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The Organization of Wariness of Heights in Experienced Crawlers

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Abstract

Most infants with more than 6 weeks of crawling experience completely avoid the deep side of a visual cliff (Campos et al., 1992; Gibson & Walk, 1960). However, some experienced crawlers do move onto the transparent surface suspended several feet above the ground. An important question is whether these *non-avoiders* lack wariness of heights or whether they have a qualitatively different way of showing their wariness than do *avoiders* of the deep side. The current study addressed this question by measuring heart rate (HR) acceleration upon being lowered on the deep and shallow sides of the visual cliff, latency to crawl toward the mother, and tactile exploration of the cliff surface. Non-avoiders and avoiders had indistinguishable patterns of HR acceleration, showing greater HR acceleration when lowered onto the deep than when lowered onto the shallow side of the cliff. Non-avoiders also showed more tactile exploration and longer latencies than did a comparable group of infants tested on the shallow side. This study illustrates how the same emotion, wariness of heights, can be shown by qualitatively different behaviors, all serving the same function of protecting the individual from falling over a drop-off.

Keywords

visual cliff; wariness of heights; heart rate; mother-infant interaction; coherence of behavior

Wariness of heights takes many forms. When visiting the Grand Canyon Skywalk – a transparent platform suspended 2,000 feet above the canyon floor – some will not even walk

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onto the platform, others will slowly venture out while clinging to the rail, while a third group may simply express verbally a slight discomfort (Rothstein, 2007). While almost all adults have a concern with preventing painful falls, the ways by which they show this concern differ greatly.

After 6 weeks of crawling experience,the majority of infants show wariness of heights by completely refusing to crawl onto a transparent surface suspended 4 feet above the ground (Campos, Bertenthal, & Kermoian, 1992). Experienced crawlers tested on a visual cliff apparatus will show this refusal even when their mother is calling for them on the other side of the transparent surface and even when they have crossed the same surface a few weeks earlier. Yet, they will readily cross to the mother on the shallow side of the cliff at both ages (Campos, Hiatt, Ramsay, Henderson, & Svejda, 1978). These and other findings linking duration of locomotor experience to avoidance of drop-offs have led to the well-established view that self-produced locomotion brings about a developmental shift in infant wariness of heights (Bertenthal & Campos, 1990; Campos et al., 1978).

However, 10-40% of experienced crawlers *do* venture onto the transparent “deep side” of a visual cliff when called by their mothers (Campos et al., 1992; Campos et al., 1978; Walk, 1966). There are two potential explanations for this pattern of behavior. One possibility is that the non-avoiding crawlers are just as wary as the complete avoiders, but that non-avoiders have qualitatively different ways of displaying their wariness. Just as terrified visitors to the Grand Canyon Skywalk walk onto the transparent platform only while clinging to the rail, wary infants might for instance crawl onto the deep side of the visual cliff only with great caution. The other possibility is that experienced crawlers who fail to show complete avoidance are not afraid of the drop-off. If indeed a substantial proportion of experienced crawlers show no signs of wariness of heights whatsoever, the hypothesis that experience with self-produced locomotion brings about wariness of heights would need revision (Bertenthal & Campos, 1990).

No previous studies have tested whether experienced crawlers who venture onto the deep side of a visual cliff show signs of wariness of heights. By signs of wariness of heights we mean behavior indicating that the infant has a concern with preventing a fall over a drop-off. In the current study, we assessed the following three indices of such wariness: Differential heart rate (HR) acceleration upon being lowered on the deep and shallow sides of the visual cliff, latency to move onto the deep side of the visual cliff, and tactile exploration of the transparent surface.

Wariness and fear typically lead to HR acceleration (Campos, 1976; Campos, Emde, Gaensbauer, & Henderson, 1975; Sartory, 1986). HR acceleration prepares the individual for escape or defense, whereas deceleration goes along with intake of information (Graham & Clifton, 1966; Lacey, 1967). HR acceleration upon being lowered toward the deep side of the visual cliff may be a more sensitive index of wariness than avoidance of crossing the cliff. Accordingly, some studies suggest that crawling infants begin to show HR accelerations on the deep side of the visual cliff before they show avoidance of drop-offs (Campos et al., 1992). If non-avoiders are less wary of the drop-off than avoiders, they would be expected to show less HR acceleration when lowered onto the deep side of the visual cliff. In contrast, there should be no difference between the two groups on HR acceleration upon being lowered onto the shallow side of the cliff.

A wary individual may approach the source of threat, but only with much reluctance. An index of reluctance on the visual cliff is prolonged latency to venture onto the deep side of the cliff compared to the shallow side (Campos et al., 1978). By definition, non-avoiders will have shorter latency to move onto the deep side of the visual cliff than do avoiders. However, if non-avoiders lack wariness of the drop-off their latency to crawl onto the deep side should be similar to the latency of a comparable group of infants to crawl onto the shallow side. On the other hand, if non-avoiders do perceive the drop-off as a threat, they should venture onto it after a period of hesitation, leading to increased latencies compared to a comparable group of infants tested on the shallow side.

