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Gender Bias in Mothers' Expectations about Infant Crawling

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Although boys outshine girls in a range of motor skills, there are no reported gender differences in motor performance during infancy. This study examined gender bias in mothers' expectations about their infants' motor development. Mothers of 11-month-old infants estimated their babies' crawling ability, crawling attempts, and motor decisions in a novel locomotor task—crawling down steep and shallow slopes. Mothers of girls underestimated their performance and mothers of boys overestimated their performance. Mothers' gender bias had no basis in fact. When we tested the infants in the same slope task moments after mothers' provided their ratings, girls and boys showed identical levels of motor performance.

Key Words: gender; locomotion; infants; parents' expectations; crawling; motor development; gender bias.

In contrast to the large literatures on gender bias in parents' expectations in cognitive, social, and language development (see Ruble & Martin, 1998, for review), few researchers have examined gender bias in infant motor development. Lack of research in this area is particularly striking because gender differences in motor development undergo a dramatic developmental shift: There are no differences in infancy but large ones years later.

One reason for the paucity of research on parents' expectations about motor ability is that early motor development is rarely considered in its social context (Biringen, Emde, Campos, & Applebaum, 1995). Typically, infant motor development is portrayed as a lonely exercise, where babies achieve each motor milestone on their own. However, motor skill acquisition does occur in a social context. Most infants' first steps are into the open arms of an encouraging parent.

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As infants begin to sit up, crawl, and walk, parents reconfigure their play environments and "baby-proof" their homes. Parents' expectations about their infants' motor abilities may play a role in how they structure children's environment and how they interact with their children.

Gender differences in infants' physical growth and activity level may inform parents' expectations. By 6 months, infant boys begin to outstrip girls on their growth charts; boys are 1 kg heavier and 2 cm longer than girls (Hamill et al., 1979). Parents' reports of activity level and objective measures of activity level obtained with mechanical actimeters show that boys are consistently more active than girls and that gender differences increase with age (Eaton & Enns, 1986).

Despite these physical differences, boys and girls do not differ in motor development until after the infancy period. According to developmental norms, girls and boys achieve early motor milestones such as reaching, sitting, crawling, and walking at roughly the same ages (Allen & Alexander, 1990; Bryant & Davies, 1974; Capute, Shapiro, Palmer, Ross, & Watchel, 1985; Francis-Williams & Yule, 1967; Neligan & Prudham, 1969; Shirley, 1931; Solomons & Solomons, 1975). The most prevalent standardized instruments of developmental norms in infancy, the Bayley Scales of Mental and Motor Development and the Denver Developmental Screening Test, show no gender differences on their motor items (Bayley, 1965; Frankenburg & Dodds, 1967).

We know of no reported gender differences in the literature on infant motor skill acquisition (e.g., Bertenthal & Clifton, 1998; Bril & Breniere, 1992; Clark, Whitall, & Phillips, 1988; Freedland & Bertenthal, 1994; Thelen et al., 1993). Reanalyses of existing data sets from our laboratory show that infant girls and boys display similar rates of improvement in crawling and walking and do not differ on motor ability within a given age (Adolph, 1997; Adolph & Avolio, 2000; Adolph, Vereijken, & Denny, 1998). Girls and boys move just as quickly, their steps are of equal length, their patterns of interlimb coordination are similar, and changes in these variables follow similar developmental trajectories. Likewise, girls and boys perform equally well in novel laboratory tasks such as crawling and walking over steep slopes and large cliffs (Adolph, 1995, 1997, 2000).

Similarly, we know of no reported gender differences in the functional aspects of infants' motor skills—motor decisions about which movements to employ in various situations. Infant girls and boys are equally accurate in their decisions about whether to crawl and walk over safe and risky slopes (e.g., Adolph, 1997), avoid an apparent drop-off on the visual cliff (e.g., Campos, Bertenthal, & Kermoian, 1992), lean forward over gaps of various sizes (Adolph, 2000), step over high and low barriers (Schmuckler, 1996), reach with one or two arms (Corbetta & Thelen, 1999), and so on. As with motor ability, there are no reported gender differences in developmental changes in the accuracy of infants' motor decisions.

