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Fear of Heights in Infants?

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Abstract

Based largely on the famous "visual cliff" paradigm, conventional wisdom is that crawling infants avoid crossing the brink of a dangerous drop-off because they are afraid of heights. However, recent research suggests that the conventional wisdom is wrong. Avoidance and fear are conflated, and there is no compelling evidence to support fear of heights in human infants. Infants avoid crawling or walking over an impossibly high drop-off because they perceive affordances for locomotion—the relations between their own bodies and skills and the relevant properties of the environment that make an action such as descent possible or impossible.

Keywords: emotion, locomotion, affordances

Evidence That Infants Are Afraid of Heights

Are human infants afraid of heights? At first blush, the answer appears to be a resounding "yes." More than half a century ago, Gibson and Walk (1960) reported that crawling infants readily cross a visible surface of support but avoid crawling over an apparent, meter-high drop-off. To ensure infants' safety, researchers tested babies on a glass-covered precipice, dubbed a "visual cliff" because the drop-off was only illusory (Figure 1A), rather than a real cliff from which foolhardy infants could fall. The visual cliff is a classic paradigm in developmental psychology; the image of an infant peering into a checkerboard-patterned abyss is among the most famous icons in developmental science; and the basic findings are well known to the thousands of students who have sat through introductory courses in developmental psychology, experimental psychology, or perception. Perhaps because the paradigm has such common-sense appeal and apparent face validity (everyone can understand the importance of avoiding locomotion over a large drop-off and most of us have experienced some sort of fear of heights), avoidance and fear are commonly conflated.

Subsequent research expanded on Gibson and Walk's original findings and introduced a few caveats regarding the role of locomotor experience (Adolph & Kretch, 2012). For example, human infants (and altricial animals such as kittens) require several weeks of self-produced locomotor experience before they avoid the deep side of the visual cliff (Bertenthal, Campos, & Barrett, 1984; Held & Hein, 1963). Likewise, on a real cliff, a large gap in the surface of support, or an impossibly steep slope (Figures 1B-D), in-

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fants plunge right over the edge unless they have many weeks of locomotor experience (Adolph, 1997, 2000; Adolph, Berger, & Leo, 2011; Kretch & Adolph, 2013a). These apparatuses have no safety glass; experimenters catch infants if they begin to fall. Moreover, the apparatuses are continuously adjustable so that researchers can precisely assess the correspondence between infants' attempts and their actual abilities. Over weeks of crawling and walking, infants become increasingly accurate, attempting drop-offs, gaps, and slopes within their abilities and avoiding those beyond their abilities.

What then is the role of locomotor experience in facilitating adaptive avoidance responses? The best-known hypothesis is that self-produced locomotion leads to fear of heights, and fear leads to avoidance (Bertenthal et al., 1984; Campos et al., 2000; Campos, Hiatt, Ramsay, Henderson, & Svejda, 1978). In support of this account, crawling infants show accelerated heart rate—a standard index of fear—when placed on the deep side of the visual cliff, but pre-locomotor infants do not (Campos, Bertenthal, & Kermoian, 1992; Campos et al., 1978). Likewise, kittens, goats, and other animals show stereotyped fear responses such as freezing and backing up with stiff forelegs when they are placed directly onto the glass or pushed over the edge onto the deep side. Although the placing paradigm is more like being thrown off a cliff than exploring the view from the edge, the common interpretation is that fear of heights mediates avoidance.

Evidence That Infants Are Not Afraid of Heights

Despite half a century of undergraduates learning that infants avoid a drop-off because they are afraid of heights, several sources of evidence argue against this idea. First, researchers have no corroborating evidence of fear. The evidence for fear of heights is the avoidance response itself. The argument is circular and goes something like this: Infants avoid because they are fearful; we know they are fearful because they avoid. Physiological measures such as heart rate do not provide independent corroboration that fear mediates avoidance. Two weeks of crawling experience is sufficient to elicit accelerated heart rate when infants are placed on the deep side of the visual cliff, but not to elicit avoidance when infants are allowed to cross (Campos et al., 1992). The same infants with pounding hearts in the placing paradigm crawl straight over the glass in the crossing paradigm (Ueno, Uchiyama, Campos, Dahl, & Anderson, 2011). Accelerated heart rate may reflect arousal, not fear.

