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Do Visually Salient Stimuli Reduce Children's Risky Decisions?

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Abstract Children tend to overestimate their physical abilities, and that tendency is related to risk for unintentional injury. This study tested whether or not children estimate their physical ability differently when exposed to stimuli that were highly visually salient due to fluorescent coloring. Sixty-nine 6-year-olds judged physical ability to complete laboratory-based physical tasks. Half judged ability using tasks that were painted black; the other half judged the same tasks, but the stimuli were striped black and fluorescent lime-green. Results suggest the two groups judged similarly, but children took longer to judge perceptually ambiguous tasks when those tasks were visually salient. In other words, visual salience increased decision-making time but not accuracy of judgment. These findings held true after controlling for demographic and temperament characteristics.

Keywords Risk-taking · Safety · Injury · Perception · Ability estimation · Fluorescence

Introduction

Risk-taking is a necessary part of child development. Without taking a risk, the toddler would never walk, the child would never climb, and the adolescent would never drive a car. As its name implies, however, risk-taking involves risk—including risk for unintentional injury Injury is the leading cause of pediatric mortality in the United States (National Center for Injury Prevention and Control [NCIPC], 2008), and one factor that contributes to pediatric injury is the tendency of youth to take risks that adults recognize as unsafe choices. This study addresses whether or not introduction of visually salient stimuli might reduce children's tendency to make risky decisions.

Estimation of Physical Ability

Plumert and Schwebel conducted a series of studies designed to study how children estimate the risk of physical situations in a controlled laboratory setting (Plumert, 1995; Plumert & Schwebel, 1997; Schwebel, 2004b; Schwebel & Bounds, 2003; Schwebel & Plumert, 1999). The experimental paradigm is rather straightforward: Children are presented with a series of stepping, reaching, and crouching tasks that are sometimes within their physical ability and sometimes beyond. Before attempting each task, children judge their ability to complete it. Across samples and age groups, children consistently overestimate their ability; this pattern is particularly true among younger children (age 6), boys, and children who score higher on measures of impulsivity and disinhibition (Plumert, 1995; Schwebel & Plumert, 1999). The finding also translates to more ecologically-valid scenarios such as streetside and simulated pedestrian crossings (Barton & Schwebel, 2007; Schwebel, Gaines, & Severson, 2008) and simulated bicycle environments (Plumert, Kearney, & Cremer, 2004), suggesting the laboratory results of ability overestimation are relevant to real-world situations such as children's walking or bicycling across streets.

Further, children's overestimation of ability is linked to a history of more frequent unintentional injuries (Plumert,

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1995; Plumert & Schwebel, 1997; Schwebel, 2004b). In other words, children—and in particular young children—who overestimate their ability more frequently also tend to experience unintentional injuries more frequently. This finding raises a critical question for child safety and injury prevention: What strategies might discourage overestimation of physical ability when there are injurious consequences for doing so? What types of interventions might cause children to recognize when a risk is acceptable and when it might result in injury?

Theoretical Framework

Successful intervention to reduce children's overestimation of ability, and ultimately to reduce risk for unintentional injury, requires the interventionist to understand what set of cognitive, perceptual, and social processes might lead children to overestimate their ability. In other words, what trait or traits influence the process through which a child estimates his or her ability, and therefore might be targeted in interventions?

One theoretical framework to guide consideration of the developmental processes that might influence estimation of physical abilities is ecological theory (Gibson, 1979). Ecological theory suggests that adaptive behavior within an environment requires perception of the affordance of that environment: Is there a fit between one's physical characteristics and the properties of the environment in which one is engaging? As an example, a child climbing a tree must judge the affordance of the tree's structure. Does the tree offer an environment that would allow safe climbing to the next branch?

In classic Gibsonian theory, judgment of affordances is viewed to be driven by perception, but more recent Gibson-influenced scholars have argued that judgment of affordances might be influenced not just by perception of the environment but also by cognitive, social, developmental, and other psychosocial factors. Plumert (1995) found, for example, that adults estimate their ability more accurately than children, and older children estimate more accurately than younger children. These findings suggest there might be some aspect of child development, including perhaps both perceptual and cognitive development, that influences judgment of affordances. We have suggested also that individual differences in personality or temperament might influence judgment of affordances in both children (Schwebel & Plumert, 1999) and adults (Schwebel & Yocom, 2007), and that children might estimate their ability more accurately under particular social circumstances, such as after seeing a peer fail on the same tasks (Plumert & Schwebel, 1997) or having a parent stand silently nearby while judgments are made (Barton & Schwebel, 2007; Schwebel & Bounds, 2003).