By the preschool years, boys begin to outperform girls in gross motor skills (Toriola & Igbokwe, 1986), and their superiority becomes increasingly evident

by grade school (Thomas & French, 1985). Boys run faster, throw farther, and jump higher than girls (Espenschade & Eckert, 1974; Toriola & Igbokwe, 1986). They develop mature forms of kicking (Butterfield & Loovis, 1994), catching (Loovis & Butterfield, 1993), throwing (Butterfield & Loovis, 1993), and side-arm striking (Loovis & Butterfield, 1995) earlier than girls. A meta-analytic review of the literature indicates that boys outperform girls at all ages across a range of motor tasks (e.g., agility, arm hang, and reaction time) and that for particular tasks (e.g., dash, sit-ups, long jump, and shuttle run) the gap in skill level increases with age (Thomas & French, 1985). Boys' skills improve continuously between 7 and 17 years, but girls show only slight improvement after 12 years of age (Cratty, 1986).

Like research with infants, there are no reported gender differences in experimental studies of the accuracy of children's motor decisions in the preschool and grade school years (e.g., Plumert, 1995, 1997; Pufall & Dunbar, 1992). However, some studies have found that older boys do experience more accidents than girls and accidents may be due, in part, to errors in their motor decisions (Plumert, 1997). Grade school and teenage boys engage in more physically risky behaviors than girls (Cobb, Cairns, Miles, & Cairns, 1995; Jelalian et al., 1997). They are more likely to speed when driving (Harre, Field, & Kirkwood, 1996) and to be the victims of car wrecks and other accidents (Maxim & Keane, 1993). Grade school and teenage boys report more risk-taking behaviors associated with injuries and close calls than girls (Cobb et al., 1995), primarily in reckless driving and physically challenging sports (DeJoy, 1992).

This study extends the literature on gender differences in two ways. First, we report gender bias in parents' expectations in a population and developmental domain where no known gender differences exist: infant motor development. We examined whether mothers' expectations about their infants' motor performance reflect infants' current status (thus showing no gender biases) or instead anticipate the gender differences that appear several years later. Mothers of 11-month-old crawling infants estimated their babies' crawling ability and crawling attempts in a novel locomotor task—crawling down steep and shallow slopes. From these data, we evaluated gender bias in mothers' expectations relative to infants' performance on the task.

A second way in which this study builds on previous work is that it relied on directly observable and quantifiable motor behaviors as the index of infants' actual status rather than subjective assessments. The slope task was gender neutral, thereby eliminating demand characteristics that plague many gender studies.

We selected 11-month old crawling infants for study because they tend to be experienced crawlers who are impressively accurate in their judgments about safe and risky ground. By the time their infants are 11 months old, most mothers have witnessed their infants coping with various motor challenges across a range of situations. Previous research showed that the slope task is age-appropriate and reveals no gender differences in infants' motor ability or motor attempts (Adolph,

1997). Thus, we expected no gender differences in infants, but we did expect possible gender bias in mothers' expectations.

METHOD

Participants

Families were recruited through mailing lists, referrals, and flyers. Twenty-three mother–infant pairs completed the study (12 girls and 11 boys). On average, mothers were 33.82 years old ($SD = 3.93$). All had some college training, and 11 had graduate degrees. All infants were 11.25 months old (± 1 week), healthy, and born at term. Sixteen infants were first-born and seven were later-born. Eighteen were white, five were Latino or South Asian, and all families were of middle-class socioeconomic status. Twenty-two babies could crawl at least 10 feet on their hands and knees and one crawled on her belly. Most were experienced crawlers ($M = 2.97$ months, $SD = 1.31$). Twelve infants could crawl up stairs, but only four could go down stairs and only six could descend a playground slide independently. Data from an additional four mother/infant pairs were not analyzed because their infants became fussy during testing or could not crawl to criterion. Families received a souvenir diploma and photograph for participating.