Similarly, although one might imagine that infants display other indices of fear when they avoid a drop-off, they do not. Infants who avoid crawling over the deep side of the visual cliff "do not show prototypic fear expressions. Indeed, they often smile!" (Saarni, Campos, Camras, & Witherington, 2006, p. 231; Sorce, Emde, Campos, & Klinnert, 1985). Infants appear to enjoy the problem of deciding how to cope with obstacles. Likewise, on steep slopes, infants' facial expressions and vocalizations are primarily positive or neutral, not negative, regardless of whether they go over the edge or avoid (Adolph, Tamis-LeMonda, Ishak, Karasik, & Lobo, 2008; Tamis-LeMonda et al., 2008). And there is no increase in negative expressions such as crying or clinging with infants' age or locomotor experience. Thus, some researchers have argued that the only valid index of fear on the visual cliff is refusal to crawl or walk over the brink because facial expressions and heart rate are not reliable indicators (Saarni et al., 2006).

A second line of evidence against the notion that fear mediates avoidance is infants' proximity to the edge. Although readers might assume that "avoidance" means that infants stay away from the drop-off, it does not. In every paradigm—the visual cliff, real cliffs, gaps, slopes, and bridges—infants spend most of each trial right at the edge of the drop-off, exploring possibilities for locomotion by stretching an arm toward the bottom of the precipice or by rocking back and forth at the brink (Adolph, 1997, 2000; Kretch & Adolph, 2013a, 2013b; Ueno et al., 2011; Walk, 1966; Walk & Gibson, 1961; Witherington, Campos, Anderson, Lejeune, & Seah, 2005). In fact, on the visual cliff, infants do not get scored as crossing until they have placed all