The Present Study

Theoretically, the present study hearkens back to classic Gibsonian thought by hypothesizing that a change in how the environment is perceived might change the way a child judges the affordance of that environment. From an applied perspective, we hypothesized that making an environment highly visually salient, by coloring it in fluorescent colors, would increase children's attention directed toward that environment and ultimately cause individual children to estimate their ability to negotiate that environment more accurately. In other words, our primary hypothesis was that increasing the visual salience of stimuli would cause children to attend to the stimuli for a longer time period, and also to judge the safety of that environment more accurately.

This hypothesis was based on three sets of data. First, psychophysiological researchers have long recognized the fact that fluorescent colors attract visual attention and are more visually salient than other colors (e.g., Evans, 1959, 1974; Schieber, 2001, 2002). Use of visually salient fluorescent colors has also been shown to increase visual attention to risky situations and environments in other safety-relevant domains (Kwan & Mapstone, 2004; Schieber, Willan, & Schlorholtz 2006; Thornley, Woodward, Langley, Ameratunga, & Rodgers, 2008). Second, children who attend to stimuli for longer time periods tend to judge their ability to negotiate that environment more accurately (Schwebel, 2004b); parallel findings are reported in other domains, such as through manipulation of time constraints in risk-taking gambling studies (Ordóñez & Benson, 1997). Third, as reviewed above, there is evidence that children have the capacity to judge their physical ability more accurately under certain circumstances (e.g., when a parent is present; Schwebel & Bounds, 2003) but, to date, researchers have been unsuccessful in obtaining that change intrapsychically, without social influence.

As a secondary set of hypotheses, we tested the influence of covariates on our primary hypotheses. Given previous findings that children's estimation of ability is related to age, gender, SES, and temperament (Plumert, 1995; Plumert & Schwebel, 1997; Schwebel & Bounds, 2003; Schwebel & Plumert, 1999), we assessed those four variables and expected findings discovered in our primary hypotheses—that increasing the visual salience of stimuli would cause children to attend to the stimuli for a longer time period, and judge safety of those environments more accurately—would be maintained after controlling for the covariates.

Our hypotheses were tested in a laboratory-based study using a between-subjects experimental design. We viewed this as initial research investigating an unexplored domain, and therefore used a fairly small sample size ($N = 69$).

Experimental apparatuses were identical to those used in previous work (e.g., Plumert, 1995), with the exception that half the children judged their physical ability using stimuli marked with visually salient fluorescent lime-green colors and the other half judged their physical ability using the standard, all black, apparatuses.

Methods

Participants

Participants were recruited for a 1-h laboratory session from a database of local families interested in participating in research on child safety. Children in the database were recruited from various community sources, including local newspaper advertisements, mass mailings to area homes with children, and recruitment for previous studies from local schools. In total, 69 six-year-old children participated in the study (mean age = 6.70 years, *SD* = 0.43 years; 37 boys, 32 girls). Six-year-olds were chosen to participate because previous work suggests 6-year-olds tend to overestimate their ability to a greater degree than older children but are old enough to understand the relatively complex experimental protocol (Plumert, 1995). The sample was moderately diverse racially, with 46 parents identifying their children as Caucasian (67%), 15 as African American (22%), 4 as Asian American (6%), and 2 as Hispanic (3%). Two parents declined to report child race/ethnicity. All procedures were approved by the university Institutional Review Board (IRB), and all parents provided informed consent for their children to participate.

Procedure and Measures

Demographic Information

Parents completed a brief demographic survey that included information on child age, sex, and ethnicity. The survey also assessed mother and father education on a 7-point scale (as shown in Table 1, means were close to 5, which represents a bachelor's degree; median for both mothers and fathers was 5) and family income on a 6-point scale (the mean was close to 4, which represents the $60,000–$79,999 range; median was 4). These measures were standardized and aggregated into a measure of family SES, with family income and parental education each comprising half the aggregate.