Infants who are wary of the drop-off are also likely to explore the transparent surface on the deep side before potentially venturing onto it. Cautious exploration of the source of threat is an adaptive way of seeking information that will help determine the extent of the threat. If non-avoiders are less wary of the drop-off than avoiders, they should show minimal tactile exploration of the transparent surface on the deep side. On the other hand, if non-avoiders are wary of the drop-off, they should be more likely to engage in tactile exploration of the cliff surface than a comparable group of infants on the shallow side surface.

We also wanted to control for two alternative explanations of the difference between avoiders and non-avoiders. First, it is possible that non-avoiders fail to perceive the drop-off, and merely look at the mother while crawling toward her (Campos et al., 1978). We therefore coded the looking behavior of infants while their mothers were encouraging them to cross the deep side. A second potential explanation for the non-avoiders' behavior is that they receive more encouragement from their mothers (Sorce, Emde, Campos, & Klinnert, 1985). To rule out this possibility, we coded the amount and valence of maternal communication.

The present study compared the reactions of three groups of experienced crawlers on the visual cliff: (1) Those who crawled onto the deep side (non-avoiders), (2) those who avoided the deep side (avoiders), and (3) those who crawled onto the shallow side (shallow side comparison group). In sum, if non-avoiders show similar signs of wariness of the drop-off as avoiders, and more signs of wariness of the deep side than the comparison group show of the shallow side, we could conclude that non-avoiders with substantial crawling experience generally *are* wary of drop-offs.

Method

Participants

In the main study, twenty five full-term infants participated, ranging in age from 40 to 45 weeks (*M* = 42.46 weeks, *SD* = 1.58; 8 girls, 17 boys). Data from four additional infants could not be collected because of fussiness before the experiment began. All infants were experienced crawlers, having more than 4 weeks of hands-and-knees crawling experience (*M* = 6.50 weeks, *SD* = 1.99, range = 4.00-11.57 weeks). Crawling onset was defined as the first day when infants could crawl 2.4 m forward without support or stopping to rest. We chose 2.4 m as a criterion because it corresponded to the length from the edge of the shallow side to the mother.

The parents, all of whom were Japanese and middle class, were recruited at a healthcare center in Kyoto, Japan, and were contacted by phone and invited to participate with their infants. Mothers provided written informed consent before their infants participated in the study.

Apparatus

The visual cliff apparatus is a 120 × 240 cm glass-covered table, divided into two 120 × 120 cm halves: the *shallow* side and the *deep* side. Immediately beneath the glass on the shallow side was a checkerboard pattern of 7.5 cm square red and white tiles. Lying 110 cm beneath the glass on the deep side was a checkerboard pattern of 17 cm square red and white tiles. To prevent infants from falling from the periphery of the visual cliff table, a 35 cm high wooden barrier surrounded the glass surface. Under the glass surface, a beige curtain was hung around the visual cliff. The checkerboard tiles, which were translucent on both sides of the cliff, were illuminated by fluorescent lights placed underneath the tiles. Such lighting prevented the infant from seeing his/her reflection on the glass surface.

Design and Procedure

All infants in the main study were tested first in the *crossing paradigm*, where mothers encouraged the infants to cross the deep side of the visual cliff, and next in the *descent paradigm*, in which the infant's HR was measured while an experimenter lowered the infant onto the deep or shallow side (Campos et al., 1978). We conducted the crossing paradigm first, in order to prevent the experience on the glass in the descent paradigm from influencing the crossing behavior of the infants. There was a ten minute break between the paradigms.

The crossing paradigm—For infants in the main study, we conducted only deep side trials in the crossing paradigm in order to minimize exposure to the visual cliff before testing on the descent paradigm. To familiarize infants with the study setting, they were first seated on the surface of the visual cliff, which was covered with a sheet, and played with a toy. Mothers were positioned at the corner of the deep side, so as to maximize the distance between the infant and the mother. Experimenter 1 then lifted and faced the infant away from the cliff while Experimenter 2 removed the covering. Experimenter 1 subsequently placed infants prone on the center of the shallow side and signaled for mothers to encourage their infants to cross to them. Figure 1a illustrates the position of the infant, mother, and Experimenter 1 at the start of the crossing paradigm. During the trial, two experimenters stood by the visual cliff and Experimenter 2 timed the trial with a stopwatch. Mothers were instructed not to touch the glass surface nor to give any clue about the glass covering the deep side.

To further minimize experience on the deep side from influencing the HR responses in the subsequent descent paradigm, Experimenter 1 monitored the infants on a video screen and picked up the infants as soon as they shifted their weight onto the deep side. "Shifting weight onto the deep side" was defined as the infant having both hands on the deep side and moving his or her forehead in a forward direction past the center of his or her palms. An independent coder assessed the application of this criterion from the video recordings; agreement in the classification of infants as avoiders or non-avoiders was 92%. If the infant did not go onto the deep side after 60 sec, the trial was ended.