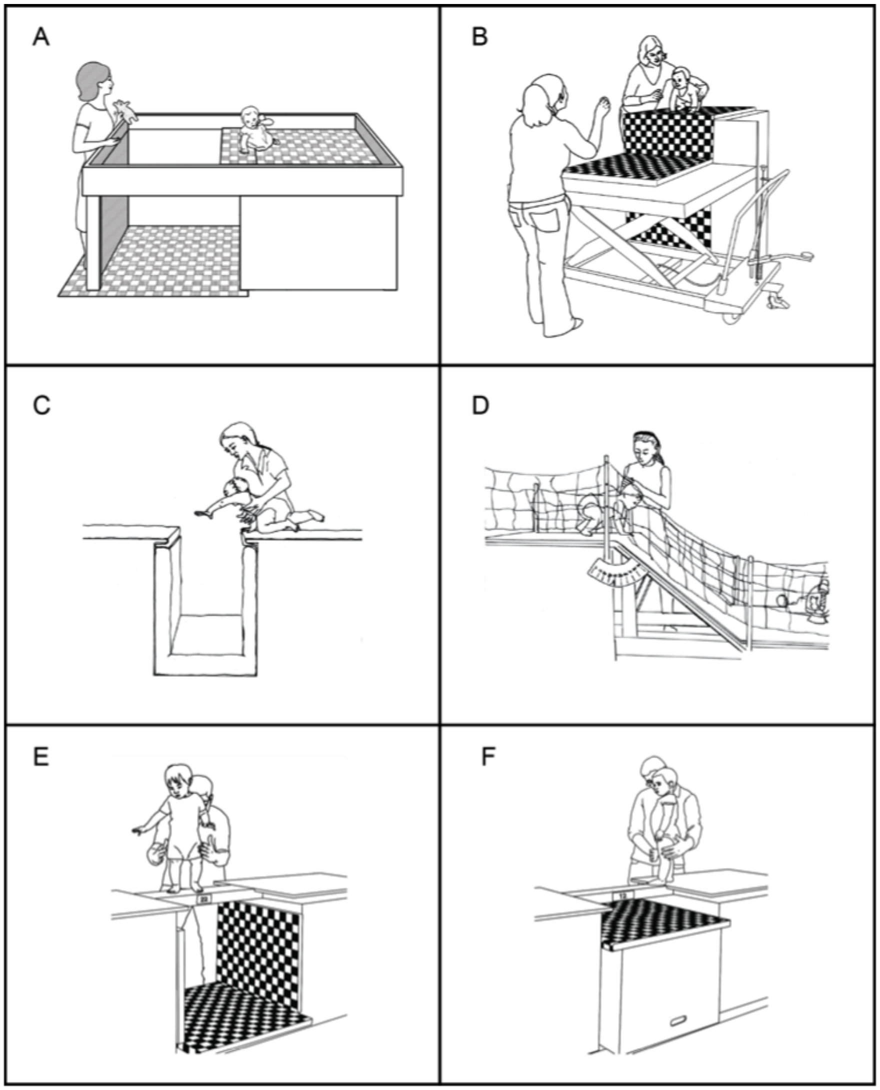

Figure 1: Apparatuses used to test infants' reactions to heights. (A) Visual cliff. The surface on the deep side is 102 cm below the centerboard and the surface on the shallow side is 3 cm below the centerboard. (B) Actual cliff used in Kretch and Adolph (2013). Height adjusts from 0-90 cm in 1-cm increments. (C) Adjustable gap used in Adolph (2000). Gap width adjusts from 0-90 cm in 2-cm increments. (D) Adjustable slope used in Adolph (1997). Steepness adjusts from 0-90 degrees in 4-degree increments. (E-F) Bridge apparatus from Kretch and Adolph (in press) shown in the large (71-cm) and small (17-cm) drop-off conditions. Bridge width adjusts from 2-60 cm in 2-cm increments.

four limbs onto the safety glass (Witherington et al., 2005). On a real cliff or gap, they would have fallen. Moreover, in every paradigm, infants who avoid crawling or walking over the drop-off are likely to attempt descent using alternative methods of locomotion such as scuttling along the side walls of the visual cliff, and backing or sliding down real cliffs and slopes (Adolph, 1997; Campos et al., 1978; Kretch & Adolph, 2013a; Witherington et al., 2005). Thus, “avoidant” infants refuse to attempt crossing in their typical mode of locomotion, but they do not avoid proximity to the drop-off and do not typically avoid descent if alternatives are available. Their behaviors at the brink provide evidence of adaptive, flexible responding, not fear of heights.

A third line of evidence against fear as the critical mediator is that infants show no evidence that they understand the different consequences of falling from different drop-off heights (Kretch & Adolph, 2013b). Adults are more leery of falling from a larger, more dangerous height than a smaller one, but infants are not. Both crawling and walking infants carefully scale attempts to cross bridges (Figures 1 E-F) to the width of the bridge, indicating that they accurately perceive the probability of falling. However, attempts to cross, gait modifications, and exploratory behavior are identical on bridges spanning a large 71-cm drop-off (infants’ standing height) and a small 17-cm drop-off (infants’ knee height), meaning that infants do not consider the severity of a potential fall when deciding whether to cross and they are not more reticent to cross a large drop-off than a small one.

A fourth source of evidence to argue against fear of heights is that infants’ actions at the edge of a precipice depend on the constraints of the test situation. Walking infants treat the same degree of slope differently, depending on whether they are wearing a lead- or feather-weighted vest (Adolph & Avolio, 2000) or rubber- versus Teflon-soled shoes (Adolph, Karasik, & Tamis-LeMonda, 2010). They correctly attempt to walk down steep slopes (with a larger drop-off) while wearing the feather-weighted vest or the rubber-soled shoes, but refuse to walk down shallow slopes (with a smaller drop-off) in the lead-weighted vest or slippery-soled shoes, where their abilities are diminished. Infants accurately reassess the situation when constraints change from trial to trial. If fear were mediating infants’ responses, they should treat the drop-offs similarly across conditions.

A final argument against fear of heights is that adaptive responding at the edge of a drop-off depends on whether infants face the obstacle in a newly acquired posture or an old, familiar posture. In an experienced sitting posture, infants refuse to span deep gaps that are slightly too large relative to their balance abilities. But in a novice crawling posture, the same infants repeatedly plunge head first into the precipice (Adolph, 2000). Similarly, novice walkers step right into impossibly wide gaps (Adolph et al., 2011). In an experienced crawling posture, infants refuse to crawl down impossibly steep slopes or cliffs, but in a novice walking posture, they walk over the edge (Adolph, 1997; Adolph et al., 2008; Kretch & Adolph, 2013a). Specificity of learning between earlier and later developing postures is so robust that infants alternate between avoiding and plunging on consecutive trials when the experimenter starts them in an experienced or novice posture (Adolph, 1997). If locomotor experience teaches infants fear of heights, adaptive avoidance responses should not depend on the posture in which infants are tested.