Estimation of Physical Ability

Children completed four blocks of four tasks designed to measure their estimation of physical abilities. A figure depicting the apparatus and a detailed explanation of the protocol can be found in Plumert (1995). Briefly, the four tasks were the vertical reach, the horizontal reach, the stepping, and the clearance tasks. The *vertical reach task* involved removal of a small toy from a shelf while standing on tiptoes. The *horizontal reach task* involved reaching out from a squatting position to retrieve a small toy off a wooden block without touching hands or knees on the floor. The *stepping task* involved stepping from behind one stick attached to the floor over a second, parallel and adjustable stick. The *clearance task* involved moving under a bar resting on two posts, without knocking the bar down or putting hands or knees on the floor.

As in Plumert (1995), children completed four variations of each task: (1) the well-within version, 13% below children's estimated maximum ability level; (2) the just-within version, placed exactly at children's estimated maximum ability level; (3) the just-beyond version, 8% beyond children's estimated maximum ability level; and (4) the well-beyond version, 13% beyond children's estimated maximum ability level. Each task was individually scaled for each child using previously measured estimates (explained below) of maximum reaching, stepping, and crouching abilities. The vertical reach and clearance tasks were adjusted in 1-inch increments and the stepping and horizontal reach tasks were adjusted in ½-inch increments.

Tasks that were well within and just within children's ability assessed underestimation tendencies. In other words, if children incorrectly judged they could not complete a task within their ability, they were underestimating ability. Tasks that were just beyond and well beyond children's ability measured overestimation tendencies. Children who inaccurately judged they could complete tasks that were actually beyond their ability were overestimating ability.

Estimates of children's maximum levels of ability were obtained before the test trials in a separate room by having children complete actions similar to, but not identical to those used to perform the four tasks described above (see Plumert, 1995). After estimates were taken, one experimenter prepared the apparatus in the testing room while a second experimenter conducted the self-report temperament battery with the child (described below).

Once the apparatus was prepared, the experimenter led children into the testing room and offered instructions for the study. Children were told that they would be playing games and were presented with $8 of play money to use in the games. The experimenter explained that children were to position themselves for each task and decide whether or not they could complete the task. If they said yes, then they would be permitted to try the task. If successful, they would be rewarded with another dollar. If unsuccessful, they would have to pay the experimenter a dollar. If they

Table 1 Means (standard deviations) and t-test comparisons of variables of interest

Measure	Overall ($N = 69$)	Regular stimuli ($n = 34$)	Salient stimuli ($n = 35$)	Differences t
Demographics				
Age (months)	80.41 (5.12)	79.63 (5.09)	81.18 (5.11)	−1.20
Sex (% male)	54%	54%	53%	0.01[a]
Ethnicity (% white)	67%	66%	68%	0.03[a]
SES composite	−0.02 (0.87)	0.01 (0.89)	−0.05 (0.86)	0.26
Mother education	5.12 (1.62)	5.26 (1.52)	4.97 (1.72)	0.74
Father education	5.06 (1.87)	5.09 (1.87)	5.03 (1.90)	0.14
Family income	4.02 (1.49)	4.03 (1.57)	4.00 (1.41)	0.08
Parent-report temperament				
Composite measure	−0.25 (0.76)	−0.22 (0.69)	−0.28 (0.83)	0.34
Impulsivity	4.35 (0.80)	4.50 (0.71)	4.19 (0.87)	1.61
Inhibitory control	4.85 (0.94)	4.94 (0.83)	4.76 (1.05)	0.80
Child-report temperament				
Composite measure	−0.37 (0.38)	−0.37 (0.38)	−0.38 (0.38)	0.05
Impulsivity	2.18 (0.54)	2.18 (0.52)	2.18 (0.56)	0.01
Inhibitory control	2.93 (0.42)	2.92 (0.45)	2.93 (0.40)	−0.08
Behavioral temperament				
Composite measure	−0.01 (0.58)	−0.12 (0.39)	0.11 (0.72)	−1.62[b]
Interruptions-speech task	1.61 (2.00)	1.33 (1.92)	1.88 (2.07)	−1.11
Fidgeting-peek task	2.73 (1.59)	2.33 (1.53)	3.12 (1.58)	−2.06*
Approach-peek task	1.41 (0.55)	1.30 (0.53)	1.52 (0.57)	−1.57
Interruptions-prize task	2.00 (2.26)	1.91 (1.87)	2.09 (2.63)	−0.32
Walk-a-line	11.69 (11.09)	10.78 (7.51)	12.62 (13.91)	−0.68[b]
Draw-a-circle	34.83 (31.85)	31.96 (23.30)	37.78 (38.91)	−0.76
Time to pick prizes	92.26 (83.40)	87.49 (82.07)	97.32 (85.78)	−0.48
Estimation of ability				
Well within ability (%)	96.50 (9.20)	95.48 (10.18)	97.55 (8.09)	−0.94
Just within ability (%)	94.81 (12.55)	94.52 (12.77)	95.10 (12.50)	−0.19
Just beyond ability (%)	33.94 (34.19)	38.81 (35.35)	28.92 (32.71)	1.21
Well beyond ability (%)	42.04 (30.75)	43.81 (28.89)	40.10 (33.02)	0.49
Latency to estimate ability				
Well within ability (Sec.)	5.28 (2.51)	4.99 (2.22)	5.59 (2.80)	−0.98
Just within ability (Sec.)	6.55 (2.51)	6.36 (2.58)	6.75 (2.45)	−0.63
Just beyond ability (Sec.)	7.06 (3.26)	6.26 (2.69)	7.93 (3.62)	−2.16*
Well beyond ability (Sec.)	7.13 (3.50)	6.24 (2.88)	8.19 (3.90)	−2.31*