Sloping Walkway

We tested mothers' expectations and infants' crawling performance using a three-section, motorized, wooden walkway with adjustable slope (see Fig. 1). Flat starting and landing platforms were attached to a middle, sloping ramp with piano hinges (each section 86 $\times$ 91 cm). The height of the starting platform was fixed at 116 cm and the landing platform lowered from 116 to 25 cm using a push-button remote. As the landing platform lowered, the slant of the ramp increased from 0° to 90° in continuous increments. Protractors attached to each side of the walkway registered the degree of slant. To ensure infants' safety, volleyball nets were attached to wooden posts along the entire length of the walkway, and a soft carpet covered the walkway to provide cushioning and traction.

Procedure

Mothers' expectations. In the first part of the test session, we tested mothers' estimates of their infants' crawling ability and crawling attempts on the sloping walkway. An experimenter demonstrated the operation of the sloping walkway and explained that normal infants show a wide range of behaviors when faced with downhill slopes. Then she asked mothers to estimate their infants' *crawling ability* ("What is the steepest slope your baby can really crawl down successfully, without any help and without falling or sliding?") and *crawling attempts* ("What is the steepest slope your baby will attempt to crawl down, regardless of whether he/she will fall or require assistance?"). The experimenter asked each question four times, alternating between initial settings of the sloping ramp at 0° and 90°.

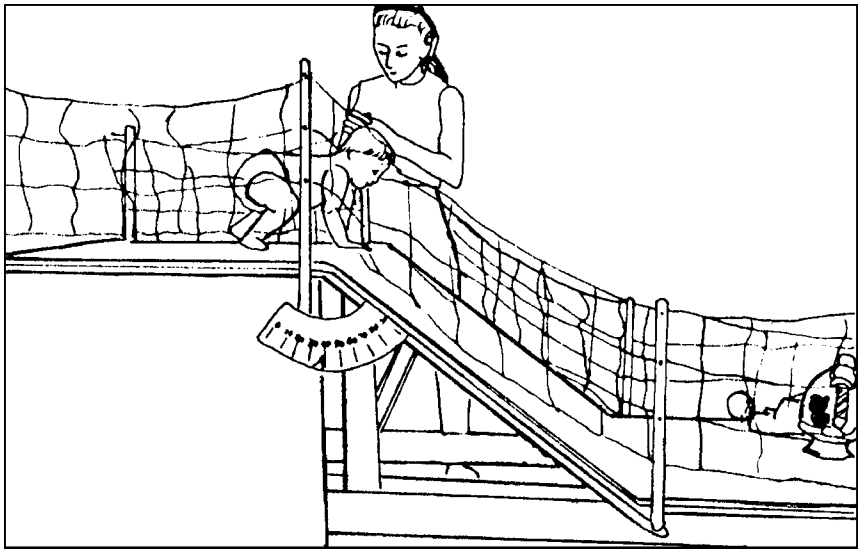

FIG. 1. Adjustable sloping walkway. During testing of mothers' expectations, the protractor on the side of the walkway was hidden. During testing of infants' performance, mothers waited at the end of the landing platform (not shown) and an experimenter followed alongside infants to ensure their safety (shown).

Questions about crawling ability and crawling attempts were blocked and counterbalanced by infants' gender. Using the psychophysical method of adjustment, mothers pressed the push-button remote to set the ramp to the appropriate degree of slant. They were free to walk around three sides of the apparatus so as to view the slope from various perspectives, but the protractor on their side of the walkway was always hidden. An assistant recorded mothers' settings from the protractor on the far side of the walkway.

Infants' performance on slopes. In the second part of the session, we tested infants on the sloping walkway to determine their actual levels of crawling ability and crawling attempts. Infants began each trial in a prone position on the starting platform and mothers sat on a stool at the end of the landing platform. Mothers encouraged their infants to descend each slope, using praise, toys, and cereal as motivation, but did not tell them how to descend or to be careful. A highly trained experimenter walked alongside infants to provide assistance if infants fell.

