British Journal of Developmental Psychology (2006), 24, 615–630

The British Psychological Society
www.bpsjournals.co.uk

The meaning of infants' looks: Information seeking and comfort seeking?

Tricia Striano[1,2,3]*, Amrisha Vaish[1] and Joann P. Benigno[1]

[1]Max Planck Institute for Human Cognitive and Brain Sciences, Germany
[2]Centre for Advanced Studies, University of Leipzig, Germany
[3]Department of Pediatrics and Kennedy Center for Human Development, Vanderbilt University, USA

In two studies, the reason that infants in a novel situation look to adults was assessed. In Study 1, 10- and 13-month-old infants encountered a visual cliff that was deep (56 cm) or ambiguous (20 cm). Infants crossed the ambiguous cliff reliably faster than the deep cliff, and the first looks to mother of infants in the deep cliff condition were longer than those of infants in the ambiguous cliff condition. In Study 2, infants on an ambiguous cliff were tested either in a condition in which the mother was looking at the cliff (face plus voice) or away from the cliff (voice only) while encouraging the infants to cross. Infants' crossing times and looks to mother did not differ as a function of condition. In the two other conditions, infants' looks to mother and duration to cross were assessed when no cues were provided (no cues) or when the mother was providing information to an adult (talk to adult). Compared with the number of infants in the face plus voice and voice only conditions, the number of infants who became fussy in the no cues and talk to adult conditions was reliably greater. Those infants who crossed the cliff in the no cues and talk to adult conditions crossed as fast as infants in the other two conditions. The discussion focuses on the meaning of infants' first looks and on infants' understanding of cues that are intended for them versus for someone else.

Infants use social referencing to gather information from others as they make decisions about their own behaviour (Dickstein & Parke, 1988; Feinman, 1982; Klinnert, Emde, Butterfield, & Campos, 1986; Sorce, Emde, Campos, & Klinnert, 1985). This social referencing ability has been demonstrated in various paradigms in which infants are placed in novel, ambiguous situations about which an adult expresses some affect, such as happiness or fear. Infants' behaviour towards the situation is then assessed in order to examine whether or not the adult's affect influenced the infants.

One common way to examine the social referencing process is to use a visual cliff (Gibson & Walk, 1960). The visual cliff is a Plexiglas®-covered apparatus divided into

*Correspondence should be addressed to Tricia Striano, Max Planck Institute for Human Cognitive and Brain Sciences, Stephanstrasse 1a, D-04105 Leipzig, Germany (e-mail: striano@cbs.mpg.de).

DOI:10.1348/026151005X67566

a shallow half under which a chequered surface is placed immediately beneath the Plexiglas®, and a deep half under which a similar chequered surface is placed some adjustable distance beneath the Plexiglas®. In a classic study using this paradigm, Sorce *et al.* (1985) found that infants cross over to the deep side of the visual cliff if their mother poses a positive facial expression but not if she poses a negative one. When depth cues are removed from the visual cliff, infants tend not even to look at their mother, and if they do look, not to guide their behaviour as a function of her facial expression. Infants manifest similar skills when they encounter novel objects or toys (e.g. Gunnar & Stone, 1984; Hornik, Risenhoover, & Gunnar, 1987), as well as strangers (Clarke-Stewart, 1978; Feinman & Lewis, 1983).

The widespread assumption in social referencing literature is that when infants look up to mother, they are looking for information (e.g. Klinnert, 1984; Sorce *et al.*, 1985). However, there are equally plausible alternative explanations. In their discussion of the Sorce *et al.* study, for instance, Baldwin and Moses (1996) argue that although infants in this study looked at their mother and used her emotional cues to guide their behaviour on an ambiguous cliff but not when presented with a solid-appearing surface, it cannot be concluded from these findings that infants were indeed referencing. As an alternative, they suggest that infants on the ambiguous cliff may have looked for comfort rather than information, whereas infants presented with no depth did not need to seek comfort, as they were not faced with a challenging or unsettling situation.

In order to tease apart whether infants look to people for comfort or specifically to gather information, Baldwin and Moses (1996) recommend further examining infants' responses to ambiguous versus unambiguous situations without the potential confound of fear or comfort seeking. They reason that if infants are looking to the adult for information, they should look more in situations that they need information about than in situations that are self-evident. One possibility, they suggest, would be to further manipulate the depth of the visual cliff to include a deep cliff condition. When faced with a very deep and potentially threatening cliff, infants need not look to the adult to gather information, given that they can themselves establish that the situation is dangerous and that they should not cross. When the depth of the cliff is somewhat ambiguous, infants will be more likely to check for information to guide their behaviour. However, if infants are looking for comfort, then they should look to mother more when facing the deep rather than the ambiguous cliff.

The present studies sought to examine this important question raised by Baldwin and Moses (1996) by assessing 10- and 13-month-old infants' behaviour on the visual cliff. We tested these ages because social referencing has been shown to begin emerging around 9–10 months (Boccia & Campos, 1983; Feinman & Lewis, 1983; Slaughter & McConnell, 2003; Striano & Rochat, 2000), and is certainly present by 13–14 months (Campos & Stenberg, 1981; Hertenstein & Campos, 2004; Mumme, Fernald, & Herrera, 1996). Thus, we might observe differences in the behaviour of 10-month-olds as a function of condition, but if not, we could be quite certain that such differences, if present, would be evident in the behaviour of 13-month-olds.

In Study 1, we manipulated the depth of the visual cliff such that 10- and 13-month-old infants encountered either a deep cliff or an ambiguous cliff. We assessed infants' looks to mother and crossing behaviour across conditions. Following Baldwin and Moses (1996), we used the working hypotheses that if infants are seeking information from others, they should be more likely to look to mother when confronted with the ambiguous cliff compared with the deep cliff. If, however, infants are looking to mother for comfort, they should look more when facing the deep cliff than when facing

the ambiguous cliff. Regarding crossing behaviour, we predicted that infants would cross faster in the ambiguous condition than in the deep condition, and that more infants would cross in the ambiguous than in the deep condition.

