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## Curiosity Killed the Cat: Investigating a Link between Curiosity and Risk-Taking Propensity

Carolyn E. Gibson

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CURIOSITY KILLED THE CAT:  
INVESTIGATING A LINK BETWEEN CURIOSITY AND RISK-TAKING PROPENSITY

by

CAROLYN E. GIBSON

(Under the direction of Ty W. Boyer)

ABSTRACT

Curiosity, or the drive for information and experiences that motivates exploration, plays a role in intellectual development. Curiosity is perhaps essential to education and intellectual achievement, but curiosity research is limited. Curiosity has been thought a motivation for learning and a cause of non-sanctioned behaviors and behavioral disorders. This prompts a connection with decision-making, specifically risky decision-making, perhaps with curiosity as a motivating force. In Experiment 1, college students were primed with curiosity, then participated in a lab-based behavioral measure of risk-taking, the Balloon Analogue Risk Task, and answered self-report inventories concerning risk-taking and curiosity. In Experiment 2, 4th and 5th grade students were primed with curiosity and then participated in a modified version of the BART. In both experiments, risk-taking did not vary as a function of curiosity. Limitations to the current research, and potential avenues for future investigations, are discussed.

*INDEX WORDS:* Curiosity, Risk-taking, Decision-making, Children, College students, Gender differences, Personality factors

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CAROLYN E. GIBSON

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CAROLYN E. GIBSON

Major Professor: Ty W. Boyer  
Committee: Karen Z. Naufel  
Wendy L. Chambers

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## CHAPTER 1 INTRODUCTION

*“Scientists have one thing in common with children: Curiosity. To be a good scientist you must have kept this trait of childhood, and perhaps it is not easy to retain just one trait.”*

*--Otto Robert Frisch, physicist (1979)*

*“The real problem of intellectual education is the transformation of more or less casual curiosity and sporadic suggestion into attitudes of alert, cautious, and thorough inquiry.”*

*--John Dewey, psychologist (1933)*

*“I have no special talent. I am only passionately curious.”*

*--Albert Einstein, physicist (1952)*

### **Curiosity**

Defining curiosity is a difficult task, being such a vague cognitive concept that researchers do not know quite where to begin (Berlyne, 1954; Jirout & Klahr, 2012). However, the “stuff” of knowledge must somehow be obtained from the world (Gibson, 1988). According to Loewenstein (1994), “curiosity has been consistently recognized as a critical motive that influences human behavior in both positive and negative ways at all stages of the life cycle” (p. 75). Opdal (2001) defines curiosity in contrast to wonder; whereas curiosity is a state of confidence and fixed interest to find something out, wonder is the state of awe associated with being struck by the strangeness or peculiarity of the things met. Litman (2005) conceptualized curiosity as reflecting quantitatively and qualitatively distinct but overlapping experiences of interest in learning something new *and* feelings of knowledge-deprivation due to uncertainty. Curiosity has been defined as the desire to learn or know about anything or a general state of inquisitiveness (Baxter & Switsky, 2008) and the threshold of uncertainty that leads to exploration (Jirout & Klahr, 2012). Exploring its developmental importance, Piaget (1936/1952) focused on curiosity in terms of novelty as important for children’s cognitive development as they strove to understand their environment. Berlyne (1978) identified different forms of curiosity, each form divided into two related types of curiosity. One form leads to increased

perception and the main goal is knowledge. The second form leads people to seek information, whether a particular piece or seeking stimulation in general (Berlyne, 1960). This latter form is known as diversive curiosity. Though there are a variety of attempted definitions of curiosity, each converges with the others in the idea of curiosity as a motivating force associated with resolving uncertain situations.

In the psychological literature, researchers have focused on the pedagogical importance of curiosity. Loewenstein (1994) suggests curiosity might serve dual roles: on the one hand, curiosity might be considered a motivational force for intellectuals, and on the other hand might be considered a cause of non-sanctioned behaviors and behavioral disorders. Here, we will take that dichotomy into consideration and focus on curiosity as a mechanism to reduce uncertainty, as defined by Jirout and Klahr (2012). We will also need to understand some of the underlying theories about curiosity. These theories try to explain what curiosity is and why it exists, but in all probability, we cannot take only one as explanation (Baxter & Switsky, 2008). First, curiosity fulfills the need to understand given that it results from attempts to master one's environment (e.g. Gibson, 1988; Piaget, 1936/1952). Second, curiosity produces an unpleasant arousal that needs to be reduced via exploration (e.g. Freud's (1915/2009) psychosexual stages; Berlyne's (1978) forms of curiosity). Third, due to violated expectations about the world, humans' attempts to make sense of the world lead to curiosity. Most researchers agree that there are various types of curiosity, but there is a disagreement about what it does. Piaget (1969) explained curiosity as the urge to explain the unexpected while Kagan (1972) explained curiosity as the need to resolve uncertainty. Both, however, agree that cognitive development progresses aided by children's efforts to understand the unknown.

Classic cognitive development theory places an emphasis on children's intrinsic motivation to investigate novel stimuli. Curiosity thus plays a motivational role in intellectual development. In contrast with this view, modern pedagogy has actually taken steps in preventing tendencies toward curiosity. Bandura (1966) doubted that children learned much for the sake of learning, but instead learned to meet achievement standards, either internal or external. Children do not find direct reinforcement from the environment itself, but instead based on achievement standards set for themselves or observed in others. After achieving a certain standard, children reward themselves. This system of self-reward has evolved to a dependence on achievement and test scores, by both children and teachers.

With teachers, this can turn into "teaching to the test," which seems more efficient because encouraging the use of curiosity in the classroom can seem slow and unorganized. Teachers often assent to the importance of curiosity when asked directly, but do not list it as a goal without prompting (Engel & Randall, 2009). In direct observation, teachers are sometimes seen discouraging natural curiosity and inquiry so that the task at hand could be finished (Engel, 2007). Researchers in Engel's study (2007) told teachers either to help a student complete a worksheet or help a student learn. Those in the first condition were far more restrictive when students deviated from the worksheet, motivated by curiosity. By discouraging curiosity in a formal situation in the classroom as teachers did in Engel and Randall's (2009) study, adults may be modeling that curiosity is a bad thing, thus encouraging its use in more experimental settings such as the playground or even risky settings.

Curious play between children is actually quite important. Pretend play is an important factor in development, because it prepares for many areas of development, such as social skills, creativity, and problem solving. Pretend play is a way in which children can satisfy the drive to

explore, or their curiosity. An emphasis on mastery of academic skills in schools, even as young as kindergarten, has led to the exclusion of play. This exclusion comes with the addition of more serious teaching at an earlier age, such as 3-5 years old. Neglecting play early in life could lead to deficits in the ability to improvise (Berlyne, 1960; Piaget, 1962). As shown by Engel and Randall (2009), when teachers are told to place an emphasis on task completion or mastery, they are far more restrictive of students' natural curiosity-driven urges. Therapists use play to diffuse frustration and anger and also to look at the child's style of coping. Pretend play can also set the stage for cognitive development and creative thought, as well as satisfying the exploratory drive, or curiosity (Berlyne, 1960).

### **Studying Curiosity**

Measuring curiosity also poses great difficulties. There are a wide variety of self-report questionnaires for adults, such as the Curiosity and Exploration Inventory (CEI; Kashdan, Rose, & Fincham, 2004). The CEI measures curiosity as a stable character trait. The scale attempts to measure the qualities of curiosity rather than the objects (specific areas, such as academia) that have been the focus of self-report measures of curiosity in the past. Being curious is associated with general tendencies to be open to and a tendency to pursue new experiences and ideas, especially those that are exciting and challenging (Kashdan et al., 2004). There are fewer measures for children's curiosity, which is most often measured based on ratings from teachers and parents (Chak, 2007; Jirout & Klahr, 2012). The *information gap theory* (Loewenstein, 1994) differentiated between two quantities: what one knows and what one wants to know. Based on Loewenstein's theory (1994), behavioral tasks have been developed to test the effects of curiosity by placing participants in high, moderate, and low level curiosity conditions, which vary in terms of how much information is given to participants. In a high curiosity condition,

there would be a large gap in the information presented, and, for instance, participants are told an incomplete story with an unresolved conflict; while in a low curiosity condition, there would be little to no gap in knowledge, and, for instance, participants are told a complete story, with a satisfied conclusion. Curiosity in children is also often measured in play situations based on the amount of time playing or exploring stimuli, whether it be novel vs. familiar or complex vs. simple (e.g. Endsley, Hutcherson, Garner, & Martin, 1979; Henderson & Moore, 1980; Switzky, Haywood, & Isett, 1974). Tieben, Bekker, and Schouten (2011) performed exploratory research in schools, where they tested if they could elicit curiosity in public spaces. For instance, in one of their experimental conditions, students would hear scared animal sounds from a speaker when they walked past a certain point. As they approached the speaker the sounds became more intense. Students' curiosity was measured by the extent of exploration of the system (i.e., whether they stopped and looked, did a double-take, explored the speaker).