* $p < .05$

[a] Chi-square reported for categorical variables

[b] Unequal variances assumed based on results from Levene's test

said no, they couldn't complete the task, children were told that they would not win or lose any play money and they would not try the task. Finally, children were told they could use their play money at the end of all the games to buy prizes. After all trials were completed, children were asked to perform the trials they had judged they were unable to complete successfully. This manipulation maintained the integrity of the game during the test trials but allowed the experimenter to determine if tasks had been scaled correctly and to compare the accuracy of children's judgments with their actual ability.

Children were randomly assigned to one of two conditions for all ability estimation tasks, salient stimuli or regular stimuli, using a between-subjects research design. Children in the "salient stimuli" condition were exposed to tasks that were made perceptually salient with black and fluorescent lime-green stripes. Thus, for example, the vertical reach was made toward a highly salient striped shelf. The fluorescent lime-green color was chosen based on research suggesting lime-green on black is the most highly visible color combination in safety situations (e.g., Lervåg & Fjerdingen, 2003; Solomon, 1990). Children in the "regular stimuli" condition were exposed to stimuli that were painted black, as in previous research (e.g., Plumert, 1995).

The total of 16 test trials was divided into four trial blocks. Task difficulty was randomly determined across trial blocks with the stipulations that each child perform each task at each of the four difficulty levels (i.e., well-within, just-within, just-beyond, and well-beyond levels) and each child complete each task once in each trial block. Between trial blocks, one experimenter worked with the child on unrelated tasks in a separate room while a second experimenter adjusted the apparatus. This ensured that children would not witness equipment adjustment and discover whether tasks might be easier or harder. All activity in the testing room was videotaped through a one-way mirror to permit later coding.

To assess children's estimation ability accurately, incorrectly scaled tasks were removed from the data set prior to analysis. A task was deemed correctly scaled if the child was able to perform a task that was at the well-within or just-within levels of difficulty, or was unable to perform a task that was at the just-beyond or well-beyond levels of difficulty. After removal of incorrectly scaled tasks (about 12% of tasks attempted), four accuracy scores were computed based on the proportion of tasks that children judged correctly at each level of difficulty. These scores were calculated by dividing the number of correct judgments by the number of correctly scaled tasks at each level of difficulty. Higher numbers reflect more accurate judgment.

The amount of time children took to decide whether or not they could do tasks in the two conditions was also measured. Videotapes of the sessions were reviewed and children's latency from getting into the starting position until a decision was made was timed (reliability between two independent coders for timing 22% of the sample was high, $r = .99$).

Temperament

Three measures of children's temperament were collected: parent-report, child-report, and a structured behavioral battery.