The procedure of the crossing paradigm was video recorded utilizing three cameras, one showing the entire visual cliff, the second showing the infant on the "edge" of the cliff from beneath the glass of the deep side, and the third showing the mother's face from the shallow side. These images were synchronized with a splitter, the output of which was recorded on a DVD recorder.

The descent paradigm—Between the testing in the crossing paradigm and the descent paradigm, an experimenter attached the electrodes on the infant's back. Then, as in the crossing paradigm, infants sat on the sheet-covered surface of the cliff and played with toys prior to the test. After the familiarization period, Experimenter 1 lifted the infants from the visual cliff and Experimenter 2 removed the sheets and toys.

In the descent paradigm, we conducted two deep side trials and two shallow side trials in alternating order. Infants were randomly assigned to begin with either a deep side or a shallow side trial. Before each trial, Experimenter 1 held the infants facing away from the visual cliff until the infant had been in a quiet alert state for at least 3 sec, with the 3 sec immediately preceding the trial constituting a prestimulus baseline period. After the baseline period, Experimenter 1 positioned the infants prone, facing away from Experimenter 1, about 90 cm above the surface of the glass, and began lowering the infants at a rate of 30 cm/sec, for a total of 3 seconds. After 5 seconds of the infant being on the glass, Experimenter 1 lifted the infant facing away from the visual cliff and initiated another period of holding, leading into the prestimulus baseline period for the next trial. If the infant became upset during the prestimulus baseline period, experimenters waited until the infant were calm. When necessary, Experimenter 1 would soothe the infant with a toy.

During the descent paradigm, the infant's mother stood on Experimenter 1's left on every trial and was instructed not to speak. The position of infant, mother, and Experimenter 1 are illustrated in Figure 1b.

The descent paradigm procedure was video recorded by three cameras, one showing the entire visual cliff, the second showing the infant on the shallow side, and the third showing the infant on the deep side. These images were recorded in the same way as they were for the crossing paradigm.

Measurement of HR—To measure the infant's HR, three disposable electrodes (M-00-S, Ambu) were placed on the infant's back in a triangular arrangement. The electrocardiogram (ECG) was amplified and input to an autonomic nervous analysis program (Map 1060, Nihon Santeku) running on a personal computer (NEC) by a polygraph telemeter (Poly Tele STS-1C, Nihon Santeku) with a built-in biosignal amplifier and transmitter. This program digitized the ECG at 1,000 Hz, detected R-waves, and measured RR intervals. HR was calculated by dividing 60000 by the RR intervals in milliseconds. Experimenter 2 watched the trial from the video monitor online and recorded three specific time points during the trial on the ECG using an event marker button: (a) the beginning of the prestimulus baseline period, (b) the beginning of descent to the glass, and (c) the point of touching the glass.

Data Reduction

The crossing paradigm—In the crossing paradigm, the following measures were coded for all infants by the first author and a coder blind to the purpose of the study. Disagreements were resolved by discussion.

1. Latency to put hands onto the glass: We measured the latencies to put two hands on the glass of the deep side. Latency to put two hands was defined as the time it took for the infant to put both hands on the glass on the deep side after the infant was placed on the shallow side (Interrater reliability: r = 1.00).

2. Mothers' vocalization: To assess the amount of encouragement infants received, we determined the proportion of trial time during which mothers were vocalizing (Interrater reliability: r = .84). To make the data approximately normally distributed, we performed an arcsine transformation on the proportions.

3. Mothers' facial expression: Mothers' facial expression was coded second-by-second as either positive, neutral, or negative. Negative expression included downward curls of the mouth, frowns, and scrunched eyebrows. Positive expression was a smile which included bilateral upward curls of the mouth. Other expression was classified as a neutral expression. No mothers showed negative expressions. Interrater reliability was r = .98 for positive expressions and r = .95 for neutral expressions. For the purposes of analysis, we calculated the proportion of total trial time during which mothers displayed positive expressions and performed an arcsine transformation to correct for skew.

4. Duration of looking during trial: The duration of looking at the deep side or at the mother during the trial was calculated as a proportion of trial time (Interrater reliability: Looking at deep side: r = .89. Looking at mother: r = .93).

5. Tactile exploration: Infants' tactile exploration of the glass of the deep side was coded. Based on the criteria of previous studies (e.g., Adolph, 1997; Adolph, Eppler, Marin, Weise, & Clearfield, 2000; Witherington, Campos, Anderson, Lejeune, & Seah, 2005), tactile exploration included pressing, patting, or rubbing the surface of the deep side of the cliff without placing their weight on it. For tactile exploration to be coded, the infant also had to look at the deep side of the visual cliff (Interrater reliability: κ = 1.00).