In Study 2, we further investigated this question by varying maternal attention. In two conditions (face plus voice and voice only), mothers provided informative and comforting cues to infants. Based upon a past study (Vaish & Striano, 2004) that involved very similar conditions and that revealed no significant differences in crossing times across the conditions, we predicted that infants would cross equally fast in face plus voice and voice only conditions.

A third condition in Study 2 (talk to adult) involved mothers providing only informative cues and no comfort cues, and a fourth condition (no cues) involved neither informative nor comfort cues. We hypothesized that if infants were looking for information, they would not cross the cliff when no information was provided (i.e. in no cues). On the other hand, if infants were looking for comfort, they would also not cross in talk to adult, since in this condition, they received information but not comfort.

STUDY 1

Method

Participants

Participants in this study were twenty-four 10-month-olds (*M*: 293.17 days, *SD*: 14.26; range: 9 months, 0 days to 10 months, 21 days; 16 male) and twenty-four 13-month-olds (*M*: 395.70 days, *SD*: 11.22; range: 12 months, 8 days to 13 months, 23 days; 15 males). Ten additional infants were tested but were excluded from the final sample. Four infants were excluded because they did not cross the cliff within 10 minutes[1], five were excluded because they were fussy, and one was excluded because the mother did not follow instructions. The parents were recruited from a database of parents who had volunteered to participate in studies on child development. Parents were contacted by phone and invited to participate with their infants. All infants were Caucasian, and families were given a small gift for participating in the study.

Setting

A female experimenter (E) placed infants on a 195 × 94.5 cm visual cliff. The adjustable surface of the visual cliff was set at either 20 cm ('ambiguous cliff') or 56 cm ('deep cliff'). Three digital video-cameras were used to film the procedure. One image provided a close-up view of the infant's face, a second image provided a close-up view of the mother's face and a third image provided a panoramic view of the infant, mother and visual cliff. All three images were synchronized with a quad splitter and simultaneously recorded on a miniature digital videocassette recorder for later coding.

Procedure

Infants were randomly assigned to either the ambiguous cliff or the deep cliff condition. Prior to testing, mothers were instructed by E to get their infants to cross without

[1] *Sorce et al. (1985) used a 2-minute criterion because they placed a toy on the Plexiglas® over the deep side, which made the deep side more attractive and cued infants about the Plexiglas®. We did not use such a toy as we wanted only maternal cues to influence infants; it was thus necessary to extend our time window to 10 minutes, which past work (Vaish & Striano, 2004) indicates may be the time some infants need to cross.*

touching the infants or the cliff, and without gesturing in any way. Mothers began by standing approximately 30 cm beyond the deep side of the cliff and facing the cliff while E placed the infants at the shallow end of the cliff. E attempted to place the infants in a sitting position, but if infants were unsteady because they were not yet used to sitting up, they were placed in the crawling position.

Mothers were instructed to begin only after infants had first looked at them. During testing, E stood near the cliff (approximately 90 cm away) so as to ensure the infant's safety, but she looked away from the infant so as not to provide any cues.

Coding

A blind coder conducted a manipulation check by coding a random 20% of the sessions with the sound off in order to ensure that mothers only began cueing once infants had looked down at the cliff and then looked up at them. Agreement was 100% for this measure.

For the remainder of the coding, a blind coder coded video-recordings of the close-up view of the infant. Coding was carried out separately for each behaviour.

Crossing time. We measured the duration in seconds it took infants to cross over to the deep side of the cliff. Timing started the moment the infant first noticed the cliff, and ended the moment the infant's entire body had crossed the cliff (as in Vaish & Striano, 2004). To establish reliability on this measure, a second observer, blind to the hypotheses of the study, coded crossing time for a random 20% of the sessions. Pearson correlation between the coders was .990, $p < .0005$.

Infant looking. A blind coder used a computerized coding system to code infant looking. While viewing the on-line video-recording, the coder pressed a key each time infants began looking to mother's head or face, and released the key when infants looked away. With this coding, two aspects of infant looking could be examined:

(a) *Duration of looks.* The duration of the first referencing look (i.e. look after infant had noticed the drop-off) as well as total duration of all looks during crossing time as a proportion of crossing time were calculated. Proportions were calculated by dividing the duration of all looks during crossing time by the crossing time, and multiplying by 100 to convert these proportions into percentages.
(b) *Frequency of looks.* Number of looks during crossing time as a proportion of crossing time was calculated by dividing the total number of looks by the crossing time, and converting these proportions into percentages.

To establish reliability, a second independent observer, blind to the hypotheses of the study, coded a random 20% of all sessions using the same coding system. The Cohen's κ, based on 1-second intervals, was .84 for infant looking.

Results

Initial analyses revealed no significant gender effects; gender was therefore collapsed for further analyses.

Crossing time. A 2 (condition: deep versus ambiguous) × 2 (age: 10 months versus 13 months) between-subjects ANOVA was conducted to analyse crossing time. This revealed a significant condition effect, showing that infants took significantly longer to cross the deep cliff ($M = 175.15$, $SD = 154.54$) than to cross the ambiguous cliff ($M = 60.96$, $SD = 66.38$, $F(1, 44) = 10.80$, $p = .002$), as shown in Figure 1. There was no condition by age interaction ($p = .922$), nor a significant age effect ($p = .558$).

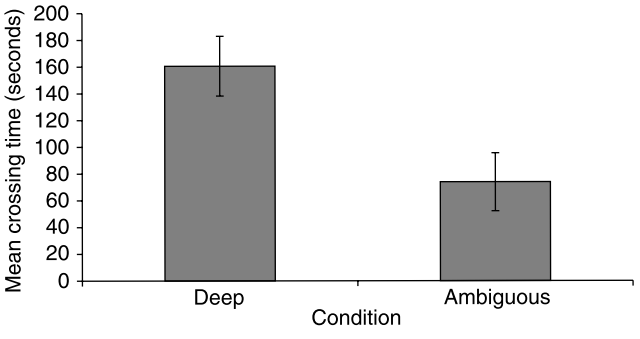

Figure 1. Study 1 – Mean crossing times as a function of condition.