Parent-report temperament was assessed through the Child Behavior Questionnaire (CBQ; Rothbart, Ahadi, & Hershey, 1994), a widely used measure of child temperament. The CBQ is a 225-item instrument that asks parents to rate items on a 7-point Likert scale, ranging from extremely untrue (1) of their child's behavior to extremely true (7) of their child's behavior within the last 6 months. Previous research suggests good internal reliability (Cronbach's alphas for the 15 scales range from .67 to .94; Rothbart et al., 1994; Rothbart, Ahadi, Hershey, & Fisher, 2001).

Of particular interest for this study, because of their correlation to pediatric injury and risk-taking (Schwebel & Barton, 2006), were scores on two individual CBQ scales, impulsivity and inhibitory control. Each scale includes 13 items with good internal reliability (Rothbart et al., 1994, 2001). Impulsivity, defined as "speed of response initiation", is represented by items such as "usually rushes into an activity without thinking about it" (Ahadi, Rothbart, & Ye, 1993, p. 377). Inhibitory control, defined as "the capacity to plan and to suppress inappropriate approach responses under instructions or in novel or uncertain situations" (Ahadi et al., 1993, p. 377), is represented by items such as "can lower his/her voice when asked to do so". Parent-reported impulsivity and inhibitory control correlated well (r (67) = −.50, $p < .01$), so the measures were aggregated into a single parent-report impulsivity/undercontrol measure for analyses.

Child-report temperament was assessed through an adaptation of the impulsivity and inhibitory control scales of the CBQ (see Schwebel, 2004a, for details). Each scale included 10 items that were answered on a 4-point Likert scale. Anchors on the scale varied depending on the question, but were most often from "all the time" (1) to "hardly ever" (4) or from "all the time" (1) to "not very often" (4). All items included specific examples for children to imagine (e.g., for inhibitory control: "It's Halloween and you have just gotten a lot of candy from trick-or-treating. You've eaten a lot, and your mom tells you to stop eating candy and save the rest for tomorrow. How much more candy would you eat?"; for impulsivity: "Think about times when you've seen something new, such as a new ride at a fair or festival. How often would you rush to try it right away without thinking?"). The measure was presented verbally by an experimenter to the children. Internal consistency on both scales was moderate (Cronbach's alpha = .66 for impulsivity and .57 for inhibitory control). Child-reported impulsivity and inhibitory control correlated modestly (r (67) = −.23, $p = .06$), and the measures were aggregated into a single child-report impulsivity/undercontrol measure for analyses.

Behavioral temperament was assessed through a 5-task behavioral battery designed to assess behaviors prototypically associated with impulsivity and inhibitory control (Rothbart et al., 1994, 2001). Behavioral temperament tasks were videotaped through a one-way mirror for later coding. Interrater reliability was computed on 22% of the sample by two coders who reviewed the videotapes independently and resolved differences through discussion. Reliability for all measures was good (correlations on continuous measures ranged from .96 to .99; kappas on categorical measures were all 1.00). Tasks are described below in the order presented to children.

In the *Long Speech* task (Schwebel, 2004a), children were brought into the experimental room, where the experimenter delivered a lengthy (60 s) and rather boring soliloquy describing the study and outlining the tasks planned for the remainder of the study. The number of interruptions children made while listening to the speech was coded.

In the *Draw-a-Circle* task (Kochanska, Murray, & Coy, 1997), children were given a paper with 2 large circles on it, and instructed to draw a third circle between the two circles on the page. Children subsequently were instructed to draw two other circles on similar pages, one as slowly as possible and the second as quickly as possible. Following previous research (Kochanska et al., 1997), the difference between the time to draw the slow circle and the baseline initial drawing time was computed.

In the *Peeking* task (Schwebel, 2004a), experimenters informed children that they had "forgotten something in the other room" and children were instructed to wait alone in the room, that the experimenter would be "right back". As the experimenter was departing the room, he or she reminded children, "Don't forget, don't look at your prizes while I'm gone"; a large tub with the children's prizes for participating in the study was left conspicuously on the opposite side of the room, loosely covered with a white bed-sheet. Children were left alone in the room for 90 s and were monitored through a one-way mirror.