We used a modified psychophysical staircase procedure to determine the steepest slope each infant could crawl down successfully, a "crawling boundary" (Adolph, 1995, 1997, 2000; Adolph & Avolio, 2000). This crawling boundary provided a point estimate of infants' crawling ability. Each trial was coded on-line as a *success* (crawled down safely), *failure* (tried to crawl, but fell), or *refusal* (slid down or avoided going). For the purpose of identifying a crawling boundary, failures and refusals were treated as equivalent, unsuccessful outcomes. Infants began with a baseline slope of 4°. Following successful trials, the

experimenter increased slant to 6°. After a failure or refusal, the same slope was repeated for reliability. After a second failure or refusal, the experimenter presented the easy baseline slope to maintain infants' motivation. Then she decreased the slant by 4° relative to the last failure or refusal. This process of presenting steeper and shallower slopes continued until the experimenter converged on a crawling boundary to a 67% criterion—the steepest slope at which infants crawled successfully on at least two of three trials and failed or refused on at least two out of three trials at the next 2°, 4°, and 6° increments.

To assess the accuracy of infants' motor decisions, infants were then tested on a series of predetermined safe and risky slopes, normalized to crawling boundary. By definition, slopes shallower than infants' crawling boundaries were safe for crawling, and slopes steeper than their boundaries were increasingly risky. The experimenter presented at least two probe trials each at safe slopes 6° shallower than boundary and risky slopes 12° steeper than boundary and 18° steeper than boundary. To assess behaviors on a uniformly steep slope, they received two trials at 46°. To assess the accuracy of mothers' estimates, infants received trials at the average slopes that mothers predicted for crawling ability and for crawling attempts. The additional probe trials were designed to ensure that infants received trials on slopes shallower, steeper, and coincident with their mothers' estimates. Occasionally, infants had already received trials at the probe increments during the course of the staircase procedure; in these cases, the earlier trials were used to minimize the total number of necessary trials. The entire test session was videotaped for later analyses. Total length of the test sessions was 60–90 min.

RESULTS

Infants' Performance on Slopes

Each trial was rescored from videotape for success, failure, and refusal. There was 100% agreement between crawling boundaries derived from videotape and those derived online. A second coder scored 25% of the video data from each child. Interrater reliability for success, failure, and refusal was 98.6%. In all cases described below, findings in which $p > .10$ are reported as nonsignificant.

Crawling ability and crawling attempts varied widely. Crawling boundary served as a point estimate of *crawling ability.* Girls' crawling boundaries ranged from 10° to 46° ($M = 23.17°$) and boys' boundaries ranged from 12° to 30° ($M = 20.36°$). There were no significant differences in the crawling ability of girls and boys; $t(21) = 0.77$. The steepest slope infants attempted to crawl down on at least 67% of the trials served as a point estimate of *crawling attempts.* By definition, attempts on slopes steeper than infants' crawling boundaries resulted primarily in failures. Girls' attempts ranged from 10° to 46° ($M = 27.50°$); boys' attempts ranged from 12° to 38° ($M = 24.18°$). There were no significant differences between attempts of girls and boys; $t(21) = 0.68$.

We assessed the accuracy of infants' *motor decisions* by calculating the difference between point estimates of their crawling attempts and their crawling boundaries. By definition, this difference score must be ≥ 0 because crawling

boundaries were conditional on infants' attempts. Thus, errors were unidirectional: The larger the difference, the more likely infants were to attempt slopes on which they were likely to fall. In this sample of relatively experienced crawlers, both boys and girls showed a close correspondence between attempted slopes and crawling boundaries; the average difference score for girls was 4.33° and for boys was 3.82 (range = 0°–18° for both genders). There were no significant differences in the accuracy of motor decisions in girls versus boys; $t(21) = 0.20$.

Girls and boys did not differ in terms of their prior locomotor experiences or family demographics. There were no relationships between infants' prior crawling experiences (duration of crawling and slide and stair experience) or family demographics (siblings and parents' age or education) and any measure of infants' performance in the slope task (crawling boundary, crawling attempts, and overestimates).

Mothers' Expectations

We calculated point estimates of mothers' expectations of their infants' crawling ability and their infants' attempts to crawl by averaging across the four trials for each question. Generally, mothers were very consistent in their settings of the slope within each question; average range across the four trials for crawling ability was 4.72° ($SD = 3.05$) and for attempts to crawl was 5.91° ($SD = 3.20$).