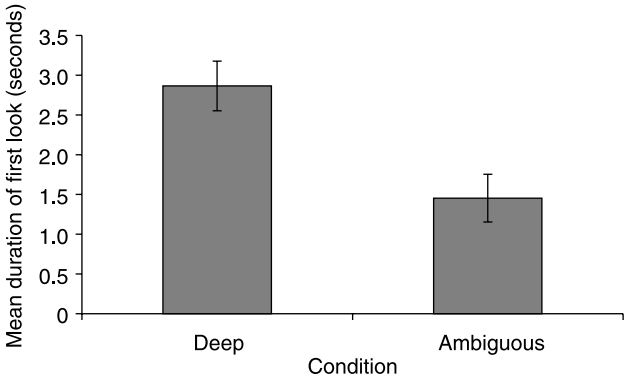

Figure 2. Study 1 – Mean duration of first referencing looks as a function of condition.

Infant looking

Duration of first looks. The mean duration of infants' first looks across conditions were compared using a 2 (age) × 2 (condition) between-subjects ANOVA. This revealed a significant condition effect (shown in Figure 2), showing that once infants had noticed the drop-off, the first looks to mother of infants in the deep cliff condition were longer ($M = 2.86$ seconds, $SD = 1.81$) than those of infants in the ambiguous cliff condition ($M = 1.45$ seconds, $SD = 1.16$, $F(1, 44) = 10.191$, $p = .003$). There was no significant age by condition interaction, $p = .764$, and no significant age differences, $p = .790$.

Proportion of total duration of looks. A 2 (age) × 2 (condition) between-subjects ANOVA was conducted to compare the proportional total duration of looks across age groups and conditions. This revealed no significant age × condition interaction, and no significant condition or age effects (all ps $> .300$).

Frequency of looks. A 2 (age) × 2 (condition) between-subjects ANOVA was also conducted to compare proportional frequency of infants' looks across conditions, but revealed no significant age × condition interaction, and no significant age differences (all ps $> .300$)[2].

[2] *Proportional duration and frequency of infant looks were also transformed using arcsine transformations in order to normalize the data. However, these transformed data also produced non-significant results and are therefore not discussed further.*

Discussion

In this study, 10- and 13-month-old infants were placed on a visual cliff with a deep or ambiguous height, and their looks and time to cross the cliff were assessed. Infants in the deep cliff condition consistently took longer to cross over than infants in the ambiguous cliff condition. This indicates that infants noticed the deep cliff and were more wary of crossing it, and perhaps needed more time and persuasion to cross, than infants who were presented with an ambiguous cliff. We also found that infants' first looks to mother after noticing the cliff were longer in the deep cliff than in the ambiguous cliff condition. Interestingly, the total duration and number of times that infants looked to mother were not significantly different across conditions.

According to Baldwin and Moses (1996), if infants are looking for information, they should look more in the ambiguous than in the deep cliff condition, whereas if they are looking for comfort, they should look more in the deep cliff condition. In our study, when first confronted with the visual cliff, those infants who saw a deep cliff looked longer to mother than those infants who saw an ambiguous cliff, which suggests that infants' first looks were not information-seeking but rather comfort-seeking looks. However, the remainder of our findings seem to suggest that the distinction is not as clear-cut; overall, infants looked equally in both conditions, indicating that they were not seeking more information or more comfort in any one situation.

One problem with the design of the study may have been that the ambiguous and deep cliff conditions were not sufficiently different, and that the deep cliff was not sufficiently threatening as to be unambiguous. This would mean that the ambiguous and deep cliff conditions were only quantitatively, not qualitatively, different, and that the deep cliff was actually more ambiguous than the ambiguous cliff. If this was the case, then infants' looks in both conditions could be considered information-seeking looks. Thus, in both conditions, infants may have initially looked to gather information, but looked longer in the deep condition because they needed to gather more information in this condition than in the ambiguous condition.

It is nevertheless noteworthy that past work has found social referencing looks to occur quite infrequently. For instance, Clyman, Emde, Kempe, and Harmon (1986) created a typology of eight classes of social looks, including social referencing, post-action referencing and bid for social interaction looks. They defined 'social referencing looks' as occurring after the infant has attended to an ambiguous situation but before she has acted upon it. Clyman *et al.* (1986) found that these looks occurred the least frequently of all (only once approximately every 3 minutes).

In our first study, these looks occurred at least once, because it was only then that mothers began cueing infants to cross the cliff. However, subsequent looks may or may not have been true social referencing looks, and may, for example, have been 'bids for social interaction' or 'orienting to a voice' looks (Clyman *et al.*, 1986). It is interesting, therefore, that infants' first looks were found to be greater during the deep cliff condition, whereas no differences were found in subsequent looks. While this hints at the possibility that infants' first looks were indeed information-seeking looks, it is equally possible that these first looks sought comfort rather than information.

Because social referencing looks are so uncommon, and because an alternative explanation is possible for infants' first looks in Study 1, we designed Study 2 to address

the information- versus comfort-seeking question from a different perspective. Rather than varying the depth of the cliff, we varied the focus of maternal attention. Thus, mothers either provided informative as well as comfort cues, informative-only cues or neither kind of cue. We then examined the situations under which infants would or would not appropriately social reference.

Some past research has shown that infants are more likely to use others' cues in the social referencing process when the cues are visually referential (e.g. Moses, Baldwin, Rosicky, & Tidball, 2001; Mumme & Fernald, 2003; Repacholi, 1998). However, Vaish and Striano (2004) showed that gaze is not an imperative referential cue. Mothers in that study cued 12-month-old infants in one of three ways: they either faced the visual cliff and vocalized to infants (face plus voice), faced the cliff without vocalizing (face only) or faced away from the cliff and vocalized (voice only). Infants were found to cross the cliff equally fast in face plus voice and voice only, and significantly slower in face only, indicating that, in the absence of a visual reference, infants can use mothers' infant-directed vocal cues just as well as if those cues were provided with a visual reference. However, in this study, adults' signals were infant-directed (i.e. in motherese). The question that remains is what infants do if mothers provide cues that are not infant-directed, which we addressed in Study 2.