Coders reviewed videotapes of the 90-s segment and rated children on two scales, approach and fidgeting. The approach scale included 6 points, from "child did not leave chair during measure" to "child looked in tub and touched the toys." The fidgeting scale included 5 points, from "child sat, but didn't move much in chair" to "child got up and moved around room."

In the *Walk-a-Line* task (Kochanska et al., 1997), a 10-foot (304.8 cm) white piece of yarn was unraveled and laid on the dark-colored carpeting. Children were instructed to walk from one end of the yarn to the other, and then told to walk on the line "as slowly as possible" and then "as quickly as possible". As in the draw-a-circle task, the difference between the baseline time and the slow time was computed (Kochanska et al., 1997).

The final task was the *Prize-Choosing* task (Schwebel, 2004a). Children were told they had "won" two prizes. The experimenter uncovered a large box of toys (approximately 25 different types of attractive toys, and 250 toys total were in the box for each child) and began displaying and discussing the various options to choose from. This presentation lasted approximately 60 s. Two measures were computed: the number of times the child interrupted the experimenter while the experimenter presented the prize options and the time it took for the child to choose his/her prize after the speech ended.

In total, therefore, seven measures of impulsivity/undercontrol were available. The measures intercorrelated reasonably well (average intercorrelation = .23; Cronbach's alpha = .67) so were standardized and aggregated into a single measure of behavioral impulsivity/undercontrol.

Results

Data were analyzed in three steps. First, descriptive data were examined, including group differences between the randomly assigned salient and not salient stimuli groups. Second, correlation matrices were constructed between independent and dependent variables of interest. Of particular interest were correlations between condition and the estimation of ability measures. Third, those dependent variables that emerged as having the strongest correlations were studied in multivariate regression equations to determine the strength of the influence of condition after controlling for variance from covariates.

Table 1 displays descriptive data for all variables of interest. As expected through random assignment, the two groups were highly similar on demographic and temperament variables. Just one temperament measure emerged as different between the groups—children randomly assigned to the salient stimuli group scored higher on fidgeting. Given the number of tests conducted and the fact that the bias this finding might cause would go against our hypothesis that children in the visually salient stimuli condition would be more inhibited in their ability estimation, we concluded that the random assignment was valid.

Table 1 also displays differences between the groups on the dependent ability estimation variables. No differences emerged in accuracy of estimation, a finding contrary to the hypothesis that children in the visually salient stimuli group might have more accurate judgment of ability than children in the non-salient stimuli group. Replicating previous work (e.g., Plumert, 1995), both groups were quite accurate in estimating tasks that were within their ability and rather poor at estimating tasks beyond their ability.

Differences between the groups did emerge when latency to decide was examined. In particular, those children exposed to visually salient stimuli took significantly longer to make their judgment when tasks were placed beyond their abilities. This finding suggests the salient stimuli may have caused children to think more carefully about their judgments in ambiguous situations, but that extra thought did not translate to more accurate judgments.

Table 2 displays a correlation matrix between all independent variables of interest and the dependent estimation of ability measures. Pearson correlation was used for correlations between continuous variables and point-biserial correlation when one variable was dichotomous. As shown, just a few significant correlations emerged. Most notably, randomly assigned condition was again related to latency to judge in both sets of beyond-ability tasks. Girls also tended to take longer to decide in the just-within condition and more impulsive/undercontrolled children, as assessed behaviorally, took longer to decide on the well-beyond tasks.

The final step of analysis was multivariate regression models. Given bivariate results, we chose to construct multivariate models predicting only latency on the just-beyond and well-beyond tasks. Multicollinearity was tested and tolerance levels found to be adequate (all VIF values < 1.25). As shown in Table 3, condition emerged as the strongest predictor in both models. In other words, children in the visually salient stimuli condition waited longer before making a decision when tasks were just beyond or well beyond their ability. SES also emerged as a statistically significant predictor of judgment latency in both models, with children from higher SES levels taking longer to judge their abilities.