As mentioned previously, curiosity is mostly studied in school settings, has been linked to learning and cognitive ability (Alberti & Witryol, 2001), and can be a motivational force for knowledge-acquisition (Chak, 2007). Most teachers rate curiosity as one of the most important qualities to teach (Engel & Randall, 2009) and the National Education Goals Panel (1995) reported that kindergarten teachers rated curiosity as a more important predictor of school readiness than the ability to count or recite the alphabet (Jirout & Klahr, 2012). Curiosity has direct relevance to academia, at the very least because the most creative scientific advances can partially be attributed to primary and fundamental search process related to curiosity (Klahr, 2007). Curiosity can also be important to education, as research with discovery learning shows that those who learned by discovery do not differ much from students who received direct instruction in the short-term, but did show significant long-term advantages (Dean & Kuhn,

2007). Not all curiosity is academic-based though, and it is not clear that children express or have the opportunity to express curiosity at school (Engel & Randall, 2009).

As Loewenstein (1994) suggested, curiosity can be the impetus for scientific discovery and greater knowledge, but can have a dark side as well. St. Augustine chastised people with the “malady of curiosity” (Pilkington, 1876, p. 276), equating it with vanity and sins of lust.

Kashdan et al. (2004) found that although curiosity as a stable character trait is related with self-determined tendencies to pursue and thrive in situations of excitement and challenge, excessive curiosity can also lead to excessive sexuality, morbid fascination, gambling, substance use, and other delinquent, risky, and dangerous behaviors. Curiosity at the wrong time or in the wrong situation could be destructive, calling to mind the common saying of “curiosity killed the cat.” This can be especially true of children. For instance, when an adult tells a child not to touch something (e.g., a hot stove), the curious child may immediately want to know what would happen upon touching the object (Engel, 2011). Adult modeling of “safe” curiosity is essential, especially as a child ages and becomes abler to investigate the environment (Bieser, 1984). It is usually necessary to help parents deal with a child’s curiosity appropriately (Bieser, 1984) and adults’ views of curiosity shape their responses to curiosity (Chak, 2007). Curiosity is most often studied from an academic point of view, and although curiosity in the classroom is certainly an important goal for educators to pursue, the current research stemmed from interest in how the cognitive development of curiosity can cause other sorts of behaviors, most specifically risk taking. Curiosity purely examined from a stance of information-seeking to fulfill a gap (based on Loewenstein’s Information Gap Theory) has reward-value for the novelty of the information. Curiosity is important to study because of the reward accompanying the resolution of uncertainty. If risk-taking and curiosity are both conceptualized as ways to resolve the

unknown, then the reward accompanying risk and the reward accompanying curiosity may be related. If they are related, perhaps the reward accompanying one could substitute for the other, and fostering curiosity could be an intervention method for at-risk youth. For youth who have low academic achievement or for those who seem incapable of learning, fostering curiosity and investing in the individual student could cause the student to care more about his or her education. Discovery learning as a teaching design has the potential to give the student some autonomy over his or her learning. Duzel, Bunzeck, Guitart-Masip, and Duzel (2010) found that increased exposure to novelty at a young age predicts increased cognitive functioning and motivation in older adults. Thus, it might translate to the fact that allowing novelty-seeking in the classroom decreases the likelihood of maladaptive novelty-seeking. For example, novelty-seeking in the classroom might take the form of asking questions or further investigation in the assigned science experiment than what is instructed. Maladaptive novelty-seeking on the playground, on the other hand, might look like cheating on a test or skipping class. Showing a relationship between risk-taking and curiosity could motivate continued research that could test for the efficacy of including discovery learning in schools, such that students learn curiosity is not a bad thing and how to safely implement it.

### **Risk-Taking**

Risk-taking has been studied from many different perspectives—such as economics, psychology, clinical practice, behavioral analysis, and health related fields—and thus has different definitions. Schonberg, Fox, and Poldrack (2011) differentiated between some of the various definitions. For instance, from an economic or financial point of view, risk is the variance between possible outcomes and seeking risk in the financial field is the preference for higher payoffs. In a clinical or lay sense, risky behaviors are those that could result in harm for

oneself or others. Weber, Blais, and Betz (2002) developed the Domain Specific Risk Taking Scale (DOSPERT) to assess risk in five different domains: social, financial, health/safety, recreational, and ethical. The results of this scale showed that respondents varied in their tendencies to be risk-averse or risk-seeking across the five domains. Hanoch and Gummerman (2011) used the DOSPERT and tested whether convicted criminals and control participants from the population would differ in terms of risk taking but found that the two groups only differed in risk-taking tendencies in the health domain.

Risk-taking is a type of decision making, though as Byrnes (1998) contends, very few decisions can be described as riskless. There are several models of decision-making used both to describe and to predict decisions. In the *expected utility model* (EU), or the Prospect Model, (Kahneman & Tversky, 1979) decisions are based simply upon what the person wants and which option has the highest expected utility. Children do have the desire and ability to seek new knowledge (Chouinard, 2007). They seek new knowledge based on its expected utility and on the basis of perceived benefit. Atkinson's *expected value* (EV) *model* (1983) may be most relevant here if we assume that curiosity and risk-taking are both necessary to success. The EV Model proposes that people are equipped with two competing motives: motive for success and motive to avoid failure. People high in motive for success are more likely to avoid low-risk or high-risk situations. People high in motive to avoid failure tend to engage in high-risk behaviors (because then failure is due to the task) or low-risk behaviors (because then success is assured).

A similar model, the Fuzzy Trace Model from Reyna, Adam, Poirier, LeCroy, and Brainerd (2005), characterizes the development of decision-making through adolescence as progressing from a system of trading off risks and benefits to processes based on intuition and the gist of the situation. It can be thought of as progress from explicit processing to implicit



processing. Byrnes (1998) proposed a model that explains and predicts decision-making development through three phases: generation (creation of options), evaluation (creating strategy), and learning (implementation). This model is known as the *self-regulation model* because without cognitive self-regulation people might bypass crucial decision-making processes, such as attending to the information, and these self-regulatory processes develop through adolescence. Similarly, the *dual process model* (Klaczynski, 2005) also describes processes that develop throughout the life-span. In this model, two systems are involved in decision-making. In the analytic system, decisions are made through conscious and effortful deliberation. The use of this system is positively related to age. The second system, the experiential system, is not conscious and involves the development of heuristics, mental shortcuts used for solving problems (Ashcraft & Radvansky, 2010). Children adopt an absolutist approach to events, such that knowledge is fully experiential and known facts are certain and inflexible. Thus, they rely on non-logical tactics in making decisions (Klaczynski, 2005) in contrast with adults who use more logical tactics. Basically, risk-taking involves proceeding with behaviors that have unknown and possibly undesirable consequences (Boyer, 2006; Byrnes, 1998). To a lay population, risk-taking is more often associated with behaviors that could result in self-harm or harm to others (Byrnes, 1998), but the decision to engage in risky behaviors could result in a variety of undesirable ends, not just physical harm.

Both Kahneman and Tversky's (1979) *expected utility model* and Atkinson's (1983) *expected utility model* perhaps have the most relevance to the current study, because of the motivational aspect. Information and experiences are sought because of the perceived benefit or the degree of success to which they might lead. This could explain curiosity (children seek out information) and risk-taking (children are drawn to the novelty of the experience).

Risk-taking in childhood can be a long-term beneficial aspect of development because learning how to deal with risky decisions early on could help people be prepared to manage risk later in life. Though some injuries may result from risky play, it can be argued that the positive benefits to a child's psychological development outweigh the negatives of minor injuries (Sandseter & Kennair, 2011). Research has shown that risky play may not only be developmentally positive, but also inevitable, thus increasing an understanding of contextual factors that influence risk-taking is very important (Steinberg, 2008). Thus, fostering curiosity and teaching children how to safely and constructively take risks may have implications for development beyond education.

There are many types of measures of risk taking, ranging from self-report questionnaires (e.g., CDC, 2001, as cited in Aklin, et al., 2005; Eysenck, Pearson, Easting, & Allsopp, 1985; Franken, Gibson, & Rowland, 1992; Weber, Blais, & Betz, 2002) to lab-based behavioral tasks (e.g., Bechara, Damasio, Damasio, & Anderson, 1994; Figner et al., 2009; Lejuez et al., 2002; Rao et al., 2011). Self-report questionnaires usually measure likelihood of participating in a risky activity, frequency of risky behaviors, or risk attitudes. As noted earlier, the Domain-Specific Risk-Attitude Scale (DOSPERT; Weber, Blais, & Betz, 2002) measures risk-taking propensity. A similar scale, the Adolescent Risk-Taking Questionnaire (ARQ; Skeel, Neudecker, Pilarski, & Pytlak, 2007), measures risk-taking across dimensions in adolescents. The Attitudes Towards Risk Questionnaire (RISK; Franken, Gibson, & Rowland, 1992), measures an individual's overall perception of risk by presenting items related to psychological risk or physical risk and asks participants to rate how much the item describes them. Another measure assesses frequency of engagement in real-world risk-taking behaviors (CDC, 2001, used in Aklin, et al., 2005).

Self-reported attitudes on the above measures are reliable predictors of behavior. Lab-based tasks, however, may be even more consistent in measuring risk tendencies. The lab-based tasks vary and correlate with the self-report measures and self-reported behaviors, such as drug and alcohol use. For instance, the Balloon Analogue Risk Task (Lejuez et al., 2002) is a computerized experimental task that involves pumping up a virtual balloon to accumulate points in a bank. Each balloon has a probabilistically specified explosion point that if reached results in the complete loss of the points for that balloon. Participants can make a decision to stop pumping at any point and collect the points. Another lab task, the Columbia Card Task (Figner, Mackinlay, Wilkening, & Weber, 2009) instructs participants to select cards to turn over, with each card adding a specific amount of gain or subtracting all accumulated gains to the payoff. The participant can stop at any point, like in the BART, to collect the payoff, but if a loss card is turned over, the trial ends and the payoff is lost. Other lab-based tasks usually involve a similar game-like structure that forces the participant to choose between a risky decision and a safe decision. Some involve asking the participant about strategies used in deciding, such as mathematical evaluation or a gut feeling or based on emotional arousal. For a more complete listing and description of these measures, see review articles by Boyer (2006), Charness et al. (2013), and Schonberg et al. (2011).