In Study 2, we extended the Vaish and Striano (2004) paradigm by manipulating mother's visual and vocal attention. We investigated whether 10-month-old infants on the ambiguous cliff would use mothers' cues regardless of the mother's attentional focus, or only when the cues were intended for the infants. We chose to test 10-month-olds because past work has shown that by 10 months, infants display some sophisticated understanding of the importance of visual attention. For instance, in Striano and Rochat (2000), 7- and 10-month-old infants were presented with a novel toy while an experimenter either attended to them and emoted about the toy (look towards), or looked away, read a book and was unresponsive to the infant's looks (look away). The results indicated that 10-month-old infants looked to the experimenter more in look towards than look away, whereas 7-month-old infants did not show such a difference.

Along similar lines, Feinman and Lewis (1983) tested 10-month-olds' behaviour when mothers provided positive or neutral cues about a stranger either by speaking to the infant about the stranger, or by speaking to the stranger herself. Infants were found to be friendlier to the stranger when the mother provided positive cues, but only when mothers directly addressed infants. The findings from Striano and Rochat (2000) and Feinman and Lewis suggest that 10-month-old infants successfully monitor others' attentional focus, and use it to modulate their own behaviour.

Infants in Study 2 were in one of four conditions. In one condition, mothers looked at the cliff, smiled and vocally encouraged infants to cross (face plus voice). Thus, mothers provided information via their vocal directions and positive affect, and also provided comfort since their positive cues were meant for, and were likely soothing to, the infants. In a second condition, mothers looked away from the cliff while providing encouraging cues to cross (voice only). This condition was different from face plus voice only in the lack of facial information; mothers did still provide both information and comfort via their infant-directed instrumental and affective cues. Based on Vaish and Striano (2004), we predicted that infants would cross equally fast in face plus voice as in voice only.

In a third condition (talk to adult), mothers provided appropriate and contingent instrumental information, but in non-motherese and directed at an adult. Thus, in this condition, infants did not receive comfort, because mothers' attention was not directed at them and the cues were not infant-directed. Finally, in a fourth condition (no cues), mothers provided neither information nor comfort. Our working hypotheses were that if infants look for information, they should cross the cliff in all conditions except no cues, whereas if infants look for comfort, then they should also not cross the cliff when mothers are attending to another person (talk to adult).

STUDY 2

Method

Participants

A total of 100 full-term infants and their parents participated in this study. The parents were recruited from a list of parents who had volunteered to participate in studies on child development. Of these 100 infants, 66 were excluded for the following reasons: 23 because the mothers did not follow directions (19 because mothers turned to look at the cliff and/or the infant in conditions in which they were supposed to look away, 2 because they talked prior to being signalled, 1 because the mother talked in motherese in the talk to experimenter condition and 1 because the mother clapped her hands), 22 because the infants became fussy, 7 due to experimenter error (2 because the experimental set-up was imprecise, 4 because the experiment was aborted prematurely, not giving the infant ample time on the cliff, and 1 because the mother was not correctly instructed), 6 due to equipment failure, 2 because the infants were not yet able to crawl, 2 because the infants did not cross within our 10-minute criterion, 1 because the infant was repeatedly leaning dangerously over the cliff, 1 because the father, rather than the mother, brought the infant to the laboratory, 1 because the infant crossed without noticing the cliff and 1 because the infant crossed without referencing the mother. The final sample therefore consisted of thirty-four 10-month-old infants (24 female; *M*: 299 days, *SD*: 13.5 days; range: 9 months, 6 days to 11 months, 1 day). Of these infants, 12 were in the face plus voice and voice only conditions each, 6 were in the talk to adult condition, and 4 were in the no cues condition.

Procedure

The cliff was set at a height of 20 cm to match the ambiguous cliff in Study 1. Prior to testing, mothers were instructed by E to get their infants to cross without touching the infants or the cliff, and without gesturing in any way. An experimenter (E1) then led mothers into the laboratory room and instructed them to stand approximately 30 cm beyond the deep side of the cliff behind a curtain that separated the mother from the visual cliff. At this time, a second experimenter (E2) placed the infants on the shallow side. E2 attempted to place the infants in a sitting position, but if the infants were unsteady, they were placed in the crawling position.

Mothers in all conditions began by standing sideways with respect to the cliff and watching on the television screen near them as E2 put the infants on the cliff. As soon as the infant was on the cliff, E1 drew the curtain that separated the mother from the cliff. Both E1 and the television (TV) screen remained hidden behind the curtain so that the infant could not see them. E2 stood next to the cliff throughout the experiment to

ensure infants' safety, but she looked away so as not to provide cues. E1 now observed the infant on the mini-VCR screen, and, in the face plus voice, voice only and talk to adult conditions, when the infant looked up to the mother after looking down at the cliff, E1 signalled the mother to start (by holding up a sign that read, 'You can start!'). At this time, the mother started positively cueing the infant (according to the condition) so as to encourage the infant to cross the cliff. In the no cues condition, the mother was not signalled in any way; she simply continued to look at the TV screen until the 10 minutes had passed, the infant became fussy or the infant crossed.

Mothers behaved in one of the following ways according to the condition:

Face plus voice. Turned to face the cliff, smiled and vocalized.

Voice only. Remained standing sideways, continued looking at the TV screen, and vocalized. Mothers were permitted to vocalize as they normally would and to call their infants by name.

Talk to adult. Remained standing sideways, E1 stood near them, facing the mothers and visible to the infants. Mothers looked at and spoke to E1 in non-motherese, telling her to cross a line of tape on the floor. E1 watched the infant on a TV monitor and yoked her walking according to the infants' crawling movements.