Discussion

Findings offer partial support for our hypotheses. The presence of visually salient stimuli caused children to have a longer latency before judging their ability to complete a task that was beyond their ability, but did not improve children's accuracy in estimation of physical ability. Thus, as expected from classic theory (Gibson, 1979), perception proved relevant to children's estimation of physical ability: Visually salient fluorescent stimuli caused children to attend more carefully to the stimuli presented to them. Interestingly, this effect emerged as statistically significant only for the tasks beyond children's ability—those tasks that assessed overestimation of ability rather than underestimation of ability. These tasks are consistently the most

Table 2 Correlation matrix between independent measures and estimation of ability

	Judgments				Latencies			
	Well within	Just within	Just beyond	Well beyond	Well within	Just within	Just beyond	Well beyond
Age	.06	.02	−.08	.04	−.20	−.19	−.01	.04
Sex (1 = male, 2 = female)	−.15	.06	.08	.08	.14	.29*	.04	.19
Condition (1 = regular, 2 = salient)	.11	.02	−.15	−.06	.12	.08	.26*	.28*
SES composite	−.11	−.04	−.03	−.14	.06	.05	.23	.14
Parent-report temperament composite	−.22	−.08	.07	.15	−.04	.02	.07	.04
Child-report temperament composite	−.13	.09	−.12	.02	.06	−.03	.06	.09
Behavioral temperament composite	.09	.04	−.17	−.15	−.14	.03	.07	.25*

Note. $df = 58–67$

* $p < .05$

Table 3 Linear regression predicting latency to judge ability ($N = 69$)

Variable	Just beyond ability			Well beyond ability		
	B	SE B	β	B	SE B	β
Age	−0.07	0.08	−0.12	−0.04	0.09	−0.07
Sex (1 = male, 2 = female)	0.05	0.79	0.01	1.07	0.84	0.16
Condition (1 = regular, 2 = salient)	2.39	0.81	0.37**	2.48	0.87	0.36**
SES composite	1.31	0.49	0.34*	1.05	0.52	0.26*
Parent-report temperament composite	0.31	0.58	0.07	0.26	0.61	0.06
Child-report temperament composite	0.21	1.10	0.02	1.03	1.17	0.11
Behavioral temperament composite	−0.18	0.67	−0.04	0.83	0.73	0.15

Note. Just beyond ability: $R^2 = .22$; $F(7, 53) = 2.19$, $p = .05$. Well beyond ability: $R^2 = .26$; $F(7, 51) = 2.59$, $p < .05$

* $p < .05$, ** $p < .01$

difficult for children to judge correctly in previous work (Plumert, 1995; Schwebel & Plumert, 1999), and also represent tasks that might result in injury most frequently in real-world settings.

Despite the longer decision latencies, children exposed to visually salient stimuli did not make more accurate decisions about their physical abilities in those environments. That finding parallels a previous report (Schwebel, 2004b), when children were required to wait several seconds before judging physical ability. In the previous study, a forced decision latency did not result in more accurate judgments, just as the unforced latency evolving from visually salient stimuli did not result in more accurate judgments in the present work.

There are a few possible explanations for this finding. First it may be that 6-year-old children simply do not have the cognitive ability to accurately judge physical ability, no matter how long they take to judge. This hypothesis is contrary, however, to findings that social factors (i.e., witnessing a peer fail on the task or having a parent present while making a judgment) cause children to estimate ability more cautiously (Plumert & Schwebel, 1997; Schwebel & Bounds, 2003). Another possibility is that the fluorescent colors were visually salient but somehow disrupted perception of distance of the stimuli. In other words, the fluorescence may have attracted attention but also lengthened decision-making time because it created a perceptually more complex estimation task. A third possibility is that the fluorescence caused children to look more carefully and recognize the risk involved, but that children decided to attempt the task anyway. The consequences for incorrect judgments in the game paradigm were minor (loss of a play dollar); if consequences had been more severe (e.g., injury), children may have behaved more cautiously. Further experimentation with larger sample sizes and more sophisticated research designs is needed to test these and other possible hypotheses.

Implications to Injury Prevention

As reported in psychophysiological research (e.g., Scheiber, 2001, 2002), fluorescent colors increase the visual salience of stimuli. In the present research, fluorescent colors caused children to attend to stimuli for a longer time while judging the risk involved in laboratory-based physical tasks but did not improve accuracy of children's judgments. The field of injury prevention has long struggled to balance the relative importance of active versus passive injury prevention strategies (Damashek & Peterson, 2002; Rivara & Aitken, 1998; Roberts, Fanurik, & Layfield, 1987; Wilson & Baker, 1987). Active strategies, which focus on changing individual's behavior, are viewed to be effective but challenging to implement. From the perspective of preventing children from overestimating their abilities, active strategies geared toward increased adult supervision in risky environments like playgrounds are likely to have some utility (Schwebel, 2006; Schwebel & Bounds, 2003; Schwebel, Summerlin, Bounds, & Morrongiello, 2006).