Why Do Babies Avoid a Drop-off?

So why do infants avoid a drop-off? And what do infants learn from locomotor experience that facilitates adaptive responding at the edge of a precipice? Answering these questions requires an apparatus more modifiable than the visual cliff. The standard visual cliff has only two drop-off heights, the shallow and the deep side, and the safety glass precludes assessment of infants’ actual abilities because both sides are safe for locomotion. In contrast, on a real cliff with continuously adjustable drop-off height, researchers can assess infants’ attempts to cross relative to their actual ability to navigate the drop-off. For experienced crawling and walking infants, a small drop-off—13 cm—is simply a step: If infants attempt to crawl or walk over the edge, they will succeed. But for novice walkers, the same 13-cm drop-off is essentially a cliff: If they attempt to walk, they will fall (Kretch & Adolph, 2013a). The distinction between a stepping-off place and a falling-off place depends on the fit between infants' physical capabilities and the relevant environmental properties—what James Gibson (1979) termed an "affordance." On this account, infants decide whether to cross or avoid a drop-off by detecting information for affordances (e.g., limb length, muscle strength, and balance control relative to drop-off height). What infants learn from locomotor experience is how to perceive affordances for locomotion (Adolph, 1997; Adolph & Robinson, 2013; Kretch & Adolph, 2013a).

In her later writings, Gibson (E. J. Gibson, 1991; E. J. Gibson et al., 1987; E. J. Gibson & Schmuckler, 1989) reinterpreted findings from the visual cliff in terms of perception of affordances (Adolph & Kretch, 2012). Gibson did not equate avoidance with fear and she did not believe that fear necessarily accompanied perception of affordances: "[Affordances] are not the attachment to a perception of feelings of pleasantness or unpleasantness. They are information for behavior that is of some potential utility to the animal... I doubt that a mountain goat peering over a steep crag is afraid or charged with any kind of emotion; he simply does not step off" (E. J. Gibson, 1982, p. 65).

Although the evidence does not support an account based on fear, it is consistent with an affordance account. Infants explore a precipice to generate information for affordances. Exploration increases on more challenging cliffs, gaps, slopes, and bridges as attempts to crawl and walk decrease (Adolph, 1997, 2000; Kretch & Adolph, 2013a, 2013b). Indeed, on the visual cliff, infants pat the glass with their hands, lean their weight on the glass, and lay their face on it (Ueno et al., 2011; Walk, 1966; Walk & Gibson, 1961; Witherington et al., 2005). After one trial, they figure out the illusion, and cross the deep side (Campos et al., 1978; Walk, 1966). When experienced crawlers and walkers are tested on modifiable apparatuses with no safety glass, they rarely err: Attempts to crawl or walk are matched to their abilities—they only attempt risky obstacles that are within 1-3 centimeters of their actual ability on real cliffs, gaps, and bridges, and within 2-6 degrees of slant on slopes (Adolph, 1997, 2000; Adolph et al., 2008; Kretch & Adolph, 2013a, 2013b). Moreover, experienced infants retain impressive accuracy when their abilities are altered with weighted shoulder-packs or slippery shoes (Adolph & Avolio, 2000; Adolph et al., 2010). Such finely attuned perception of affordances requires many weeks of locomotor experience because infants must identify the relevant parameters for their new action systems and learn to calibrate the settings of those parameters under varying conditions. Infants fail to show transfer from earlier to later developing postures because affordances and the information to specify the relevant relations are different for sitting, crawling, cruising, and walking (Adolph & Robinson, 2013).