No cues. Remained standing sideways and looked at the TV screen, but did not vocalize or otherwise cue infants.

When the infant's entire body had crossed the cliff, E1 indicated that the experiment was over. However, if infants did not cross within 10 minutes, the experiment was aborted because it was assumed that if infants were going to cross, 10 minutes would be long enough for them to do so. Mothers were debriefed about the purpose of the study, and infants were given a small toy.

Coding

Coding was carried out for crossing times and infant looking (first looks, and proportional duration and frequency of all looks). For operational definitions of and methods of coding these measures, please refer to Study 1. One additional coding was carried out as follows:

Number of infants excluded due to fussiness. This coding was added because such a large number of infants ($N = 22$) were excluded from the sample for fussiness, and we wanted to check whether different numbers of infants were excluded as a function of condition. The operational definition used was that infants were excluded if they were unduly distressed for 30 seconds to 1 minute, or whined persistently for 3 minutes or more. This determination was made by E1 during the procedure. The number of infants who were excluded was analysed as a function of condition.

Two manipulation checks were carried out. First, to ensure that E1 had correctly signalled mothers to begun cueing only once infants had looked down at the cliff and then looked up to the mother, a blind coder coded a random 20% of the sessions with the sound turned off. Second, a blind coder coded 100% of the infants excluded due to fussiness in order to assess whether E1 had excluded infants appropriately. Agreement was 100% for both measures.

A blind coder also coded crossing time in 20% of the sessions, and Pearson correlation between the primary and reliability coders was .996, $p < .0005$. Finally, a blind coder coded infant looking time in 20% of the sessions, and Cohen's κ on this measure was .85.

Results

Number of infants excluded due to fussiness. Infants in each condition who were placed on the cliff and excluded due to fussiness were counted. The ratios of excluded versus included infants in each condition were as follows: 3 versus 12 in face plus voice; 4 versus 12 in voice only; 8 versus 6 in talk to adult; and 7 versus 4 in no cues. A chi-square analysis of these ratios revealed a significant difference in the number of infants excluded as a function of condition, $\chi^2(3, N = 56) = 8.31$, $p = .040$. Pairwise comparisons revealed several significant differences (see Figure 3). Number of infants excluded in the talk to adult and no cues condition was significantly higher than the number excluded in the face plus voice condition, $p = .039$, and $p = .024$, respectively. Number of infants excluded in the talk to adult and no cues conditions was marginally significantly higher than the number excluded in the voice only condition ($p = .078$ and $p = .054$, respectively). Number of infants excluded was not different across the face plus voice and voice only conditions.

Crossing time. Infants' crossing times were analysed using a 2 (gender) × 4 (condition) between-subjects ANOVA, which revealed no significant interaction or main effects (all ps $> .10$)[3].

Infant looking. Means and standard deviations for each of the three looking behaviours are located in Table 1.

Duration of first looks. A one-way ANOVA (four levels: face plus voice; voice only; talk to adult; no cues), conducted to compare infants' first looks across conditions, revealed a significant condition effect, $F(3, 30) = 3.03$, $p = .044$. Pairwise comparisons revealed that infants' first looks were longer in talk to adult ($M = 7.4$, $SD = 10.27$) than in face plus voice ($M = 1.49$, $SD = .59$, $p = .010$), voice only ($M = 1.62$, $SD = 1.14$, $p = .011$) and no cues ($M = 1.78$, $SD = 1.32$, $p = .051$). There were no other differences across conditions (see Table 1).

Proportion of total duration of looks. To determine whether infants looked significantly more or less as a function of condition, a one-way ANOVA (four levels: face plus voice; voice only; talk to adult; no cues) was conducted. Amount of infant looking was not significantly different across conditions, $p = .256$.

Frequency of looks. Finally, a one-way ANOVA (four levels: face plus voice; voice only; talk to adult; no cues) was conducted in order to assess whether infants looked a different number of times as a function of condition. However, no significant differences were obtained across conditions, $p = .367$.

Discussion

Study 2 assessed whether infants look to mothers for information or comfort by testing infant behaviour in response to infant-directed, adult-directed, or no cues. As expected, when vocal cues were provided along with a visual reference (face plus voice), infants crossed the cliff. Additionally, as predicted, and replicating past work (Vaish & Striano, 2004), when vocal cues were provided but not accompanied by gazing, infants crossed the cliff as fast as in face plus voice – but only when the vocal cues were intended for the

[3] *Because the sample sizes of talk to adult and no cues were small (6 and 4, respectively), and our null results may have been due to small Ns, we also combined the data from these two conditions to create one condition, and re-ran the ANOVA to examine differences in crossing times. However, there continued to be no significant differences across conditions, p = .465.*

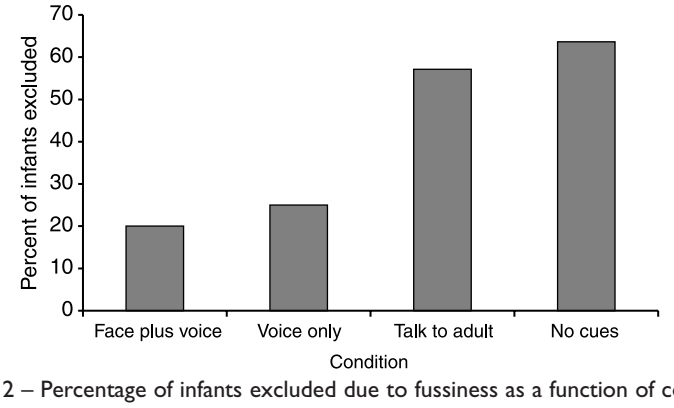

Figure 3. Study 2 – Percentage of infants excluded due to fussiness as a function of condition.