The descent paradigm—In the descent paradigm, we analyzed HR level from the RR intervals for the 3 seconds from the start of descending onto the glass for each trial, as well as the 3 seconds prior to the decent (which constituted the prestimulus baseline period). Next, we calculated differences between the mean HR level of the prestimulus baseline period and the mean HR level of the descent onto the glass for each side condition. We analyzed incomplete RR intervals at the end of the 3-second epochs by measuring the interval between the last R-wave during the epoch and the next R-wave of the epoch. No artifact occurred in the HR data. A preliminary ANOVA revealed no significant effects of side or trial number on the average baseline HR. For the analyses reported below, we used HR acceleration as an index of the infants' cardiac reaction to being lowered onto the cliff surface. HR acceleration was defined as the raw difference between the average HR during the 3 sec baseline and the average HR during the 3 sec descent, calculated separately for each of the four trials.

Comparison group tested in crossing paradigm on shallow side only

To obtain normative latency times for placing hands on the shallow side of the cliff, we tested 9 additional infants in the crossing paradigm. Infants in the comparison group were of the same age as the 25 infants in the main study (M = 41.14 weeks, SD = 1.25; 3 girls and 5 boys), and they had comparable crawling experience (M = 6.97 weeks, SD = 1.41, range = 4.72-8.72 weeks). One infant in the comparison group was excluded because of experimenter error. The comparison group was tested only in the crossing paradigm on the shallow side. Because of the location of the cameras, we could not code looking behavior on the shallow side. The procedure and data reduction were otherwise identical to that of the crossing paradigm in the main study. Interrater reliability was r = 1.00 for latency to place both hands on the shallow side and κ = 1.00 for tactile exploration.

Results

Classification of Infants as Avoiders and Non-Avoiders

We first divided infants in the main study into avoiders and non-avoiders based on their behavior in the crossing paradigm. 18 infants (the *avoiders*: 6 girls, 12 boys) did not go onto the deep side and 7 infants (the *non-avoiders*: 2 girls, 5 boys) did shift their weight on the deep side. In preliminary analyses, we found no effects for infant sex; hence, we combined data from girls and boys. Avoiders and non-avoiders did not differ by age (Avoiders: M = 42.51 weeks, SD = 1.41. Non-avoiders: M = 42.35 weeks, SD = 2.08), $t(23)$ = .223, *ns*, or by crawling experience (Avoiders: M = 6.33 weeks, SD = 2.12, range = 4.00-11.57 weeks. Non-avoiders: M = 6.94 weeks, SD = 1.69, range = 4.43-9.86 weeks), $t(23)$ = -.686, *ns*.

The descent paradigm

Five of the avoiders (3 girls and 2 boys) could not be tested on the descent paradigm due to fussiness from being held by the experimenter. To examine differences in HR change during descent onto the glass for the remaining 20 infants, we conducted a 2 (group) × 2 (side) × 2 (trials) repeated measures ANOVA, with group as a between-subjects factor and side and trials as within-subjects factors.

The analysis revealed a main effect of side, $F(1,18) = 15.65$, $p < .001$, partial $\eta^2 = .47$. No other main effects and no interaction effects emerged. With regard to the main effect of side, infants' mean HR change was +7.61 bpm on the deep side (SD = 4.61) and +3.41 bpm (SD = 5.27) on the shallow side. Thus, the deep side produced significantly greater HR acceleration than the shallow side. As shown in Figure 2a, there was no tendency for avoiders to show greater HR differentiation between the deep and the shallow side than did non-avoiders: The mean deep-shallow difference in cardiac acceleration was 4.10 bpm for avoiders and 4.39 bpm for non-avoiders, $t(18) = -.134$, *ns*. In other words, the HR data suggested that non-avoiders showed similar defensive cardiac accelerations on the drop off (Graham & Clifton, 1966).

Crossing paradigm

Latency to put hands on the deep side—A second way to assess wariness of the deep side in non-avoiders was to see whether they took longer to place their hands on the deep side than the 8 infants in the comparison group took to place their hands on the shallow side. For non-avoiders in the main study, mean latency to put two hands on the deep side was 35.33 sec (*SD* = 16.10). The average latency in the shallow side group was 11.44 seconds (*SD* = 14.46), which was significantly shorter than the latency of the non-avoiders in the main study to put their hands on the *deep* side, $t(13) = 3.03$, $p < .05$, as shown in Figure 2b. Thus, the latency data supported the hypothesis that the non-avoiders were more wary of the deep side than a comparable group of infants were wary of the shallow side.

Tactile exploration—Tactile exploration before crawling onto a surface was another way in which infants could show wariness. As shown in Figure 2c, in the crossing paradigm, 5 of 18 avoiders and 6 of 7 non-avoiders engaged in tactile exploration, Fisher's exact test: $p < .05$. Thus, proportionally more non-avoiders than avoiders engaged in tactile exploration of the glass of the deep side.

In contrast, only 1 of the 8 infants tested on the shallow side engaged in tactile exploration, which was significantly lower than the proportion of non-avoiders engaging in tactile exploration on the deep side, Fisher's exact test: $p < .05$. Like the HR and the latency data, the tactile exploration data suggested that the non-avoiders were generally wary of the drop-off.