Mothers' expectations about their infants' performance in the slope task differed for girls and boys. Mothers of girls tended to estimate shallower slopes for their infants' crawling ability ($M = 14.04°$, $SD = 7.93°$) than mothers of boys ($M = 19.63°$, $SD = 4.93°$); $t(21) = -2.00$, $p = .058$. Similarly, mothers of girls estimated shallower slopes for their infants' crawling attempts ($M = 19.27°$, $SD = 9.36°$) than mothers of boys ($M = 32.45°$, $SD = 11.04°$); $t(21) = -3.10$, $p = .005$.

The difference between mothers' estimates of their infants' attempts and of their crawling ability served as an index of mothers' expectations about the accuracy of their infants' motor decisions. Although mothers of both genders expected their infants to attempt slopes beyond their abilities, mothers of girls showed smaller difference scores ($M = 5.23°$, $SD = 6.89°$) than mothers of boys ($M = 12.83°$, $SD = 10.02°$); $t(21) = -2.14$, $p = .045$.

Mothers' expectations were inaccurate on every measure. Across boys and girls, there was no significant relationship between mothers' estimates of crawling ability and infants' crawling boundaries ($r = .18$), mothers' estimates of crawling attempts and infants' attempts ($r = -.30$), and mothers' estimates of infants' motor decisions and infants' decisions ($r = -.12$).

The pattern of mothers' errors revealed gender bias. We calculated difference scores between each mother's estimates and her infant's performance for each measure. Negative difference scores represent underestimation of infants' performance and positive scores represent overestimation. Scores approaching zero

represent accurate estimates. Mothers of girls underestimated their crawling ability ($M = -9.13°$, $SD = 11.25°$) and mothers of boys gauged their ability more accurately ($M = -0.74$; $SD = 6.89°$); $t(21) = -2.13$, $p = .045$. Mothers of girls underestimated their crawling attempts ($M = -8.23°$, $SD = 18.17°$) and mothers of boys overestimated their crawling attempts ($M = 8.27°$, $SD = 16.62°$); $t(21) = -2.27$, $p = .034$.

Gender-based differences were not due to the responses of one or two mothers, but rather reflected a consistent pattern. Figure 2 illustrates difference scores for each of the 23 mothers' estimates of her infant's ability (top panel) and attempts (bottom panel). Values of bars <0 represent underestimates; values of bars >0 represent overestimates; and bars closer to 0 represent estimates that are relatively accurate. As indicated by Fig. 2a, 9 of the 12 mothers of girls underestimated crawling ability by $\geq 2°$, 2 mothers estimated accurately, and 1 mother overestimated. In contrast, 3 mothers of boys underestimated crawling ability, 4 estimated accurately, and 4 overestimated. Figure 2b indicates that 7 of 12 mothers of girls underestimated infants' crawling attempts by $\geq 2°$, 2 estimated accurately, and 3 overestimated. In contrast, 3 mothers of boys underestimated attempts, 2 estimated accurately, and 6 overestimated.

We next calculated the accuracy of mothers' expectations about their infants' motor decisions based on the difference between two difference scores: (mothers' estimates of crawling attempts − estimates of crawling ability) and (infants' crawling attempts − crawling boundary). On average, mothers of girls produced accurate estimates of their infants' motor decisions ($M = 0.90°$, $SD = 9.12°$) but mothers of boys overestimated, meaning that mothers expected them to attempt risky slopes beyond their ability ($M = 9.01°$, $SD = 12.86°$). Variability in difference scores was high and the statistical comparison resulted in a nonsignificant trend; $t(21) = -1.75$, $p = .094$.

In general, infants' locomotor experience and families' demographics were unrelated to the magnitude or accuracy of mothers' expectations. Thus, we interpret significant correlations with caution. Infants' prior experience on stairs was related to mothers' settings of the sloping walkway. Mothers estimated steeper slopes for infants' crawling ability and steeper slopes for crawling attempts if they reported their babies to climb up stairs ($r = .50$, $p = .015$ and $r = .42$, $p = .044$, respectively). In addition, mothers' level of education was related to overestimates of crawling ability ($r = .45$, $p = .038$).