### **Risk-Taking and Curiosity**

The process of curiosity leading to risky decisions is well documented in classic literature (e.g. the biblical Eve and Lot's wife, the Greek myth of Pandora, Lewis Carroll's Alice, Tolkien's Peregrin Took) but this relation is not discussed much in the psychological literature (Loewenstein, 1994). Taking risks and curiosity are often described with the same language. A child who has made a mess "trying something new" often just wanted to see what would happen.

The child was curious and took a risk to answer the question. Curious people may experience an intense and immediate desire for information and even seek it out “against their better judgment” (Loewenstein, 1994, p. 86). The explanation for why the above literary figures would take such risks was that they were presented with the opportunity and they were interested in having the new experience. This may be because they cannot grasp all the possible outcomes of risky behaviors.

Perhaps curiosity is a motivating force behind risky decision making, as shown by Shaw and colleagues (2011) who measured how adolescents represent their own risk taking to themselves and to others. Shaw, Amsel, and Schillo (2011) described four main stances of risk taking: Curious, Risk-Seeking, Avoidant, and Opportunistic (both of the latter two do not take risks). These representations concerned the reasons for taking risks, which formed four general stances for or against taking risks. Adolescents with a curious stance were less likely to engage in risky behavior than the risk-seeking stance but more likely than those with an avoidant stance or an opportunistic stance. Assessing the propensity to take risks, rather than just the frequency of risky behavior, increases our understanding of risk taking in general (Shaw et al., 2011). Adolescents with a curious stance justified their risky behavior using multiple contexts and under the guise of openness (e.g., they were interested in experiencing the new opportunity).

Resolving uncertainty is essential to success in a world filled with uncertainties. Byrnes (1998) argued that success means knowing how to take risks. Instruction and education are important to provide the context for success but something must be added to the knowledge base in order to be successful. In a one-to-one comparison of performance, students who received direct instruction for a task performed better than students who had engaged in a discovery learning task (Dean & Kuhn, 2007). The long-term benefits of discovery learning, however, are

far greater than direct instruction. The ability to problem-solve and the willingness to take risks are important in making discoveries. Klahr (2007) found that the most creative scientific advances were dependent on a largely biological (and therefore not learned) system of primary problem-solving methods and processes, based on research showing that these methods change little over the lifespan, but formal education provides the context in which and the tools with which the basic processes are used. The preparation from education allows for the creative use of the basic processes to make advances. Among these basic processes is the ability to know how to take risks. Curiosity, or information-seeking, can also be considered as a basic process, but it involves a knowledge-based system as well (Gottlieb, Oudeyer, Lopes, & Baranes, 2013). Without the knowledge system, there is no frame-of-reference (possibly creating an unsolvable situation), and metacognitive awareness is limited such that an individual might not be able to discern what they do not know (Gottlieb et al., 2013). Curiosity and risk-taking both play a huge role in resolving the unknown and in personal success.

The desire to resolve the unknown may be a developmental characteristic as well. Tymula et al. (2012) did research with a large sample ranging in age from 12 to 50 and found that adolescents did indeed take more risks than their older peers, but what distinguished adolescents was their tolerance for the ambiguous and unknown. This study shows that adolescents are more willing to take risks in light of the unknown, implying that this age-group might be more likely to act on a curious or risk-seeking impulse. As Boyer's (2006) review showed, there may not be a difference between adolescents and adults cognitive decision-making capacities, but adolescents may be more willing to take risks when there are unknowns, whereas adults are more likely to make choices where they know the risk involved or there is low risk. Curiosity is also reliant on a variety of motivations (Gottlieb et al., 2013). Extrinsically-

motivated curiosity, such as that based on the acquisition of food or money, fulfills a goal-directed process of maximizing and/or obtaining the end reward. Based on intrinsically-motivated curiosity, humans seek out information based on brain-generated values placed on said information. In a rapidly changing environment, intrinsic motivation for learning maximizes success.

Sensation-seeking is a concept related to curiosity and risk-taking in that high sensation-seekers enjoy the pursuit of novel stimuli that are exciting and complex and are willing to pursue those stimuli for the sake of the experience (Zuckerman, 2009). Sensation-seeking is related to curiosity, though sensation-seeking is more defined in terms of experiences only, rather than experiences and knowledge, as with curiosity (Zuckerman, 2009). Sensation seeking does predict risk taking (Humphreys, Lee, & Tottenham, 2013), but not always curiosity. Byman (2005) empirically compared curiosity and sensation seeking, finding that sensation seeking was most like the type of curiosity Berlyne (1960) called diversive curiosity. Diversive curiosity stems from feelings of boredom or the need for varied stimuli. Baumeister and Campbell (1999) examined the motivations of perpetrators who were also high-sensation seekers and found that the goal is often to overcome boredom and find excitement. Sensation-seeking has been studied in relation to risky behaviors such as gambling. High sensation seekers are more likely to be interested in gambling and in a variety of gambling activities than low sensation seekers (McDaniel & Zuckerman, 2003).

Finally, curiosity is not a passive characteristic (Loewenstein, 1994). It is not a characteristic that lies in wait for a negative sensation in order to resolve it or for information that clashes with previous knowledge. Instead, it is a state that people seek and induce. It can be

temporary but intense. It has also been associated with impulsivity (Loewenstein, 1994; Sharma, Markon, & Clark, 2013), and thus with risk taking.

### **Current Study**

The current study seeks to make a unique contribution by establishing if there is a relationship between curiosity and risk-taking. Specifically, these two experiments attempted to find a causal relationship between curiosity and risk-taking. No other study has tried to show a causal relationship between these concepts. For the purposes of this study, curiosity was defined as a motivator, the desire to know or the reason people want to know. The “how” of knowing, the goal of knowing, and development of knowing have been studied thoroughly (see e.g., Kuhn, 2011; Kuhn, 2003; Kuhn, 2001). Some would say curiosity has been studied thoroughly via in-class observation (as in the methods of Alberti & Witryol, 1994; Chouinard, 2007; Engel, 2007; Maw & Maw, 1978), play observation (Henderson & Moore, 1979, 1980), surveys, and even brain imaging (Kang, Hsu, Krajbich, Loewenstein, McClure, Wang, & Camerer, 2009). Curiosity has been examined as a trait and state (Maw & Maw, 1978; Naylor, 1981) and related to personality characteristics (Byman, 2005). Risk taking has been studied thoroughly as well. There are numerous behavioral and self-report measures of risk-taking. It has been studied in various contexts and is almost a personality characteristic in and of itself. Information-seeking in an attempt to reduce uncertainty can be both extrinsically and intrinsically motivated (Gottlieb et al., 2013). Thus, curiosity is not only a motivating force, but can be motivated. This study seeks to understand whether curiosity can lead to increased risk-taking behavior, based on the intrinsic motivation to resolve uncertainty. By priming participants with real-world instances of curiosity and then having them participate in a risk-taking task, we will see how curiosity affects the propensity to take risks. If it does lead to higher risk taking, it does not change the call for

better fostering of curiosity from teachers and parents. In fact, it intensifies the call for focus on curiosity because without examples of curiosity being used to increase knowledge without harm, curiosity may become more and more focused on risk. Or, in a different direction, people may become less able to deal with novelty, a fundamental cognitive component (Alberti & Witryol, 2001).

It was hypothesized that those primed with curiosity would take more risks and would make more risky decisions. In an attempt to elicit curiosity, conditions that contained various amounts of uncertainty and novelty were created. One condition only included in Experiment 1, called the trivia questions condition, contained ten trivia questions taken from a study that examined the neural correlates of curiosity (Kang et al., 2009). Three of the conditions involved a story about an event in a science classroom where the main character took a risk to seek new information. The curious story condition, which was also only included in Experiment 1, began with a story without an ending as a means to create an information gap, but this information gap was unrelated to the risk-taking task as participants' risk-taking would not lead to resolution. A second condition, the curiosity contingent condition, had a story without an ending but instructions that performance in the next task could lead to learning the end of the story. The control story condition had the same story, but complete, as a comparison to the incomplete stories. In each condition, the story or questions were followed by a behavioral risk-taking measure called the Balloon Analogue Risk Task (Lejuez et al., 2002). This order was an attempt to discover if curiosity had an effect on risky decisions. The BART involves a balloon on a computer screen pumped by the participant until the participant chooses to stop pumping or pops the balloon. It was hypothesized that those in the curiosity contingent condition would have the highest average pumps on the BART, those in the curious story condition with slightly fewer,



those in the trivia questions condition with slightly fewer than that, and the control with the lowest number of pumps. If curiosity is indeed a motivating force, then the curiosity contingent condition would yield the highest number of pumps, because those participants had the most motivation to take risks. Data collection took place with two distinct samples, one with college students and another with 4<sup>th</sup> and 5<sup>th</sup> grade students, as a means of determining if there was an age difference in the effect of curiosity on risk-taking. In Experiment 1, college students participated in one of four curiosity conditions, completed the BART, and answered two self-report inventories, the DOSPERT and the CEI. In Experiment 2, 4<sup>th</sup> and 5<sup>th</sup> grade students participated in one of two curiosity conditions and then completed the BART. Each experiment tested whether curiosity has a causal effect on risk-taking.

