual effects. Happy and fearful body postures were both characterized by arms that were at or above waist level (see Figure 1), and yet only fearful body postures interfered with categorization of sad faces. Furthermore, no congruency effects were observed in the four children in Experiment 1 who were unable to categorize sad/fear body postures.

Previous studies with adults have revealed that congruency effects are maximal when the facial displays of the emotions in the face and in the context share physical characteristics (e.g., furrowed brows; Aviezer, Hassen, Ryan et al., 2008). Both computational models and adults' similarity ratings indicate that sad faces share more physical characteristics with fearful faces than they do with happy faces (Susskind et al., 2007), and so finding congruency effects for sad/fearful stimuli but not sad/happy stimuli is consistent with the emotional seed model. Circumplex models also predict that congruency effects are more likely when participants are making sad/fear judgments than when they are making sad/happy judgments (Russell, 1997). First, sad is closer to fear on the circumplex than it is to happy, making sad/fear judgments more difficult than sad/happy judgments. Second, whereas happiness is unique in being positively valenced and moderate to high in arousal, fear is one of several emotions (including anger and disgust) that are negatively valenced and high in arousal, making fearful displays more difficult to recognize than happy displays (Russell, 1997). Thus, observers may rely more on contextual cues to recognize fear in the face than to recognize happy. Thus, both the dimensional model and the emotional seed model predict the pattern of congruency effects observed previously in adults and 8-year-olds (Mondloch, 2012).

Our finding adult-like patterns of congruency effects in 4- to 6-year-old children is consistent with evidence that like adults (Carroll & Russell, 1997; Susskind et al., 2007), by 3 years of age children's similarity judgments show systematic relationships among emotions, with some emotion pairs (e.g., sad and fear) being judged as more similar and more easily confused than others (e.g., sad and happy) (e.g., Russell & Widen, 2002; Wellman et al., 1995; Widen & Russell, 2008a). When asked to sort facial expressions into piles, even preschool children's representation of emotion is best characterized as a circumplex with two underlying axes: valence and arousal (Russell & Bullock, 1985). Because preschoolers perform poorly when asked to produce emotional labels, Russell and Bullock (1985) argue that both the circumplex and the underlying dimensions are not artifacts of language but inherent characteristics of how humans represent emotion, although children's sensitivity to arousal takes time to develop (Boyatzis, Chazan, & Ting, 1993; Camras & Allison, 1985; Widen & Russell, 2003) and the underlying dimensions are not fully adult-like until later (Gao et al., 2010). Likewise, although 3- to 5-year-old children make more errors than adults when asked to match faces to verbal labels, their choices are systematic (Bullock & Russell, 1984); they most frequently select either the best match for each label or its nearest neighbors. More recently, Gao et al. (2010) used multi-dimensional scaling to map the perceptual structures of the six basic facial emotions with four levels of intensity in 7-year-olds, 14-year-olds, and a group of adults. In each trial, participants were presented with a triad of photographs of facial expressions and asked to indicate which was most different. Children's perceptual structure partially overlapped that of adults, with differences in the way they represented surprise, fear, and neutral expressions. Collectively, evidence that children's representation of emotion is similar to that of adults is entirely consistent with our finding congruency effects for two similar emotions (sad/fear) but not two dissimilar emotions (sad/happy).

It is intriguing that facial displays of happiness are relatively impervious to congruency effects. Although congruency effects involving happy expressions have been observed, the effect is absent (Mondloch, 2012) or small (Van den Stock et al., 2007) unless the task is made more difficult by presenting adults with morphed expressions (e.g., happy blended with fear) (Van den Stock et al., 2007; see also de Gelder & Vroomen, 2000)—a manipulation that, by definition, increases the number of shared physical characteristics and alters valence. Developmental studies of emotion perception may provide some insight here. Happiness is treated as distinct from all other emotions beginning in infancy (see Widen & Russell, 2008b for a review) reflecting early development of sensitivity to valence. Perhaps adults and children, like infants and 2-year-old children, first categorize stimuli as happy/not happy and then categorize stimuli as high/low arousal. Rapid classification of happy faces may preclude their perception being influenced by incongruent contexts that, by definition, are negatively valenced.