Table 1. Study 2 – Looking behaviours as a function of condition

Looking behaviour	Face plus voice ($N = 12$)	Voice only ($N = 12$)	Talk to adult ($N = 6$)	No cues ($N = 4$)
Duration of first looks (sec)				
M	1.49	1.62	7.40	1.78
SD	0.59	1.14	10.27	1.32
Proportion of total duration of looks[a]				
M	27.63	18.47	25.33	12.25
SD	17.48	12.87	16.01	11.57
Proportion of total number of looks[a]				
M	15.72	14.13	8.75	10.51
SD	9.96	8.31	4.35	7.98

[a] As a percentage of total crossing time.

infants (i.e. in voice only). In talk to adult, infants tended not to cross and instead became fussy.

Why did infants in talk to adult become fussy? The only difference between the voice only and talk to adult conditions was that mothers' vocal attention (in terms of both semantics and prosody) was directed to infants versus to adults, respectively. The fact that more infants became fussy and that infants' first looks were different in talk to adult versus voice only indicates that infants recognized the difference between contingent, infant-directed cues versus contingent, non-infant-directed cues, and responded appropriately only when they themselves were the focus of attention.

Our findings may seem at odds with the work of Moses *et al.* (2001), who showed that infants only use social referencing information provided by an emoter about a novel object if the emoter is present and visually attending to that object. In our voice only and talk to adult conditions, mothers were not looking at the visual cliff, but rather, were providing instrumental cues about how to behave. However, in our study, infants seem to have used maternal cues only in voice only, when mothers were clearly addressing infants using motherese and infants' names; in the talk to adult condition, which presented very similar instrumental information, infants became fussy instead. It is possible that infants in Moses *et al.*'s study did not use cues from an experimenter who emoted without visually attending to the object because such cues were not clearly

about the object, nor clearly meant for infants to use. We thus suggest that in the absence of visual regard, infants can use other cues (such as prosody and content of speech) to determine what adults are referring to and who they are addressing. This supports Campos and Stenberg's (1981) hypothesis that when the mother is visually inaccessible, infants are likely to increase their reliance on vocal cues.

Our findings are in contrast to work on overheard speech (e.g. Akhtar, 2002, 2005; Akhtar, Jipson, & Callanan, 2001), which has shown that in their second and third years, children can effectively learn language even if the person that they are learning from is not directing her speech at them. This discrepancy might arise from the fact that we tested 10-month-olds, whose understanding of social interactions and communication might be more limited than that of older children. Alternatively, it is possible that under the stress of a mildly threatening social referencing situation, children use only those cues that are directed at them, whereas in a non-threatening situation, children can pay attention to events in the environment that are not relevant to them at no cost to their own well-being.

Interestingly, similar numbers of infants were excluded from the talk to adult and no cues conditions. Since infants in talk to adult received information but not the comfort of maternal attention, we argue that these 10-month-old infants were seeking comfort, and when they did not receive it in talk to adult, they became upset. However, alternative explanations are possible, and will be discussed below.

GENERAL DISCUSSION

By 1 year of age, infants have consistently been found to engage in social referencing (Feinman, 1982; Klinnert *et al.*, 1986; Sorce *et al.*, 1985). However, Baldwin and Moses (1996) suggest that, in social referencing situations, infants should not be assumed to be looking for information, since an equally plausible explanation could be that infants are seeking comfort. We conducted two studies to try to tease apart infants' information-seeking versus comfort-seeking behaviours.

In Study 1, we followed Baldwin and Moses' (1996) suggestion and manipulated the depth of the visual cliff such that infants were faced with either an ambiguous cliff or a deep, threatening cliff. Both 10- and 13-month-old infants' first looks were longer in the deep than in the ambiguous condition. If we accept that the deep cliff condition did not serve its purpose, and was not actually threatening but only more ambiguous than the ambiguous cliff condition, then our results suggest that infants were looking for information. However, this is only conjecture, since it is difficult to ascertain the point at which infants view a drop as truly and unambiguously dangerous. Furthermore, mothers cueing infants to cross an extremely deep cliff perhaps creates a far more ambiguous situation than mothers cueing infants to come across a shallow cliff[4].

Given these concerns about ambiguity on the visual cliff, we suggest that this may not be the optimal situation in which to investigate infants' looks. Infants on the visual cliff must overcome the obstacle of the cliff in order to be near their mother. Considering that the visual cliff is a reasonably threatening situation (Mumme *et al.*, 1996; Vaish & Striano, 2004), the task of having to cross it to get to mother is likely to elicit more comfort- than information-seeking looks, even when the 'cliff' is set at a relatively shallow depth. This makes it difficult to tease apart infant behaviour on an

[4] *We thank an anonymous reviewer for this suggestion.*

ambiguous versus deep cliff situation, since the behaviour is likely to be rather similar regardless of the depth of the cliff. Future studies could therefore attempt to address this question using ambiguous versus unambiguous novel toys. In contrast to the visual cliff, novel toys pose less, if any, immediate threat or danger. Additionally, infants faced with novel toys are not *forced* to play with or otherwise manipulate the toys in order to approach the mother.

In past work involving the novel toy paradigm, researchers have been able to determine which toys infants perceive as ambiguous and which they perceive as clearly positive or negative (e.g. Gunnar & Stone, 1984; Mumme & Fernald, 2003; Mumme *et al.*, 1996). Using toys that have already been identified as eliciting ambiguous versus clearly aversive reactions from infants, researchers could assess whether infants look more to mother when faced with the ambiguous or the aversive toy. Using Baldwin and Moses' (1996) logic, if infants in social referencing situations look for information, they should look more when dealing with the ambiguous toy, whereas if they look for comfort, they should look more when facing the aversive toy.

To attempt a different and perhaps more informative approach to our question, in Study 2, we investigated infant behaviour in conditions that varied in terms of the focus of mothers' attention. In two conditions (face plus voice and voice only), mothers provided informative and comforting infant-directed cues; in a third condition (talk to adult), mothers provided instrumental information but not comforting cues, and in a fourth condition (no cues), mothers provided neither information nor comfort.