## CHAPTER 2

### EXPERIMENT 1: CURIOSITY & RISK-TAKING IN A COLLEGE POPULATION

#### Method

##### Sampling Procedures

Data collection took place at Georgia Southern University. Participants were recruited through the online SONA system and offered course credit for their participation. Data collection took place in the fall of 2013 through spring 2014.

##### Participants

Data for 235 participants were collected, 123 women and 112 men. Most were in the first or second year of study ( $n=180$ ), but there were some third and fourth years ( $n=55$ ). Two participants were removed from analysis due to technical difficulties during the BART. As a result, 233 participants were used in analysis. Participants were randomly assigned to one of four conditions. There were 60 participants in the trivia questions condition and 57 in the curiosity story condition. There were 58 participants in the curiosity contingent condition and in the control story condition.

##### Procedure and Measures

The stimulus presentation and data collection took place on desktop computers using E-Prime software (Psychology Software Tools, Pittsburgh, PA). As stated previously, the conditions were based on the curiosity stimulus: the trivia questions condition, the curiosity story condition, the curiosity contingent condition, and the control condition. In the trivia questions condition, participants were presented with 10 trivia questions and asked to indicate whether they would like to know the answers to the questions (See Appendix A for the questions). Participants in a 2009 study (Kang et al., 2009) ranked each of these questions as highly curious. The questions were used as the third condition because they were “novel” information to most

people, which would potentially bring out the novelty-seeking component of curiosity and further motivate curiosity as a desire to fill gaps in knowledge (Loewenstein, 1994). Kang et al. (2009) studied the neural underpinnings of curiosity by having participants read questions and guess at answers and found that the regions activated when reading were associated with anticipated reward and regions activated when reading answers, especially when they had guessed at the answer, were linked to memory and learning. Thus, reading can activate curiosity. Primes and framing can affect risk preferences as well, with people becoming more or less risk seeking based on the information provided (Reyna, 2012). After the questions, participants indicated the degree to which they were interested to know the answers to the questions on a Likert-type scale.

The rest of the conditions also relied on Kang et al.'s (2009) conclusion that reading can activate curiosity by utilizing a story, written by the researchers. In the curiosity story condition, participants read a story about an occurrence in a science class, but the end of the story, though predictable, was not presented (See Appendix B). Participants then rated the degree to which they would like to know the ending of the story on a Likert-type scale. This condition provided an information gap (Loewenstein, 1994), thus motivating curiosity. However, if curiosity is a motivating force, then an incomplete story might not increase risk-taking given that the risky situation was in no way linked to the story. Thus, a second curious story condition was created. As in the first, participants in the curiosity contingent story condition read an incomplete story about an occurrence in a science class. After they read the story, participants were told via instructions on the computer that if they received enough points in the upcoming game, they would be presented with the end of the story. (Note: There is no actual minimum, but participants did not know that.) In this way, the risky situation was connected to the story, providing

motivation to be more risky in order to resolve the uncertainty at the end of the story (Baxter & Switsky, 2008; Jirout & Klahr, 2012). In the control condition, participants read the same story as those in the story experimental conditions, but the story was resolved. Participants in all conditions then rated the degree to which they enjoyed the story. The curiosity prompts ideally would lead to information seeking, or cognitive curiosity (Reio et al., 2006).

Participants then participated in the Balloon Analogue Risk Task (Lejuez et al., 2002), which has been shown to be associated with psychological measures of risk taking, such as sensation seeking and personality factors, as well as self-reported behavioral measures, such as smoking, heavy drinking, drug use, and gambling (Szrek, Chao, Ramlagan, & Peltzer, 2012). In the version of the task used in this experiment (presented as a game), participants inflated a blue balloon on the screen and received ten points per pump (see Figure 1). They were told the objective of the game was to get as many points as possible. The more times they pumped the balloon, the more points they received. They could save their points and move on to another balloon, but the balloon could also pop at any time, even after a single pump. For each of the 30 balloons participants pumped, the maximum number of pumps was 128. Thus, the optimal strategy to maximize one's score would be to pump 64 times per balloon. The popping point for each balloon would sometimes be less than 64 but sometimes more, controlled systematically by the computer program. Lejuez et al. (2002) found an average of 29.4 pumps in a sample of young adults ages 18-25. Men had a higher average ( $M=30.5$ ) than women ( $M=25.0$ ). This is far below the expected ideal earning point of 64. Lauriola, Panno, Levin, and Lejuez (2014) analyzed 18 recent studies that made use of the BART and found that the average performance levels across studies was 35.60 pumps, still far below the optimal expected earning point. Cyders et al. (2010) found that participants popped, on average, 11.62 balloons.

The BART has been widely used and validated and could be modified for use with younger populations. The BART has been significantly and positively correlated with the Barratt Impulsiveness Scale and each of the subscales of the Eyesenck Impulsiveness Scale (Lejuez et al., 2002). It has been shown to correlate with adolescent self-reports of risky behavior. In addition, it views risky decisions on a continuum, with the point of high riskiness varying across trials, rather than remaining constant throughout the session. Each balloon has a different risk probability, though risk does increase as the size of the balloon increases. Because participants did not know the probability of explosion beforehand, this task involved risk-taking under uncertainty, which was directly related to this study's comparison of risk-taking and curiosity. This task included stepwise decisions, where participants made pump-by-pump decisions.

Participants in Experiment 1 completed two self-report measures after the BART: one measuring curiosity (the Curiosity and Exploration Inventory (CEI); Kashdan, Rose, & Fincham, 2004) and one measuring risk-taking propensity (the Domain Specific Risk Task (DOSPERT); Weber, Blais, & Betz, 2002) (See Appendices C and D). The DOSPERT assessed risk-taking propensities in certain areas (Figner & Weber, 2011). This would help interpret the risk propensity of each individual participant and thus would help in interpreting ceiling effects seen with experienced risk-takers. For instance, a person with high-risk tendencies may not show any increase in risk-taking due to the curiosity primes but may show effects when grouped based on risk tendency scores and allowing exploration into whether the effectiveness of the prime varies for individuals who have different risk-taking tendencies. The two surveys were combined with the questions from the CEI mixed in with the DOSPERT and the questions were presented randomly to avoid order effects by question. The prediction is that those with higher DOSPERT

scores would have higher scores on the BART, as both measure risk taking, and that those with higher scores on the CEI might have higher interest ratings for the story and questions, and potentially, higher scores on the BART.

### **Measures and Data Analysis**

**Manipulation check.** Participants were asked after each of the prime conditions about their curiosity level or interest level in the material. This score was used to determine whether the prime actually evoked curiosity. This was a single question answered on a Likert-type scale, 5 being highly interested/curious and 1 being not interested at all (e.g., “How interested are you in knowing the end of this story?”). Differences in interest level were examined as a predictor of BART performance.

**Behavioral measure of curiosity.** Those in the trivia condition determined whether or not they would like to see the answer to the question or skip to the next. It was planned that the number of times participants decided to see the answer would be analyzed as a behavioral measure of curiosity level. However, all participants chose to see the answers to the questions, so this measure was not included in analyses.

**BART.** The measures taken from the BART were Total End Score, Number of Explosions, Average Pumps, and Total Number of Pumps. Lejuez et al. (2002) excluded the trials ending in explosions from the average number of pumps, yielding an adjusted score. This adjusted pump value was not used as the primary dependent variable, as it did not seem to take into account the risks taken as a measure that included popped balloons did. A recent study that used the BART (Cyders et al., 2010) also did not use the adjusted pumps because of the desire to include the negative outcomes of risky behavior.