Unanswered Questions

What would constitute convincing evidence that infants are afraid of heights? Although infant fear is a controversial topic due to considerable individual variation (Saarni et al, 2006), infant distress is not. Unfortunately for parents, infants are quite adept at displaying negative affect. In the laboratory, infants in the same age range as those who avoid drop-offs are also capable of negative affect: When approached by a stranger, for example, some 8- to 22-month-old infants produce negative affect in facial expressions and vocalizations; they may also withdraw from the stimulus, cling to their mothers, show accelerated heart rate, and stiffen their bodies (e.g., Sroufe, 1977; Waters, Matas, & Sroufe, 1975). Thus, in addition to accelerated heart rate, evidence for fear of heights should include converging evidence such as negative affect and withdrawal from the edge of the drop-off. But infants do the opposite: Their facial expressions and vocalizations are positive or neutral and they spend most of their time exploring at the edge of the drop-off and finding alternative means of crossing.

So when does fear of heights develop and how is it acquired? To our knowledge, there are no longitudinal data to address this question. Previous work suggests that acquiring fear of heights does not necessitate direct conditioning experiences such as a traumatic fall (Menzies & Clarke, 1993; Poulton et al., 1988). Indirect pathways may include observational learning or transmission of negative verbal information (Rachman, 1977). Individual differences in temperament or trait anxiety might also play a role by making some children more likely to acquire fear of heights than others (Mineka & Zinbarg, 1996).

A final question for future research is whether infants may show heightened sensitivity to other stimuli, without displaying evidence of fear. Fear of snakes and spiders, for example, is common in adults, but recent research indicates that infants and young children do not show fear of snakes or spiders (LoBue, 2013). Instead, they display positive or neutral affect, and they approach rather than withdraw from photographs, videos, and live snakes and spiders. However, infants and young children do show heightened visual sensitivity to snakes and spiders, akin to their heightened attention to drop-offs. Possibly, early perceptual sensitivity to stimuli like heights and snakes facilitates fear learning later in development (LoBue, 2013).

Conclusions: Who's Afraid of Heights?

Although infants, children, and adults can perceive affordances for locomotion, fear of heights is not universal at any age. Some sensation-seekers enjoy the thrill of heights and seek out activities like mountain climbing, parasailing, or skydiving (Salassa & Zapala, 2009; Zuckerman, 1983). Others have more trepidations: About 30% of adults report nonclinical height fear and another 5% have full-blown height phobia (Agras, Sylvester, & Oliveau, 1969; Depla, ten Have, van Balkom, & de Graaf, 2008; Huppert, Grill, & Brandt, 2013). Despite substantial variability in adults, fear of heights in infants is described as a universal development, akin to language acquisition or learning to walk. Indeed, some researchers claim that fear of heights is innate (Menzies & Clarke, 1993; Poulton, Davies, Menzies, Langley, & Silva, 1998). From an evolutionary standpoint, avoidance of falling-off places is undoubtedly adaptive, making accounts of innate or early developing height fear popular and satisfying. However, the processes mediating avoidance of a cliff in infancy appear unrelated to the development of fear of heights. Young infants respond flexibly to novel challenges by detecting the fit between the environment and their own abilities. They actively explore, they assess, and they generate creative alternatives that suit the constraints of the current situation. Far more adaptive than an automatic fear response is the ability to perceive affordances. Although the construct of fear is attractive, it is not necessary to describe the flexible and adaptive behavior of infants at the edge of a drop-off.

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The classic paper reporting the first comparative experiments on the visual cliff, including several animal species and human infants.

Campos, J. J., Hiatt, D., Ramsay, D., Henderson, C., & Svejda, M. (1978). The emergence of fear on the visual cliff. In M. Lewis & L. Rosenblum (Eds.), *The development of affect* (pp. 149-182). New York: Plenum.

A series of studies that explore the relations between locomotor experience and responses to the visual cliff, including the placing and crossing paradigms.

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Describes research on the visual cliff and research inspired by the visual cliff and places the original paradigm and subsequent studies into historical context.

Kretch, K. S., & Adolph, K. E. (2013). Cliff or step? Posture-specific learning at the edge of a drop-off. *Child Development, 84*, 226-240.

A recent study using an actual, adjustable cliff that provides evidence against fear of heights in infancy.

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A description of the development of locomotion, from prenatal movements to mature walking and beyond, relating the phenomena to general conceptual issues of learning and development.