The number of infants who became fussy and were excluded from talk to adult indicates that infants discriminated between signals that were meant for them and those that were not, and when they did not receive maternal attention, they became fussy. Thus, on the surface, the results indicate that infants on the visual cliff do look primarily for the comfort of maternal attention (see also Sorce & Emde, 1981). However, it is important to consider the role of age in this regard. It is possible that 10-months-olds look to mother primarily for comfort, especially when placed in a mildly threatening situation, whereas as they get older and are better able to gather, understand and use cues and information provided by other people, their reason for looking probably changes as well, perhaps becoming more aimed at seeking information rather than comfort. This possibility needs further examination.

An alternative interpretation of our findings is that, having recognized that mothers' cues in talk to adult were not meant for them, infants entirely ignored those cues, and therefore did not use the information that mothers in that condition provided. Going against this possibility is the finding that infants' first looks in talk to adult were longer than those in the other conditions, which indicates that infants were in fact paying *more* attention to the situation in this condition than in the others. However, during the course of the experiment, they looked equally often and for equally long as in the other conditions, indicating that they did not continue to pay more attention in this condition. Thus, although it seems that 10-month-old infants were seeking maternal attention, it is possible that they were actually looking for information, but simply did not use the information that was present because it was not directed at them.

The few infants that did cross in the talk to adult condition crossed just as fast as infants in face plus voice and voice only. This finding implies that these few infants were looking for information, and were able to use the information that mothers provided to the experimenter. However, the problem with this interpretation is that there were also a few infants in no cues that crossed the cliff, and just as fast as infants in the other conditions. Together, these data might suggest that the infants who crossed in talk to

adult and no cues did not engage in true social referencing, and that they would have explored and crossed the cliff under almost any circumstance.

We thus propose that there is a baseline of brave, 'dare-devil' infants who explore their surroundings without others' guidance and perhaps do not engage in social referencing as frequently as other infants do. In fact, in several social referencing studies, some infants did not reference the mother or adult at all (e.g. 21% in Sorce *et al.*, 1985); thus, there are probably significant individual differences between infants in whether and how much they social reference (see Hornik Parritz, Mangelsdorf, & Gunnar, 1992; Nelson, 1987).

Hornik Parritz *et al.* (1992) suggest that infants' temperament and attachment styles, among other factors, may play some role in determining their social referencing behaviours. Further research is needed to clarify what kinds of inter-individual differences determine social referencing styles in infants. Accordingly, we are currently in the process of examining possible relationships between infants' attachment styles and social referencing behaviours on the visual cliff (see also Carr, Dabbs, & Carr, 1975; Dickstein, Thompson, Estes, Malkin, & Lamb, 1984; Feinman & Lewis, 1983).

Another possibility is that the infants who crossed in the two non-infant-directed conditions (talk to adult and no cues) were relying on their past experiences that mothers do not leave them alone in dangerous situations, and if, in this case, mothers seemed unconcerned, perhaps the situation was not so dangerous after all. Indeed, in some cultures, infants often do not receive constant attention from their parents. For instance, Yucatec Mayan infants receive far less direct attention from adults compared with American infants. These infants also look up to their mothers three times less often than do American infants (Gaskins, 2000). However, when infants are in truly harmful situations, Yucatec mothers do intercede to ensure the child's safety. In general, the mother is not available to provide guidance, and so the infant has to learn that if the mother is not interceding, the situation must be safe enough to explore. Different parental styles might thus account for the individual differences in infants' social referencing that appeared in our studies.

Interestingly, in Study 1, we found no age differences across conditions or in looking behaviours. This was surprising considering that other researchers have reported that as infants grow older, they look more and quicker at parents when dealing with ambiguous situations (Klinnert, 1984; Walden & Baxter, 1989; Walden & Ogan, 1988). We therefore expected that 13-month-olds would be more advanced and efficient in their social referencing behaviour, and especially looking behaviours, than 10-month-olds. However, we may not have found this difference because we used a different paradigm: whereas other researchers used the novel toy paradigm to explore age differences in social referencing, we used the visual cliff. As mentioned earlier, the visual cliff presents a more threatening situation than does a novel toy, and infants may reference differently in the two kinds of situations. Further research is needed to explore whether infants respond differently to referencing cues if they are in ambiguous, harmless situations versus more threatening situations.

An unconventional aspect of Study 2 was that one of our dependent variables was the drop-out rate. Although this is an unusual approach to examining condition differences, it may be a useful approach as the number of infants who become fussy once they have been exposed to an ambiguous situation may differ based on the nature of the situation. Just as Sorce *et al.* (1985) analysed the number of infants who did not cross within the 2-minute window, we used the number of infants who became fussy as our dependent variable. We believe that this can be a telling measure of how infants perceive and understand a situation as a function of its ambiguity or novelty.

Tuning into information that is intended for the infant is a highly adaptive skill, and, as the current studies show, early precursors of this ability may exist by 10 months. This finding not only confirms that infants discriminate between motherese and non-motherese (e.g. Fernald, 1985), but also confirms past findings that young infants generally use others' cues when those cues are directed at the infants, whether visually, vocally (prosody and/or content) or both (Feinman & Lewis, 1983; Moses *et al.*, 2001; Striano & Rochat, 2000; Vaish & Striano, 2004). This probably changes as infants get older and are better able to pay attention to information that is not directly addressed to them (e.g. Akhtar, 2002, 2005).

Our studies do not entirely clarify, however, whether infants on the visual cliff look to mothers for information or for comfort. Although the results of Study 2 suggest that infants were seeking comfort, the complex nature of our findings suggests that information- and comfort-seeking looks might not be mutually exclusive. However, we would recommend that future studies addressing this issue use paradigms other than the visual cliff, because the special characteristics of the visual cliff might elude an answer to this question.

Acknowledgements

This research was supported in part by the Sofja Kovalevskaja Award granted by the Alexander von Humboldt Foundation to T. Striano. We thank the Universitätsfrauenklinik and the Eitingon Krankenhaus for help with participant recruitment, and the parents and infants who participated. Amrisha Vaish is now at the University of Chicago, and Joann P. Benigno is now at the Institute of Child Development at the University of Minnesota.