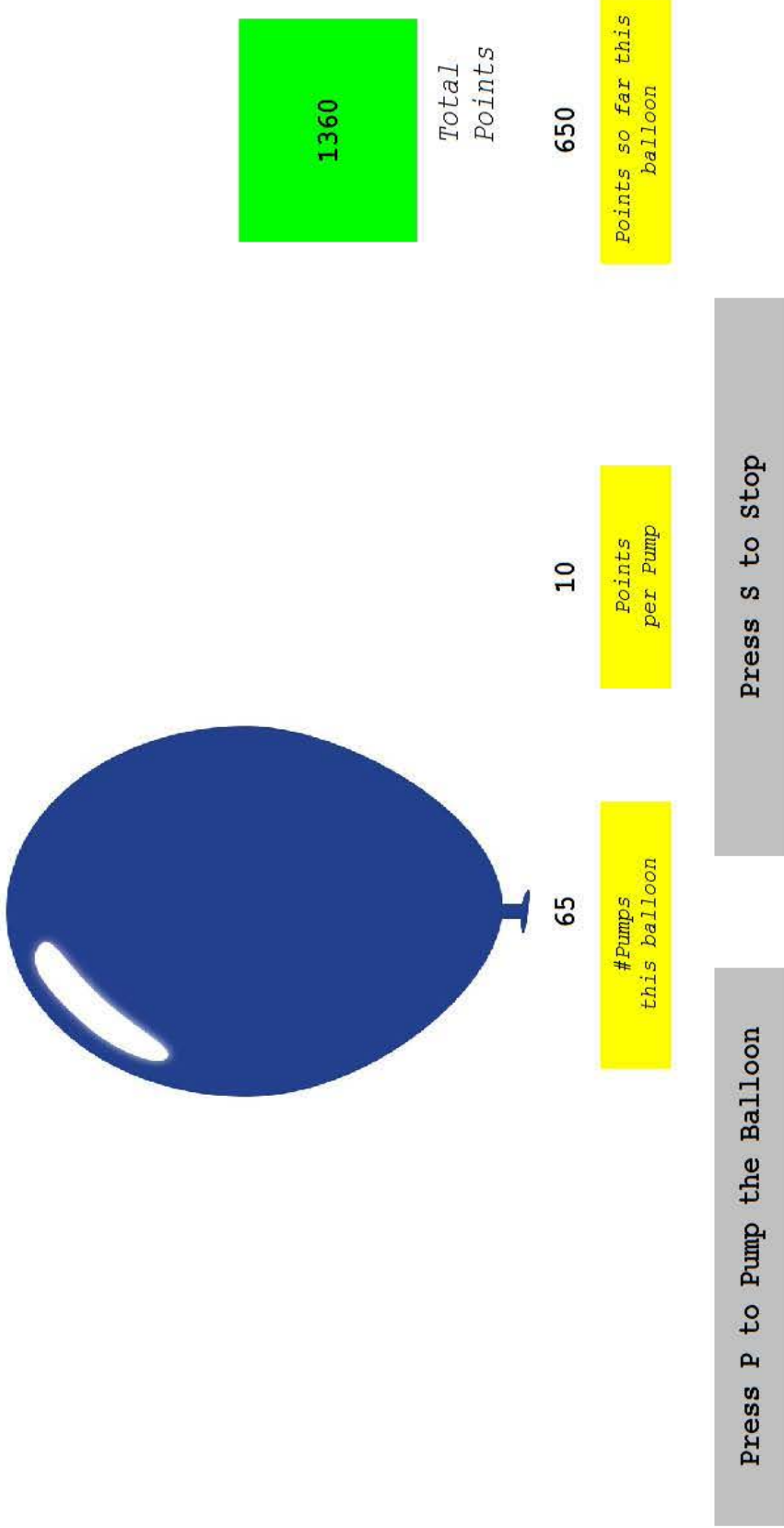


Figure 1. Screenshot of BART screen. Participants were shown the number of pumps for that balloon, the number of points per balloon, and the points so far for that balloon. The green bar expanded with the point values to show the total payoff.

**DOSPERT and CEI.** Participants in the current experiment received two self-report inventories. These questions were analyzed together, with curiosity adding another domain to the five DOSPERT domains. Questions were separated into domains and self-reported scores added to reveal risk attitudes in each domain. These scores were used in a moderator analysis, against the BART scores. It was hypothesized that scores on the DOSPERT would moderate the number of risky decisions by providing a measure by which to group participants based on their risk-taking propensity. In this way, people who have a high risk-taking propensity would display a ceiling effect on the BART, and vice versa for people with a low risk-taking propensity.

### **Analysis Plan**

In order to see whether the curiosity prime had an effect on BART scores, a one-way Analysis of Variance (ANOVA) was run such that the curiosity prime was the independent variable and the BART scores were the dependent variables. We looked at final BART score, number of explosions, and total average pumps.

## **Results and Discussion**

### **Hypothesis Testing**

It was hypothesized that participants in the curiosity contingent condition would have the highest scores and highest average pumps, with the rest of the conditions having less in this order: curiosity story, trivia questions condition, and control condition. There was not, however, a significant effect of the curiosity condition on performance on the BART.

**Average Pumps.** The hypothesized pattern was not observed,  $F(2, 229)=.437, ns, \eta_p^2=.01$ , (See Figure 2). On average, participants in the curiosity story condition pumped the balloon the most ( $M=36.84, SE=2.12$ ), followed by the trivia questions condition ( $M=35.87, SE=1.82$ ), the



control ( $M=35.19$ ,  $SE=2.11$ ), and the control contingent story ( $M=33.68$ ,  $SE=1.97$ ). The pattern was the same for the total number of pumps,  $F(3, 229)=.491$ ,  $ns$ ,  $\eta_p^2=.01$ .

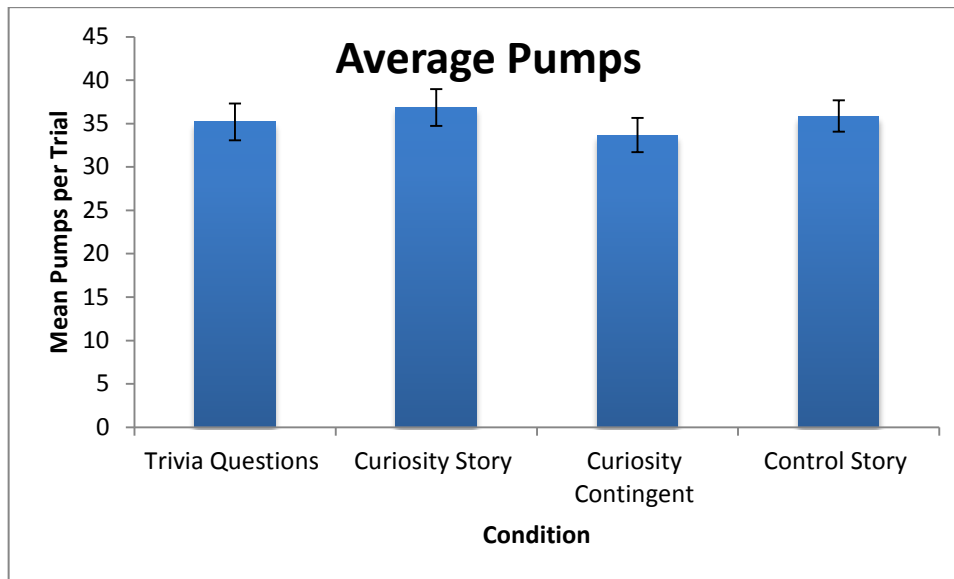


Figure 2. Mean number of pumps per trial on the BART as a function of condition.

**Total Score.** Total score was presented to participants at the end of the game. Participants received 10 points per pump. The total at the end of each balloon that did not pop was added together to get the total score. A high score would be indicative of higher risk propensity, or willingness to take risks. For total score, the pattern did not follow the hypotheses and the differences between conditions were not significant,  $F(3, 229)=.603$ ,  $ns$ ,  $\eta_p^2=.01$ .

**Explosions.** Condition did not have a significant effect on the number of explosions,  $F(3, 229)=.446$ ,  $ns$ ,  $\eta_p^2=.01$ , though the relative order of conditions was slightly different.

Participants in the curiosity condition had the most explosions, popping an average of 8.65 of the 30 balloons ( $SE=.53$ ), followed by the trivia questions condition ( $M=8.53$ ,  $SE=.44$ ), the curiosity contingent condition ( $M=8.19$ ,  $SE=.55$ ), and the control condition ( $M=7.90$ ,  $SE=.51$ ).

## Reliability Statistics for Self-Report Surveys

**DOSPERT.** Each of the subscales of the DOSPERT was analyzed individually. The current sample had a Cronbach's  $\alpha = 0.80$  for the Financial Risk subscale,  $\alpha = .71$  for the Health/Safety subscale,  $\alpha = .83$  for the Recreational subscale,  $\alpha = .78$  for the Ethical Risk subscale, and  $\alpha = .52$  for the Social Risk subscale. This is largely consistent with what has been previously found (Weber et al., 2002), reported alphas of .69, .73, .82, .83, and .69 for the Financial, Health/Safety, Recreational, Ethical, and Social Subscales, respectively.

**CEI.** Kashdan et al.'s (2004) Curiosity and Exploration Inventory measures two distinct components of curiosity: exploration (seeking out new information and experiences) and flow (the degree of absorption in specific activities, while ignoring unimportant information). The current sample had an overall alpha of 0.65. This is consistent with what has been previously found (Kashdan et al., 2004 reported a range of Cronbach's alphas of 0.72 to 0.80).

## DOSPERT and CEI

A regression analysis was run with each of the DOSPERT subscales and the CEI on BART scores. Ethical Risk significantly predicted the variance in average number of pumps,  $r^2=.03$ ,  $F(1, 231)=6.64$ ,  $p<.01$ , as did Financial Risk,  $r^2=.02$ ,  $F(1, 231)=5.75$ ,  $p<.01$ . The Health Risk subscale,  $r^2=.02$ ,  $F(1, 231)=5.29$ ,  $p<.05$ , and the Recreational Risk subscale,  $r^2=.02$ ,  $F(1,231)=5.09$ ,  $p<.05$ , also significantly predicted variance in the average number of pumps. The Social Risk Subscale and the CEI were not significant predictors.

## Exploratory Analyses

**Manipulation check.** Answers to the manipulation check question did vary according to condition,  $F(3, 225)=14.35$ ,  $p<.01$ ,  $\eta_p^2=.16$ . Participants in the curiosity contingent prime were the most interested in knowing the end of the story, with a mean rating of 4.02 out of 5 ( $SE=.13$ ).

The participants in the trivia questions condition indicated the second highest interest level. Answering the question “how interested were you in knowing the answers to the questions” on a 5-point scale, these participants indicated an interest level of 4.0 ( $SE=.12$ ). Participants in the curious story prime indicated an interest level of 3.75 out of 5 ( $SE=.14$ ) for wanting to know the end of the story. Finally, participants in the control condition indicated an interest level in the story as a whole at 2.97 out of 5 ( $SE=.12$ ). CEI scores explained a significant proportion of variance in manipulation check answers,  $r^2=.07$ ,  $F(1, 231)=16.69$ ,  $p<.01$ . Participants who rated themselves as generally more curious indicated more interest in the questions or story. Interest level, however, did not predict performance on the BART,  $r^2=.07$ ,  $F(2, 230)=.78$ ,  $ns$ .