Mothers' Emotional Expression and Vocalization—The purpose of analyzing maternal communication in the crossing paradigm was to see whether non-avoiders received more encouragements from their mothers than did avoiders of the deep side. For 4 of the infants (2 avoiders and 2 non-avoiders), the mother's face was not visible. While we could not obtain data on their facial expressions, data from these mothers were included in the analysis of mothers' vocalization.

There were no significant differences between the maternal communication received by the two groups. The mothers of the avoiders called to their infants 41.48% of the time (*SD* = 8.28) during the crossing task, and the mothers of the non-avoiders did so 39.23% of the time (*SD* = 5.54), $t(23) = .685$, *ns*. Furthermore, the mothers of the avoiders displayed positive expression 77.19% of the time (*SD* = 22.41) and the mothers of the non-avoiders did so 64.33% of the time (*SD* = 33.10), $t(19) = .794$, *ns*. Hence, there was no evidence that non-avoiders placed their hands on the deep side simply because they received more encouragement from their mothers.

Duration of looking during trial—Looking behavior data were analyzed to see whether it was possible that non-avoiders ventured onto the deep side because they did not see the drop-off. Avoiders looked at the deep side 21.54% (*SD* = 12.80) and the mother 36.03% (*SD* = 16.07) of time during the crossing task. While, non-avoiders looked at the deep side 46.23% (*SD* = 18.72) and the mother 27.93% (*SD* = 5.83) of the time. We conducted a 2 (group) × 2 (direction) repeated measures ANOVA with group as a between-subjects factor and direction as a within-subjects factor. This analysis revealed a significant Group × Direction interaction, $F(1,23) = 13.33$, $p < .01$, partial $\eta^2 = .37$, but no main effect of group or of direction. With regard to the interaction, non-avoiders looked at the deep side more than avoiders, $F(1,23) = 14.44$, $p < .01$, partial $\eta^2 = .39$. Avoiders looked at the mother more than the deep side, $F(1,23) = 9.29$, $p < .01$, partial $\eta^2 = .29$, and non-avoiders looked at the deep side more than the mother, $F(1,23) = 5.77$, $p < .05$, partial $\eta^2 = .20$. Accordingly, there was no reason to think that non-avoiders simply failed to perceive the drop-off.

Discussion

The present study showed that experienced crawlers who venture beyond a drop-off nevertheless show evidence from other indices for wariness of heights. The infants in the main study who shifted their weight onto the deep side of the visual cliff in an attempt to cross to the mother showed wariness in several ways. First, the non-avoiders showed larger HR acceleration upon being lowered onto the deep than upon being lowered onto the shallow side, similar to infants who completely avoided the deep side.[1] Next, the non-avoiders showed both longer latency to place their hands on the deep side and more tactile exploration of the surface than a comparable group of infants tested on the shallow side. Taken as a whole, this pattern of physiological activation and behavior provides strong evidence of wariness.

Although the increased tactile exploration and longer latencies in the non-avoiders than in the comparison group might be related, each measure provides separate evidence for the presence of wariness. That is, non-avoiders might have had longer latencies to crawl onto the deep side than the comparison group had for crawling onto the shallow side primarily because the former engaged in more tactile exploration before venturing onto the deep side. Yet, one obviously cannot infer the value of one index from the value of another. For instance, the one non-avoider who did *not* engage in tactile exploration had a longer latency than 6 out of the 7 comparison group infants who did not show tactile exploration. Both indices are useful in characterizing the *pattern* of wariness behavior on the visual cliff.

The current study instantiates how the same emotion – wariness – can be shown through qualitatively different behaviors, a principle referred to as the *equifinality* of emotion (Campos, Dahl, & He, 2010). What defines an emotion is not a particular emotional display but the particular concern, or function, that the emotional behaviors serve (Barrett & Campos, 1987; Frijda, 1986). The implication here is that wariness of heights, when defined

[1]Adult parachuters show a similar pattern of co-occurring HR acceleration and behavioral non-avoidance when facing a threat. Whether experienced or inexperienced, they have a marked increase in HR while preparing to jump from the airplane (Fenz & Jones, 1971), and do report wariness (Epstein & Fenz, 1965), yet nevertheless take the plunge.

by the concern with avoiding a painful fall over a drop-off, can principally lead to two patterns of behavior: *Complete avoidance* or *cautious approach*. Complete avoidance serves the concern with safety by reducing the chances of falling to almost zero. Cautious approach involves minimizing the risk of falling by looking for safe ways of traversing the dangerous area, be it by using ropes when mountain climbing or by exploring the transparent surface before venturing onto the deep side of the visual cliff.