References

Akhtar, N. (2002). Relevance and early word learning. *Journal of Child Language*, *29*, 677–686.

Akhtar, N. (2005). The robustness of learning through overhearing. *Developmental Science*, *8*, 199–209.

Akhtar, N., Jipson, J., & Callanan, M. (2001). Learning words through overhearing. *Child Development*, *72*, 416–430.

Baldwin, D. A., & Moses, L. J. (1996). The ontogeny of social information gathering. *Child Development*, *67*, 1915–1939.

Boccia, M. L. & Campos, J. J. (1983, April). *Maternal emotional signals and infants' reactions to strangers*. Paper presented at the biennial meeting of the Society for Research in Child Development, Detroit, MI.

Campos, J. J., & Stenberg, C. R. (1981). Perception, appraisal, and emotion: The onset of social referencing. In M. Lamb & L. Sherrod (Eds.), *Infant social cognition* (pp. 273–314). Hillsdale, NJ: Erlbaum.

Carr, S. J., Dabbs, J. M., & Carr, T. S. (1975). Mother–infant attachment: The importance of the mother's visual field. *Child Development*, *46*, 331–338.

Clarke-Stewart, K. A. (1978). Recasting the lone stranger. In J. Glick & K. A. Clarke-Stewart (Eds.), *The development of social understanding* (pp. 109–176). New York: Gardner Press.

Clyman, R. B., Emde, R. N., Kempe, J. E., & Harmon, R. J. (1986). Social referencing and social looking among twelve-month-old infants. In T. B. Brazelton & M. W. Yogman (Eds.), *Affective development in infancy* (pp. 75–94). Norwood, NJ: Ablex.

Dickstein, S., & Parke, R. D. (1988). Social referencing in infancy: A glance at fathers and marriage. *Child Development*, *59*, 506–511.

Dickstein, S., Thompson, R. A., Estes, D., Malkin, C., & Lamb, M. E. (1984). Social referencing and the security of attachment. *Infant Behaviour and Development*, *7*, 507–516.

Feinman, S. (1982). Social referencing in infancy. *Merrill-Palmer Quarterly*, *28*(4), 445–470.
Feinman, S., & Lewis, M. (1983). Social referencing at 10 months: A second-order effect on infants' responses to strangers. *Child Development*, *54*, 878–887.
Fernald, A. (1985). Four-month-old infants prefer to listen to motherese. *Infant Behaviour and Development*, *8*, 181–195.
Gaskins, S. (2000). Children's daily activities in a Mayan village: A culturally grounded description. *Cross-Cultural Research: The Journal of Comparative Social Science*, *34*(4), 375–389.
Gibson, E. J., & Walk, R. D. (1960). The visual cliff. *Scientific American*, *202*, 67–71.
Gunnar, M. R., & Stone, C. (1984). The effects of positive maternal affect on infant responses to pleasant, ambiguous, and fear-provoking toys. *Child Development*, *55*, 1231–1236.
Hertenstein, M. J., & Campos, J. J. (2004). The retention effects of an adult's emotional displays on infant behaviour. *Child Development*, *75*, 595–613.
Hornik Parritz, R., Mangelsdorf, S., & Gunnar, M. R. (1992). Control, social referencing, and the infant's appraisal of threat. In S. Feinman (Ed.), *Social referencing and the social construction of reality in infancy* (pp. 209–228). New York: Plenum.
Hornik, R., Risenhoover, N., & Gunnar, M. R. (1987). The effects of maternal positive, neutral, and negative affective communications on infant responses to new toys. *Child Development*, *58*, 937–944.
Klinnert, M. D. (1984). The regulation of infant behaviour by maternal facial expression. *Infant Behaviour and Development*, *7*, 447–465.
Klinnert, M. D., Emde, R. N., Butterfield, P., & Campos, J. J. (1986). Social referencing: The infant's use of emotional signals from a friendly adult with mother present. *Developmental Psychology*, *22*, 427–432.
Moses, L. J., Baldwin, D. A., Rosicky, J. G., & Tidball, G. (2001). Evidence for referential understanding in the emotions domain at twelve and eighteen months. *Child Development*, *72*, 718–735.
Mumme, D. L., & Fernald, A. (2003). The infant as onlooker: Learning from emotional reactions observed in a television scenario. *Child Development*, *74*, 221–237.
Mumme, D. L., Fernald, A., & Herrera, C. (1996). Infants' responses to facial and vocal emotional signals in a social referencing paradigm. *Child Development*, *67*, 3219–3237.
Nelson, C. A. (1987). The recognition of facial expression in the first two years of life: Mechanisms of development. *Child Development*, *58*, 889–909.
Repacholi, B. M. (1998). Infants' use of attentional cues to identify the referent of another person's emotional expression. *Developmental Psychology*, *34*, 1017–1025.
Slaughter, V., & McConnell, D. (2003). Emergence of joint attention: Relationships between gaze following, social referencing, imitation, and naming in infancy. *Journal of Genetic Psychology*, *164*(1), 54–71.
Sorce, J. F., & Emde, R. N. (1981). Mothers' presence is not enough: Effect of emotional availability on infant exploration. *Developmental Psychology*, *17*, 737–745.
Sorce, J. F., Emde, R. N., Campos, J. J., & Klinnert, M. D. (1985). Maternal emotional signaling: Its effect on the visual cliff behaviour of 1-year-olds. *Developmental Psychology*, *21*, 195–200.
Striano, T., & Rochat, P. (2000). Emergence of selective social referencing in infancy. *Infancy*, *2*, 253–264.
Vaish, A., & Striano, T. (2004). Is visual reference necessary? Contributions of facial versus vocal cues in 12-month-olds' social referencing behaviour. *Developmental Science*, *7*, 261–269.
Walden, T. A., & Baxter, A. (1989). The effect of context and age on social referencing. *Child Development*, *60*, 1511–1518.
Walden, T. A., & Ogan, T. A. (1988). The development of social referencing. *Child Development*, *59*, 1230–1240.

Received 3 March 2004; revised version received 24 May 2005