DISCUSSION

To date, researchers have largely ignored parents' role in infants' motor development, even though parents are active observers and lauding participants in their infants' motor milestones. In the present investigation, we compared mothers' expectations of their infants' crawling ability, crawling attempts, and motor decisions in a novel slope task with their infants' performance on the slopes moments later. The psychophysical methods for testing infants and mothers over many trials allowed a direct and precise quantification of the match

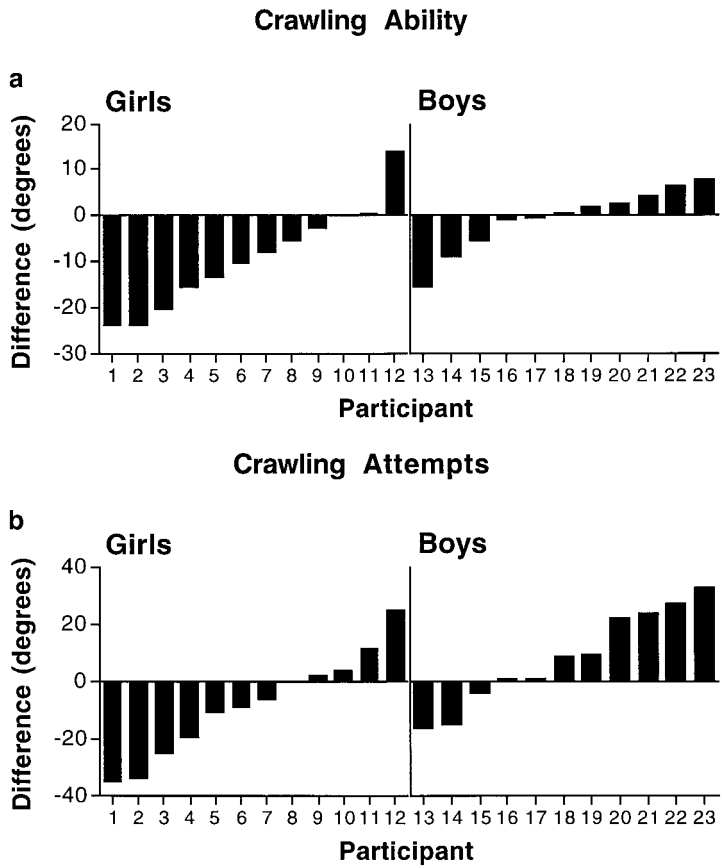

FIG. 2. Accuracy of each mother's estimates of her child's crawling performance represented as difference scores. Individual mothers are represented along the *x* axis. Height of the bars indicates magnitude of mothers' errors. Values of bars <0 indicate underestimates; values of bars ~ 0 indicate accurate estimates; values of bars >0 indicate overestimates. (a) Crawling ability: difference between mothers' estimates of infants' crawling ability and infants' crawling boundaries. (b) Crawling attempts: difference between mothers' estimates of infants' attempts and point estimates of infants' attempts.

between infants' performance and mothers' expectations. As in previous research (e.g., Adolph, 1997), there were no gender differences in infants' performance. In contrast, mothers' expectations showed gender bias. Mothers of boys expected their infants to be more successful at descending steep slopes than mothers of girls, they expected boys to attempt steeper slopes than girls, and they expected boys to attempt risky slopes and girls to limit their attempts to safe slopes. On average, mothers produced estimates 5° steeper for boys' crawling ability than for girls' ability and 13° steeper for boys' crawling attempts than for girls'

attempts. A difference of 13° represents more than 33% of the range in infants' attempts.

We assessed the accuracy of mothers' estimates by computing the difference between their estimates and infants' performance. The average size of mothers' errors was 8°. The size of mothers' errors has functional significance. Previous studies with these procedures showed that the probability of crawling successfully down slopes drops precipitously from 100% success to 0% success within a span of about 8° (e.g., Adolph, 1997; Adolph & Avolio, 2000). This means that, on average, mothers expect their girls to fail when the probability of success is 100% and expect their boys to succeed when the probability of success is 0%.