**Gender.** The main effect of gender was significant while the main effect of condition was not. For total score,  $t(231)=3.49$ ,  $p<.01$ ,  $d=.46$ , men ( $N=111$ ) tended to score higher ( $M=6409.91$ ,  $SE=179.66$ ) than women ( $N=122$ ) ( $M=5636.88$ ,  $SE=179.04$ ). For total pumps, which was also significantly different,  $t(231)=3.53$ ,  $p<.01$ ,  $d=.46$ , men ( $M=882.84$ ,  $SE=29.83$ ) pumped more than women ( $M=733.20$ ,  $SE=29.98$ ).

A 2x4 (gender x condition) ANOVA was run and there was an interaction between gender and condition for Total Pumps,  $F(3, 225)=2.93$ ,  $p<.05$ ,  $\eta_p^2=.04$ , such that the difference between pumping done by men and pumping done by women varied by condition (See Figure 3). In the trivia questions condition, men ( $N=23$ ) again pumped more times ( $M=931.30$ ,  $SE=55.10$ ) than women ( $N=37$ ) ( $M=715.54$ ,  $SE=44.65$ ),  $t(58)=3.02$ ,  $p<.01$ ,  $d=.79$ . In the Curious Story condition, men ( $N=27$ ) pumped more ( $M= 866.96$ ,  $SE= 66.00$ ) than women ( $N=30$ ) ( $M= 834.20$ ,  $SE=71.09$ ), though it was a non-significant difference,  $t(55)=.36$ ,  $ns$ ,  $d=.10$ . In the curiosity contingent condition, men ( $N=29$ ) pumped more times ( $M=799.79$ ,  $SE=54.11$ ) for the entire set of balloons than did women ( $N=29$ ) ( $M=763.52$ ,  $SE=67.02$ ), though it was a non-significant

difference,  $t(56)=.42$ ,  $ns$ ,  $d=.11$ . Finally, in the control story condition, men ( $N=32$ ) pumped more times ( $M=936.66$ ,  $SE=59.82$ ) than women ( $N=26$ ) in the same condition ( $M=608.00$ ,  $SE=52.86$ ),  $t(56)=4.02$ ,  $p<.01$ ,  $d=1.07$ . The interaction between gender and condition for Total Score approached significance,  $F(3, 225)=2.33$ ,  $p=.08$ ,  $\eta_p^2=.03$ . The interaction between gender and condition for average pumps was not significant,  $F(3, 225)=2.05$ ,  $p=.11$ ,  $\eta_p^2=.03$ .

The differences between conditions within either gender formed an interesting pattern. Women pumped most in the curious story condition ( $M=834.20$ ,  $SE=71.09$ ), then in the curiosity contingent condition ( $M=763.52$ ,  $SE=67.02$ ), next in the trivia questions condition ( $M=715.54$ ,  $SE=44.65$ ), and least in the control condition ( $M=608.00$ ,  $SE=52.86$ ). The difference in total pumps between conditions for women was approaching significance,  $F(3, 118)=2.36$ ,  $p=.07$ ,  $\eta_p^2=.06$ . Men, on the other hand, pumped most in the control condition ( $M=936.66$ ,  $SE=59.82$ ), then in the trivia questions condition ( $M=931.30$ ,  $SE=55.10$ ), next in the curious story condition ( $M=866.96$ ,  $SE=66.00$ ), and least in the curiosity contingent condition ( $M=799.79$ ,  $SE=54.11$ ) but the difference in total pumps between conditions for men was not significant,  $F(3, 107)=1.20$ ,  $ns$ ,  $\eta_p^2=.03$ , so these statistics represent simple main effects.

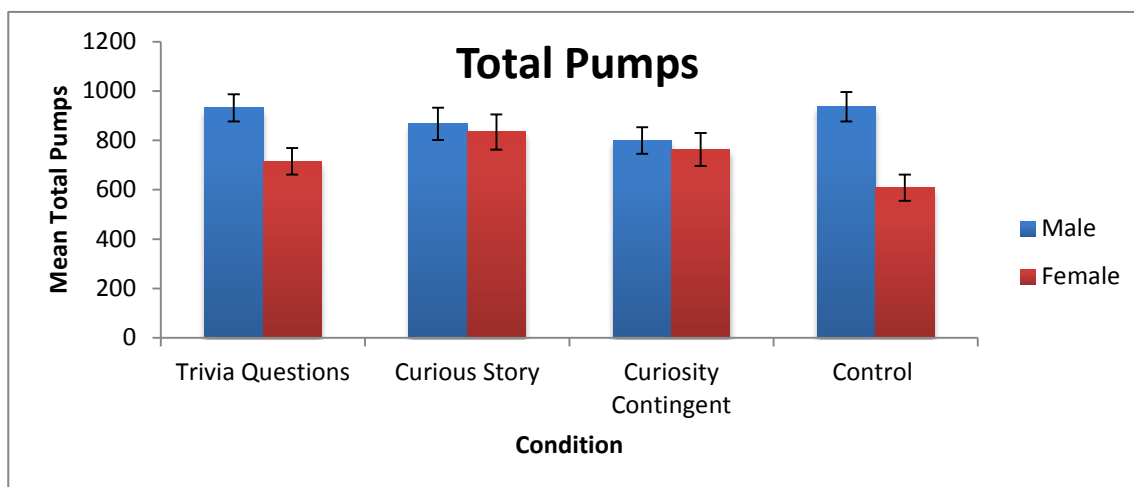


Figure 3. Between-gender comparison of mean total pumps as a function of condition.

## Discussion

The hypotheses for Experiment 1 were not supported. Though not significant, the pattern was interesting, because it might imply that curiosity, if a motivating force, may inhibit risky behavior, based on the scores for the curiosity contingent condition being the lowest out of the four. Originally, it was anticipated that the reward contingency for curiosity primes and for the risk task would be similar to the point that those in the experimental conditions would be more risky. Instead, however, those in the curiosity contingent condition, where perhaps the most curiosity was elicited, had the lowest scores on the BART. This may support the idea that creating curiosity could actually decrease risk taking.

Curiosity may be more motivating for some people than for others. People differ in their desired level of knowledge (Jepma, Verdonschot, van Steenbergen, Rombouts, & Nieuwenhuis, 2012) so even when presented with the same level of uncertainty, participants may not process it in the same way. Thus, though the curiosity contingent condition may have increased reward sensitivity in some participants, individual differences may have caused some participants not to care as much about the ambiguous ending. In fact, the CEI explained a significant amount of the variance in the answers to the manipulation check. This measure of trait curiosity did show individual differences in interest level for the priming mechanism.

Gender was not part of the original analysis plan because a recent meta-analysis found no significant gender differences in studies that use the BART (Lauriola, Panno, Levin, & Lejuez, 2014). Given this slightly surprising summary, gender was added to the analyses to see if the manipulation related to gender in any way. The difference between men and women in each condition was interesting as were differences between conditions for the same gender. The ambiguity at the end of the incomplete stories seems to have been more motivating for women

than for men. The differences between genders in the four conditions were closest in the curious story condition and in the curiosity contingent story condition. Within the group of women, the differences between the conditions approached significance, while it did not within the group of men. This perhaps indicates that individual differences may play a large role in curiosity as a motivator. This difference in motivation is interesting and could be worth future study.

## CHAPTER 3

### EXPERIMENT 2: CURIOSITY & RISK-TAKING IN 4<sup>TH</sup> & 5<sup>TH</sup> GRADE STUDENTS

#### **Introduction**

Experiment 2 followed due to the desire to see if the effect of curiosity on risk-taking would be different in a pre-adolescent population, specifically 4<sup>th</sup> and 5<sup>th</sup> grade students, but the data in this experiment were collected concurrently with those of Experiment 1. There were only two conditions in this experiment, both involving a story: an experimental condition with an incomplete ending and a control condition with a complete ending. It was hypothesized that children in the experimental condition would have higher scores on the BART while those in the control condition would have lower scores.

#### **Method**

##### **Sampling Procedures**

Permission forms were sent home with the students and then children verbally assented to participate at testing time. The children received no compensation for their participation. Data collection took place during the spring semester of 2014.

##### **Participants**

There were 55 total participants in Experiment 2 (30 girls, 25 boys). There were 24 fourth grade students and 31 fifth grade students. The average age was 10.29 years ( $SE=.09$ ). Twenty-seven of the total sample participated in the control condition and 28 participated in the curiosity contingent condition.

##### **Procedure and Measures**

The stimulus presentation and data collection took place on laptop computers using E-Prime software (Psychology Software Tools, Pittsburgh, PA). Children were asked by the

experimenter whether they would like to play a game, and if they agreed (thus providing assent), they were taken to a space just outside their classrooms. Participants were in one of two conditions. In the curiosity contingent story, participants read an incomplete story about an occurrence in a science class. This story was the same as the one used for the college student population, slightly altered to make the story more understandable (See Appendix E). Also, pictures were added to each slide of the story. After they read the story, participants were verbally told that if they received enough points in the upcoming game, they would be presented with the end of the story. (Note: There was no actual minimum, but participants did not know that.) In the control condition, participants read the same story as those in the story experimental condition, but the story was resolved. A stop sign was added at the end of the curiosity contingent story with instructions that the story was not over and they would never guess what happened next. Participants then rated the degree to which they enjoyed the story.