Both situational factors and individual differences affect the likelihood of observing these behavioral patterns on the visual cliff. To take an extreme example, we would predict that all experienced crawlers would show *complete avoidance* of the deep side in the absence of maternal encouragement. In the current study, we found that no infants in the comparison group turned around and crawled onto the deep side when the mother was encouraging them to cross the shallow side, whereas several avoiders and non-avoiders crawled onto the shallow side while encouraged to cross the deep side. Further demonstrating the importance of maternal signaling, Sorce and his colleagues (1985) found that 74% of 12-month-olds tested on a 30 cm deep cliff crossed to the mother when she displayed a joyful face while no infants crossed when she displayed a fearful face.

In contrast, *cautious approach* should be more likely among infants who are temperamentally less fearful. Though more research is needed, there is some evidence that temperament is related to individual differences in visual cliff behavior. Ueno, Uchiyama, Campos, Dahl, & Anderson (in press) tested experienced crawlers on a 30 cm deep cliff, and found that non-avoiders were rated by their mothers as being less fearful than non-avoiders, as assessed by the Rothbart Infant Behavior Questionnaire (Rothbart, 1981). Yet, the effect of temperament is likely to be smaller when the environmental pressure on behavior is greater. Goldsmith and Campos (1990), using the same questionnaire, tested infants on a visual cliff of similar depth as the one used in the present study, and found only a modest relation between fearfulness assessed by parental report and avoidance of the visual cliff. Future studies should investigate interactions between temperament and context on the visual cliff, including how temperament influences infant use of maternal communication (Feinman & Lewis, 1983).

The particular indices of wariness used in this study represent only some of the signs by which organisms can show wariness on the visual cliff. A more comprehensive assessment of how infants show wariness of heights may allow for a better understanding of the nature and determinants of individual differences in visual cliff behavior. Negative facial expressions are one obvious candidate, although such expressions are only shown on the visual cliff by somewhat older infants. At 11 months, infants lowered on the deep side show powerful facial expressions of distress; they do not do so on the shallow side (Hiatt, Campos, & Emde, 1979). Studies of non-human animals suggest other potential indices of wariness. When kittens and infant goats are placed atop the deep side of the cliff, they tremble, freeze, and leap toward the shallow side (Gibson & Walk, 1960). While no systematic studies of these reactions have been conducted with human infants, early observations in our laboratory showed that when 10-month-old infants are at the edge of the drop-off and gently pressed toward the deep side, they stiffen their bodies and extend their arms to resist going onto the deep side. Similar behavior is not seen when the infant is pushed from the center of the table toward the shallow side. Future research should address how such additional indices relate to complete avoidance, cautious approach, or even complete absence of wariness, as well as how they relate to other potential contributors of visual cliff behavior such as temperament.

Wariness of heights in human infants is no less complex than wariness of heights in adults. No *single* index can be used for determining whether, and to what extent, infants and adults are wary of a drop-off. Instead, it is necessary to consider the totality of the organism's behavior as well as the functions that this behavior serves. As in the case of the infants in the present study and the adults on the Grand Canyon Skywalk, even individuals approaching a perceived environmental threat may show strong evidence of wariness in their *manner* of approach.

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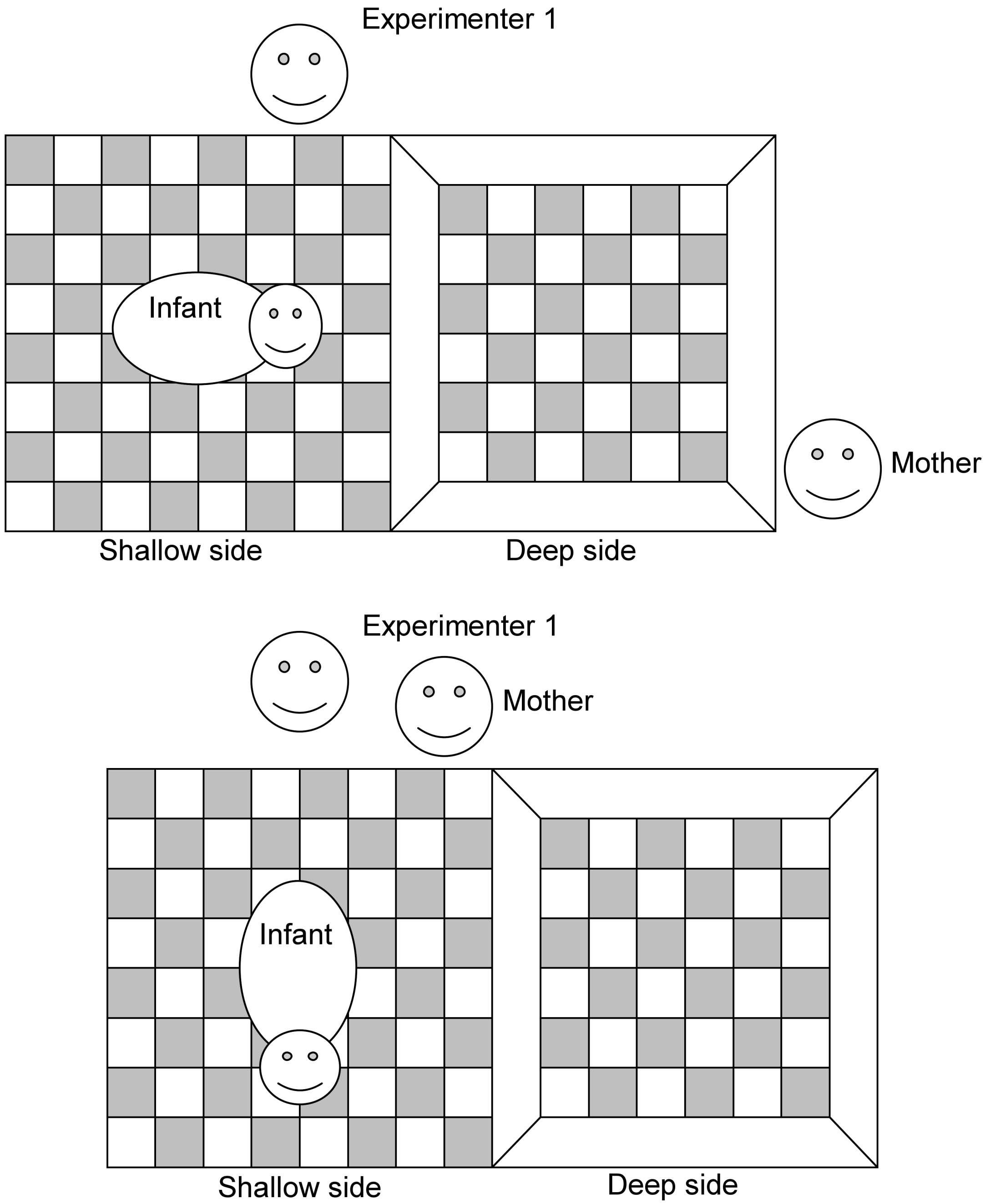