Passive strategies are designed to change the environment within which an individual engages. Because they require only one action and have long-lasting effects on all individuals thereafter, passive strategies are highly valued when effective. Use of perceptually salient stimuli is an example of a passive injury prevention strategy that appears to have some efficacy in driving situations (Kwan & Mapstone, 2004). The present results offer mixed evidence on whether the use of perceptually salient stimuli might help in locations where children could injure themselves. Future research should extend the present results, perhaps by testing the effect of fluorescent colors placed in more ecologically valid settings such as on playground equipment and at street crossings near schools.

If the present findings are replicated with larger and more diverse samples, and especially if the results could be extended to demonstrate increased accuracy of physical ability estimation in ecologically valid settings colored fluorescently, they would have broad implications for injury prevention. One might imagine, for instance, the introduction of fluorescent colored sporting equipment, playground equipment, or swimming pool bottoms. One might also imagine the use of fluorescent colors in training, both for children learning to be safe (e.g., in pedestrian safety training, to encourage more careful monitoring of oncoming traffic) and for supervisors needing to more carefully monitor risk (e.g., in training of lifeguards to notice drowning risks in swimming pools). Of course, extensive testing and replication would be necessary before such changes might be recommended.

Other Findings

Although the primary purpose of this study was to examine the role of visual salience on children's estimation of physical ability, we also uncovered a few other findings of note. First, there was a tendency for girls to take longer to judge ability at the just-within level. This finding might be due to societal expectations for boys to take risks and girls to behave more cautiously in potentially dangerous situations (Morrongiello & Dawber, 2000; Morrongiello & Hogg, 2004; Morrongiello & Rennie, 1998). Second, we found that children scoring higher on the behavioral temperament measure of impulsivity/undercontrol had a longer latency to judge ability on the well-beyond tasks. This finding is surprising on the surface: one would typically expect more impulsive and undercontrolled children to make their decisions more quickly. One possible explanation is that such children perceived the fact that the task was difficult to complete, but still had a desire to risk-take and attempt the task. In fact, this possibility matches one hypothesis for the primary result that visually salient stimuli caused a delay but not improvement in judgment of physical ability. Future research should consider whether a cognitive imbalance between recognition of a difficult task but desire to attempt it anyway may delay decision-making among risk-taking children. Finally, in both regression models the SES composite was a statistically significant predictor of latency to judge, with children from higher SES backgrounds taking longer to judge. This finding requires replication; without verification, we might attribute it to a spurious finding.

Limitations and Conclusions

This study had limitations. Most prominently, the sample size was modest. We viewed this as pilot research offering an initial investigation of a previously unexplored area of perceptual and cognitive development. Power to detect a large effect size in our independent-samples *t*-tests was .91, but was only .53 to detect a medium effect size. Similarly, power in the linear regression equations was .95 to detect a large effect size and .57 to detect a medium effect size. Given our promising findings with a modest sample, future research might consider replications that extend the results with larger sample sizes in more ecologically valid environments. Also limiting was the nature of the sample, which was recruited from only one geographic area and included just one age group. Geographic differences are likely to be few, but developmental differences might be larger. Older children appear to judge their physical abilities more accurately than younger children (Barton & Schwebel, 2007; Plumert & Schwebel, 1997), but as task difficulty increases, even older children make errors in judgment. It is unclear whether or not visually salient stimuli might have an influence on older children faced with more difficult tasks similar to that discovered in this research with younger children.

In closing, the present results suggest fluorescent colors might cause children to study risk-taking situations more carefully before choosing to engage in them. The visual salience of fluorescence did not, however, translate into more accurate decisions. Future research should be conducted to replicate these initial results. In particular, future research should use larger sample sizes, broader age groups, and more ecologically valid circumstances to determine if, in fact, the visual salience of fluorescence could reduce pediatric injury risk in a range of settings.

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