Participants then participated in an altered version of the Balloon Analogue Risk Task (Lejuez et al., 2002). Instead of a maximum of 128 pumps per balloon, the maximum was lowered to 32. The number of trials was also extended from 30 balloons to 32 balloons. Thus, the probability structure now contained balloons that popped at every number between 1 and 32, though it was completely unpredictable on a given trial at which pump number the balloon would explode. In this altered game, attempting to pump the balloon 16 times would be the optimal strategy.

### **Measures and Data Analysis**

**BART.** The measures taken from the BART were the same as those in Experiment 1 (Average Pumps, Total Number of Pumps, Total End Score, and Number of Explosions). The number of pumps on the practice balloon was also measured.



**Manipulation check.** Participants were asked after each of the prime conditions about their curiosity level or interest level in the material. This score was used to determine whether the prime actually evoked curiosity. This was a single question answered on a Likert-type scale, 5 being highly interested/curious and 1 being not interested at all (e.g., “How interested are you in knowing the end of this story?”). Differences in interest level were examined as a predictor of BART performance.

**Analysis plan.** In order to see whether the curiosity prime had an effect on BART scores, an independent samples T-test was run such that the curiosity prime was the independent variable and the BART scores were the dependent variables. We looked at final BART score, number of explosions, and total average pumps. Additionally, a 2x2 Analysis of Variance (ANOVA) was run for the purpose of an exploratory analysis using condition and popped practice balloon as the independent variables and average pumps as the dependent variable.

## Results and Discussion

### Hypothesis Testing

It was hypothesized that participants in the curiosity contingent condition would have higher total scores, higher average pumps, and more explosions than those in the control condition.

Condition did not have a significant effect on average number of pumps or total number of pumps,  $t(53)=.57$ , *ns*,  $d=.16$ . See Figure 4 for the pattern. The average number of pumps per trial for the whole sample was 7.05 pumps ( $SE=.29$ ). Those in the control condition pumped an average of 7.23 times per balloon ( $SE=.40$ ) while those in the curiosity contingent condition pumped an average of 6.89 times per balloon ( $SE=.44$ ).

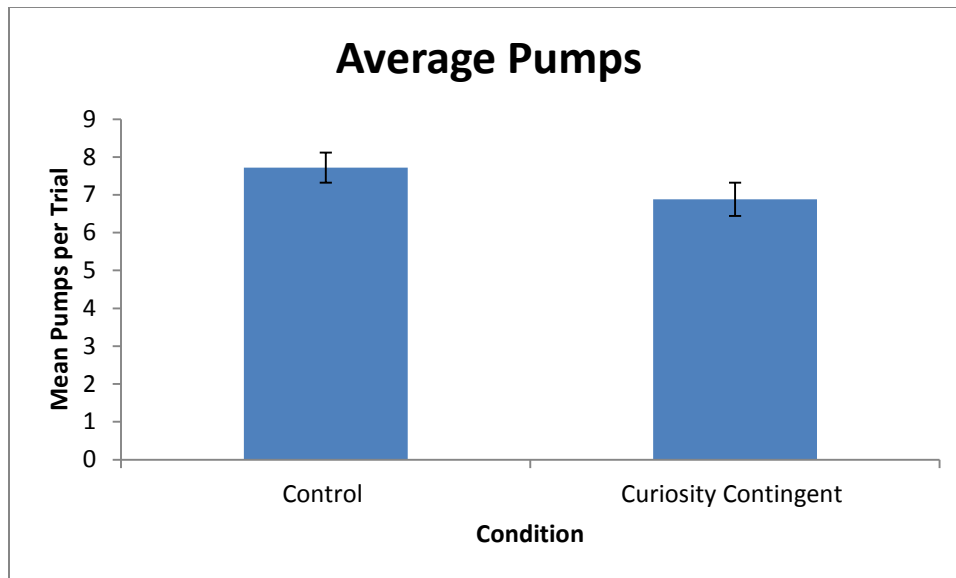


Figure 4. Mean number of pumps per trial as a function of condition.

Condition did not have a significant effect on total score,  $t(53)=.20$ ,  $ns$ ,  $d=.05$ , and the pattern was the opposite of that predicted. Participants in the control condition had a higher overall score ( $M=1705.18$ ,  $SE=75.69$ ) than those in the curiosity contingent condition ( $M=1682.50$ ,  $SE=83.97$ ). Condition also did not have a significant effect on number of explosions,  $t(53)=.76$ ,  $ns$ ,  $d=.21$ . Those in the control condition popped more balloons (8.89 out of 32,  $SE=.50$ ) than those in the curiosity contingent condition ( $M=8.29$ ,  $SE=.61$ ).

### Exploratory Analyses

**Practice balloon.** Based on the observation that participants who popped their practice balloon seemed to pump subsequent balloons less, a 2 x 2 ANOVA was run with whether or not the practice balloon popped and condition as the independent variables and the same dependent variables (total score, average pumps, explosions, and total pumps). On average, the participants who popped their practice balloon had a higher total score, higher average number of pumps, higher number of explosions, and a higher number of total pumps than those who did not pop

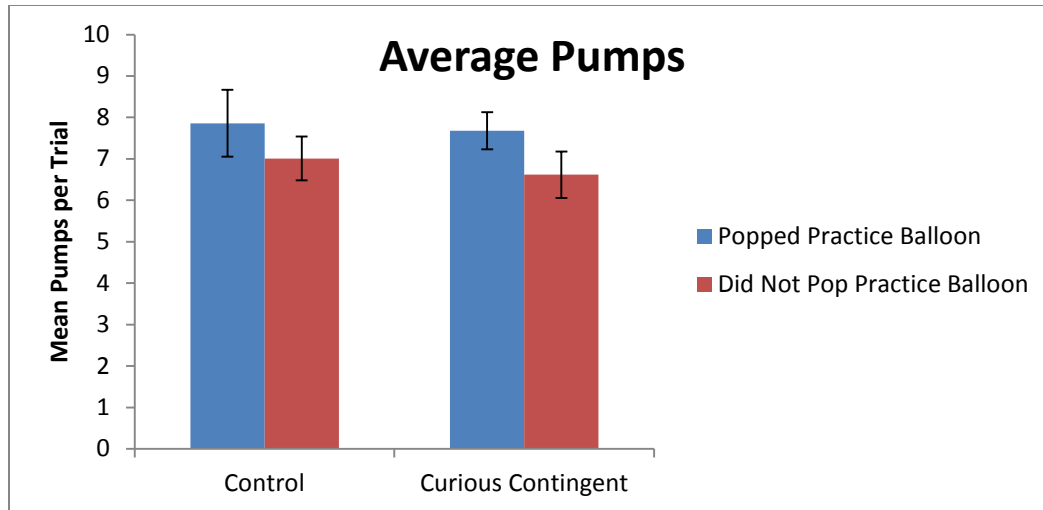
their practice balloon though these differences were not statistically significant. For average pumps, neither the main effect of popping the practice balloon,  $F(1, 51)=1.96$ ,  $ns$ ,  $\eta_p^2=.04$ , nor the main effect of condition,  $F(1, 51)=.17$ ,  $ns$ ,  $\eta_p^2=.003$ , were significant. The interaction between the two was also not significant,  $F(1, 51)=.03$ ,  $ns$ ,  $\eta_p^2=.000$ . See Table 2 and Figure 5 for the comparison.

**Gender.** In view of the fact that gender seemed to affect risk taking in Experiment 1, this sample was analyzed by gender as well. For average pumps, gender did not interact significantly with condition,  $F(1, 51)=.07$ ,  $ns$ ,  $\eta_p^2=.001$  nor did it show a significant main effect,  $F(1, 51)=1.41$ ,  $ns$ ,  $\eta_p^2=.03$ . In contrast with the typical pattern of boys pumping more, girls, on average, pumped more per balloon ( $M=7.40$ ,  $SE=.42$ ) than did men ( $M=6.64$ ,  $SE=.40$ ). In the control condition, women pumped more ( $M=7.56$ ,  $SE=.51$ ) than men ( $M=6.67$ ,  $SE=.61$ ). In the curiosity contingent condition, women also pumped more ( $M=7.18$ ,  $SE=.72$ ) than men ( $M=6.62$ ,  $SE=.55$ ). The same held true for total number of pumps, total score, and number of explosions.

Table 1

*Comparison of the differences between average pumps, total score, explosions, and total pumps based on whether the participant popped their practice balloon.*

	Average Pumps		Total Score		Explosions		Total Pumps	
	<i>Popped Practice</i>	<i>No Pop</i>	<i>Popped Practice</i>	<i>No Pop</i>	<i>Popped Practice</i>	<i>No Pop</i>	<i>Popped Practice</i>	<i>No Pop</i>
<b>Control</b>	7.86	7.01	1785.71	1677.00	10.00	8.50	241.43	224.25
<b>Curious Contingent</b>	7.68	6.62	1870.00	1620.00	9.00	8.05	245.86	211.81



*Figure 5.* Mean number of pumps per trial based on popping the practice balloon as a function of condition.