Figure 1.
Figure 1a. The position of infant, mother, and Experimenter 1 at the start of the crossing paradigm.
Figure 1b. The position of infant, mother, and Experimenter 1 at the shallow trial of the descent paradigm.

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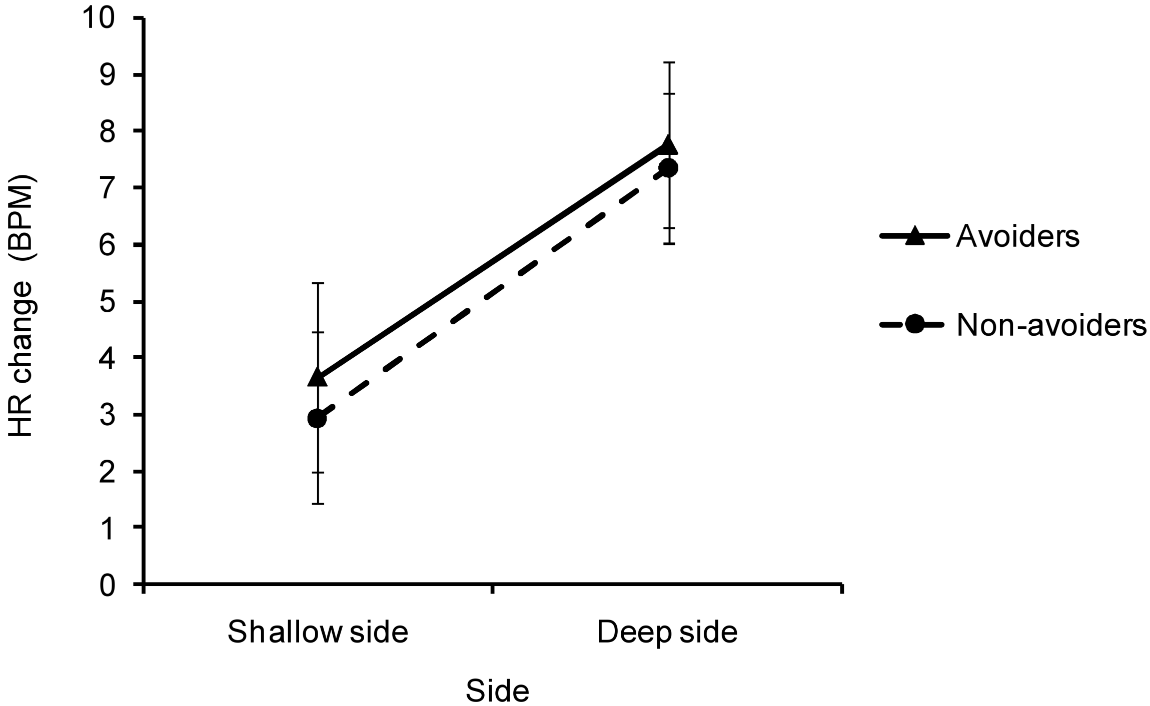