In prior studies reporting gender bias in parents' expectations, it is sometimes unclear whether parents' responses reflect already existing differences in their children. Indeed, parents may be judicious detectors of actual gender differences in children's behaviors (e.g., Burnhan & Harris, 1992). In such cases, gender stereotyping may be a bidirectional process, with its origins stemming in part from infants' behavior. In the present study, however, it is unlikely that differences in the performance of infant boys and girls motivated mothers' expectations. Not only was infants' motor behavior equivalent in the lab task, but boys and girls had similar locomotor experiences and family demographics. Based on parents' reports, both girls and boys began crawling at equivalent ages and were equally likely to have gone down playground slides and climbed up and down household stairs. Both genders were reported to have engaged in rash attempts to crawl off the edge of the changing table or bed and no infants experienced serious falls requiring medical attention. Mothers' parity and level of education was equal so that mothers of boys had no more experience raising children or learning about them than mothers of girls.

Where, then, might gender bias in parents' expectations come from? We can rule out demand characteristics because the slopes task was gender neutral. In fact, this study was not originally designed to study gender bias. Preconceived notions about "girl and boy tasks" (e.g., cooking, sewing, mowing the lawn, and fishing) were unlikely to affect mothers' expectations because the slope task was novel for most infants and mothers. One possibility is that subtle, but real, physical differences between girls and boys were somehow generalized to motor differences. Mothers may be very sensitive observers of their infants' physical growth and motor development. For example, most mothers notice when their infants undergo a growth spurt. In this study, parents who had witnessed their babies crawl up and down stairs estimated steeper slopes for crawling ability and crawling attempts than parents of infants who had never used stairs. Along these same lines, parents may have erroneously generalized gender differences in infants' physical size and activity level to their crawling performance. A second possibility is that mothers' expectations were guided by behavioral differences in girls and boys. For example, girls and boys might differ in their approach to novel situations more generally. If so, mothers might generalize what they know about infants' propensities in novel situations to the slopes task.

A third possibility concerns mothers' knowledge about motor development, a domain in which developmental change is rapid and dramatic. Tracking infants' progress must be done on a daily basis with frequent updates and revisions regarding infants' motor abilities, attempts, and decisions. Most infants cycle through several phases of improvements and decrements in motor ability as they master sitting, crawling, cruising, and walking (Gesell & Thompson, 1938; McGraw, 1945). Concurrently, they cycle through phases of displaying more and less accurate motor decisions as they gain experience maintaining balance with each new postural milestone (e.g., Adolph, 1997, 2000; Adolph & Eppler, 1998). It is likely to be difficult for parents to predict how infants will behave in an unfamiliar task as they struggle to track how infants behave in everyday tasks. In the absence of reliable information and knowledge about the course of motor development, parents may increasingly rely on social stereotypes and anticipate future endstates. The most accurate mother in the study had a Ph.D. in developmental psychology and had administered motor items on the Bayley Scales of Infant Development to dozens of children.

Finally, it is possible that mothers' expectations anticipate gender differences in motor development that will emerge years later. By preschool and grade school, boys consistently display higher levels of motor skill and these gender differences continue through adolescence and adulthood. The differences also reflect prevalent social stereotypes—that girls are weaker, less motorically competent, and timid but boys are stronger, more motorically competent, and fearless. In the context of an unfamiliar motor task, mothers' estimates may have reflected widely accepted social stereotypes and/or knowledge about pervasive gender differences that exist in childhood.

We conclude by speculating about the role of socialization agents in the development of gender differences in children's motor abilities. Differences in boys' and girls' motor abilities are common knowledge but are rarely considered with respect to the expectations and behaviors of parents. The omission of parents' role in motor development research may reflect an unquestioned assumption that gender differences result from differences in physical characteristics such as body size, weight, and fat/muscle content. However, even in the context of physical differences, infant boys and girls do not differ on motor abilities, attempts, and motor decisions. Nonetheless, mothers expect them to differ. As infants foray into a world of novel situations, the role of gender-based expectations in parents' encouragement or restriction of infants' motor skills remains to be explored.

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