Our results also provide novel insights into how children's sensitivity to body postures develops, something about which little is known. Surprisingly, 3-year-olds were unable to reliably recognize happy and sad body postures in isolation, despite the vast difference between the two postures (see Figure 1). Their inability to do so is in contrast to Nelson and Russell (2011) who reported that 75% of 3- to 5-year-old children were able to recognize dynamic displays of happy and sad in bodies, with no improvements between 3 and 5 years (see also Boone and Cunningham, 1998 for evidence that children can accurately interpret emotion in dance). Collectively, these results suggest that learning to recognize emotions in both faces and dynamic bodies may bootstrap learning to recognize emotions in static body postures, something that is deserving of future research.

One mechanism by which context influences adults' perception of emotional faces is by altering the perceived valence and arousal of the facial display of emotion; sad faces are rated as higher in arousal when presented with fear bodies than when presented with sad bodies, and disgust faces are rated as more positively valenced when presented with pride bodies than when presented with bodies (and props) depicting disgust (Aviezer, Hassen, Ryan et al., 2008). Thus, placing fearful faces on sad bodies may decrease their perceived arousal making them perceptually more similar to sad faces on sad bodies; likewise, placing sad faces on fearful bodies may increased their perceived arousal. Future studies should examine whether context also directly alters young children's perception of valence and arousal.

A second mechanism by which context influences adults' perception of emotional faces is by altering face-scanning patterns (Aviezer, Hassen, Ryan et al., 2008). Whereas adults typically direct more fixations to the eye region than the mouth region of angry faces presented in a congruent context, the number of fixations directed to the eye versus mouth region did not differ when angry faces were presented in a disgust context. Likewise, adults directed about the same number of fixations towards the eye versus mouth region of disgust faces presented in a disgust context, but directed a disproportionate number of fixations towards the eye region when disgust faces were presented in an angry context. Future studies should use eye-tracking technology to determine whether context has a similar influence on the scanning patterns of children and whether children are more likely than adults to fixate on the context, a result that would explain why children show larger congruency effects than adults for sad/fear stimuli.

Finally, our results are somewhat surprising in light of Nelson and Russell's (2011) recent finding that preschoolers' ability to accurately label dynamic facial expressions does not exceed their ability to recognize emotions in multi-cue (face, body, and voice) stimuli—a result suggesting that facial displays of emotion are processed independently of other cues. Three characteristics differentiate our method from that of Nelson and Russell: 1) they presented children with dynamic stimuli whereas ours were static; 2) they investigated whether congruent contextual cues (body movements and voice) enhanced emotion recognition whereas we investigated whether incongruent body postures interfered with categorization of facial expressions; and 3) their participants were asked to provide a verbal label whereas our participants were asked to place each stimulus into one of two houses. Nelson and Russell (2011) also tested 3- to 5-year-old children. We were unable to test children this young with a pair of emotions for which adults show a congruency effect (sad/fear). It is possible that such young children would not show congruency effects for such pairs if they could be tested, but in our study 4-year-olds were unable to correctly sort sad/fear facial stimuli, despite our having used intense facial expressions. Future research is needed to investigate which of these variables is responsible for differences in the extent to which context influences children's perception of facial expressions.

Emotional facial expressions can be used to mask felt emotions (e.g., Ekman & Friesen, 1982, see also Gosselin, Warren & Diotte, 2002; Hess, Beaupre, & Cheung, 2003), either for prosocial (e.g., smiling after receiving an unwanted gift; Gosselin et al., 2002) or more sinister reasons (as in numerous fairy tales and folk stories), rendering the ability to recognize various displays of emotion (e.g., facial expressions, tone of voice, body posture) an important skill. Research paradigms that measure the development of sensitivity to emotion in multi-cue stimuli promise a much richer understanding of emotion perception as it more closely resembles the challenge that adults and children face in the real world—multiple cues to emotion that often, but not always, are congruent.

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*Highlights (for review)

Highlights

• Four-year-olds, but not 3-year-olds, accurately sorted sad vs happy body postures and facial expressions presented in isolation
• Six-year-olds, but not 4-year-olds, accurately sorted sad vs fear body postures and facial expressions presented in isolation
• Congruency effects were measured by presenting facial expressions on congruent (e.g., sad face on a sad posture) versus incongruent (e.g., sad face on a fear posture) body posture
• An adult-like pattern of congruency effects was observed in the youngest children who could accurately sort both facial expressions and body postures —no effects for sad/happy and large effects for sad/fear