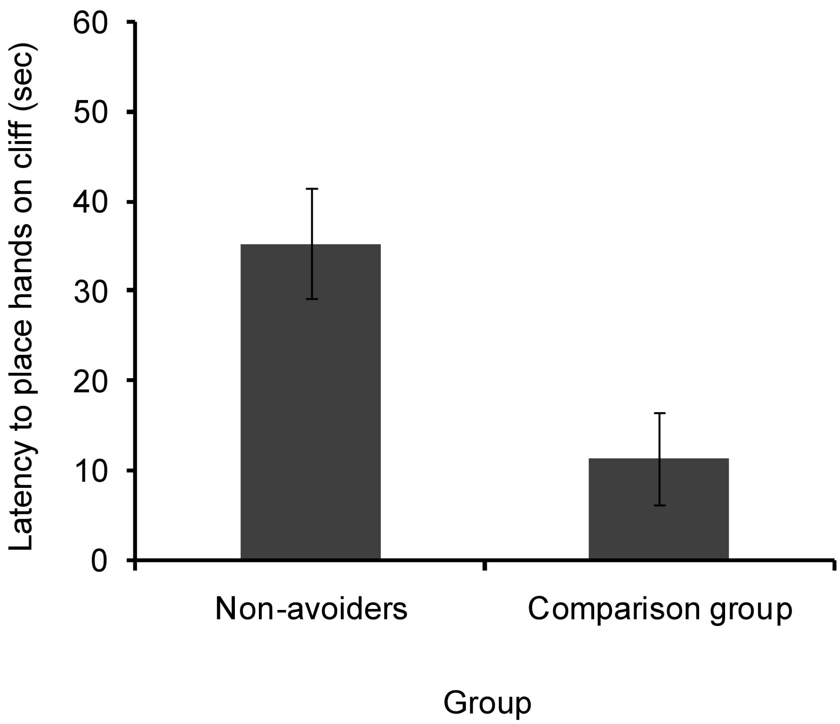

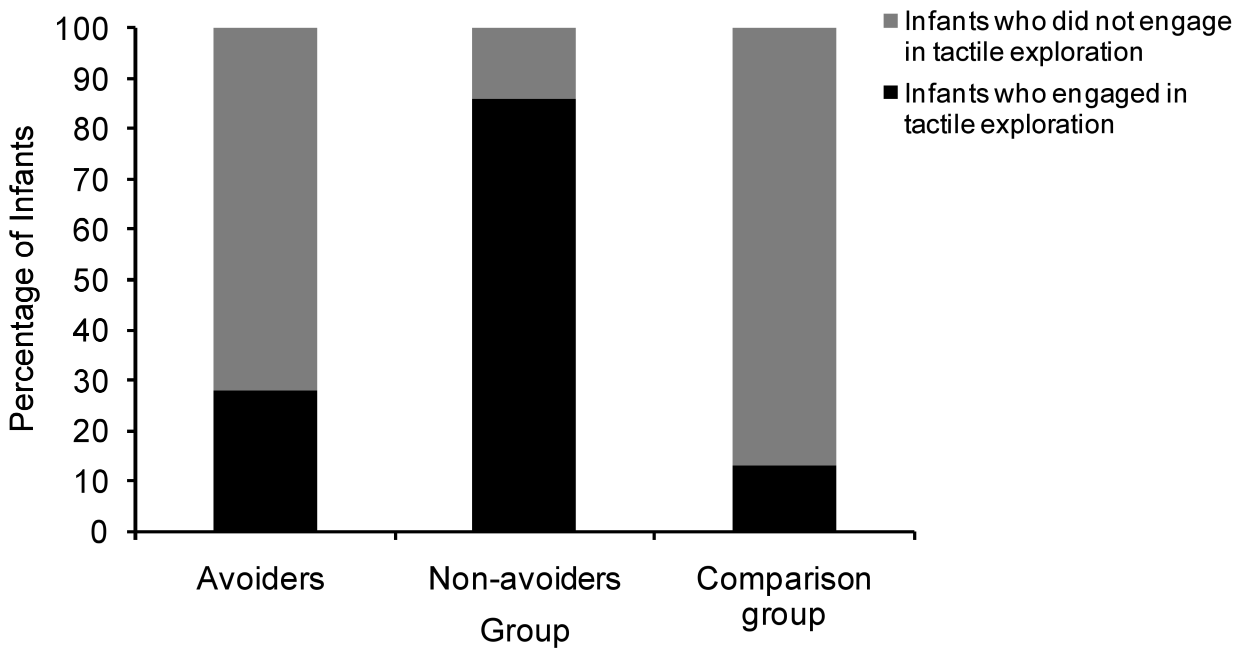

Figure 2.

Figure 2a. Mean HR change from baseline during descent onto the glass (+/- 1 *SE*). *Figure2b*. Mean latency to place hands on cliff in the crossing paradigm (+/- 1*SE*). *Figure2c*. Percentage of infants who did and infants who did not engage in tactile exploration.