## Discussion

The pattern of the means reflected those found in Experiment 1 with the college population. The children also displayed conservative pumping in the BART for the curiosity contingent group. There may have been some effect of popping the practice balloon on the number of subsequent pops in the BART. As a consideration for future research, it might be useful to modify the experiment so that the children are given more practice and can see the whole range of possible pumps. For instance, instead of one practice trial where the balloon pops at 16 pumps, two more practice trials could be added, so that one trial pops at a low number, one trial pops at 16, and one trial pops at the upper limit. Additional practice that demonstrated variability might have increased the average number of pumps. As it was, the children, not knowing what the upper limit might be, stayed below 20 pumps. Only seven balloons out of the 1650 total balloons pumped in this experiment were pumped more than 20 pumps, indicating that the children who were sampled were generally risk averse in the task. The average number of pumps for the whole sample was 7.05 pumps, when the possible number of

pumps for any balloon was 32 pumps. The relative ratio between the maximum possible number of pumps and what participants actually do seems to fit with what was found with the adult sample in Experiment 1 and what has been found in previous studies (Lauriola et al., 2014). More participants should be collected to determine if the children's behavior would change based on more extensive training.

## CHAPTER 4

### GENERAL DISCUSSION

In these experiments, we attempted to alter behavior on an established risk-taking task through various primes that elicited curiosity. However, there was no significant difference in performance between curiosity conditions. Though none of the experimental relationships in this experiment were significant, the patterns have the potential to be interesting. There are perhaps several explanations for why it did not work as hypothesized. Curiosity has been described as a motivational state (Loewenstein, 1994) for exploration. In both the college sample and the elementary school-aged sample, participants had fewer pumps in the curiosity-contingent condition compared with the curious story condition and the trivia questions condition. Thus when curiosity is a motivating force, participants were less risky. When there is value to a given behavior, participants took fewer risks, a pattern that supports the conceptualization of risk taking through the Expected Value model (Atkinson, 1983) or the Expected Utility model (Kahneman & Tversky, 1979) where risks are taken based on the expected value of the outcome or experience. Alternatively, in the incomplete story condition (the “curiosity story”), participants had the highest average for score and number of pumps. This implies that the ambiguity of the ending might have possibly prompted more risk.

Perhaps the motivating force of curiosity in the contingent condition made participants particularly sensitive to rewards and actually led to more risk-averse tendencies. This would also argue against the view of curiosity as a harmful quality (Chak, 2007). Curiosity may be more motivating for some people than for others. People might place a different value on filling Loewenstein’s (1994) information gap. Some participants might have thought risky behavior would lead to a higher payoff, and thus increase the likelihood of learning the end of the story.

On the other hand, being risky on the BART may not have seemed compatible with the goal of learning the end of the story. Participants with this strategy placed more value on consistently adding to the total score, even if it was not a large addition.

Along the same lines, curiosity may elicit different behaviors from different people, based on the values placed on the contingency. Maio, Pakizeh, Cheung, and Rees (2009) primed participants with certain value categories. For instance, priming security values (safety, harmony, and stability) decreased curiosity-driven behaviors, while priming self-direction values (independent thinking and choosing) increased curiosity-driven behaviors. Priming a curiosity contingency, as in one of our experimental conditions, may have resulted in reward-driven behaviors that would have been undermined by risky decisions. The effect of the contingency could be interesting for further study. Previous studies have shown that children do not usually make evidence-based judgments, unlike adults (Amsel & Brock, 1996). Questions at the end of the task could help in determining whether participants consciously made fewer risky decisions based on the desire to fill the information gap presented in the curiosity contingent story condition.

Alternatively, there might not be a causal relationship between curiosity and risk-taking, as hypothesized. Analysis of the CEI showed that it did not explain any of the variance seen in the BART measures. Thus, trait curiosity does not influence risk-taking, at least as measured by the BART or the DOSPERT. Perhaps the CEI does not measure the type of curiosity relevant to risk-taking. Reio et al. (2006) offered a 3-factor model of curiosity. Two sensory factors were associated with risk and involved thrill seeking, either physically or socially, while the third was cognitive curiosity. Perhaps the hypothesized pattern did not emerge because the BART correlates well with the sensory curiosity factors, while the stories and questions primed

cognitive curiosity. The BART is highly correlated with sensation seeking (Aklin et al., 2005) and a propensity for physical and social risks (Gordon, 2007). Given that the sensory factors of curiosity are related to a propensity for physical and social risks, they might be correlated with results on the BART. Sensory curiosity and cognitive curiosity both lead to exploration, but cognitive curiosity is due to the need for information and sensory curiosity the need for new experiences (Reio, 2010). Future research should attempt to tease apart these categories of risk-taking to see if priming in one of the sensory factors would produce a change in performance in the BART. Reio (2010) concluded that sensory curiosity and cognitive curiosity interact to enhance learning, but knowledge is not the main goal of sensory curiosity. By pairing sensory curiosity with a task like the BART and cognitive curiosity with a task that incorporates using learned information, we may be able to find a relationship between curiosity and risk-taking.

Curiosity has been shown to be both a trait and a state (Naylor, 1981). State curiosity is situation-specific while trait curiosity describes a general approach to most situations. Although these two constructs are positively related, they are separate and distinct qualities (Baxter & Switsky, 2008). Perhaps the curiosity primes were not strong enough to prime a state of curiosity. Scores on the CEI did not differ significantly by condition, so the primes did not change overall curiosity level. The CEI, however, only measures trait curiosity. Perhaps a measure of state curiosity should have been used in this experiment. Alternatively, the prime may not have been strong enough to elicit curiosity or perhaps the prime did not elicit the correct type of curiosity, as described above (Reio et al., 2006). Another explanation, however, may be the same reason the curious story condition was removed for the elementary school participants. An individual needs to be aware of his or her own uncertainty for curiosity to be a motivational drive (Gottlieb et al., 2013). It was concluded the children might assume that the inconclusive



end to the story indeed *was* the end of the story and there was no need to wonder what happened. If this is true, the primes may not have primed curiosity at all. Along the same lines, it is possible that the prime did indeed elicit curiosity and that curiosity does indeed affect risk-taking, but that curiosity's effect on risk-taking is cumulative over a longer period of time than the experimental task allowed. For instance, Abelson (1985) used baseball hitting averages to show that percentage variance does not adequately measure the effect of skill in a single episode, but rather over a long period of time, such as a season. Curiosity may operate under a similar time frame. It is important to further study the effects of curiosity on risk-taking, as a process that occurs in the real world. On the other hand, the primes might have elicited curiosity, but the fact that the story was not finished should have been more explicit. An additional manipulation check question could have asked whether the participants thought the story was at an end and then if they were interested in knowing the ending. If the primes did not prime curiosity, there should not have been a difference between the story conditions.

Finally, perhaps the BART was not well-suited to measure risk-taking in this situation. The BART was chosen because it elicits risk preferences that are significantly correlated with self-reported risk-taking in daily life for high school students (Charness, Gneezy, & Imas, 2013). However, the BART simulates a scenario in which there are no specific negative consequences, only the loss of potential benefits. The BART does not show the typical developmental pattern of an adolescent peak in risk-taking (Figner et al., 2009). This study attempted to connect a quality of learning—curiosity—with risk-taking. There may have been too much uncertainty involved in the BART. Adolescents have been shown to be more accepting of ambiguity than adults or pre-adolescents (Tymula et al., 2012). Perhaps for both samples used here, the uncertainty and the lack of a strategy or pattern to learn made the task unsuitable. Perhaps a better task would

have been one where participants could have learned and employed strategies to guide risk-taking behavior.

Humphreys, Lee, and Tottenham (2013) modified the BART so that certain colors of balloons had fixed explosion points, while another color had variable explosion points. Humphreys et al. (2013) measured associative sensitivity (AS), a construct of automatic cognitive activity that predicts learning, as well as sensation seeking (SS). As shown in previous studies (Lauriola et al., 2014; Lejuez et al., 2002), SS predicts increased risk taking on the BART. In the Humphreys et al. (2013) modification, participants performed best on the modified BART task when high in both SS and in AS, better than those high in only SS. Curiosity is related to sensation seeking (Kashdan et al., 2004), is a cognitive concept (Reio et al., 2006), and is a motive for learning (Jepma et al., 2012). Perhaps a risk-taking task that relied on learning would have been affected by the curiosity primes.

### **Limitations and Future Directions**

Each experiment could have used more participants. Data collection for the 4<sup>th</sup> and 5<sup>th</sup> grade sample only took place at one school. Permission forms from two other schools had been returned, but the schools' schedules did not allow time for testing. For the college population, data collection took place over two full semesters and went more slowly than expected. More participants were needed to fully power the study, but the pace of participation did not allow this.

In addition, future studies should perhaps add more extensive training for the children and even some sort of self-report measure on risk behaviors. Perhaps instead of additional practice trials, the BART's limitations could be demonstrated for the children. It would also be interesting to see if training or demonstrations would increase average pumps in an adult

population. It could be that simply telling adults that the balloons can pump up possibly 128 times might alter behavior.

This study has the potential to show that there is a link between curiosity and risk-taking, but the opposite of what was predicted. This could have implications for the way curiosity is incorporated into teaching. In Experiment 2 with elementary students, wanting to hear the end of the story due to the contingency in the experimental condition seemed to make kids risk-averse and overly conservative. If curiosity curbs risky decisions, then it could have an inhibitory effect on at-risk children and perhaps help in preventing risky behaviors. Creating an environment where exploration and discovery are encouraged would be difficult and slow, but could be helpful in helping children develop into curious learners who take adaptive risks, rather than maladaptive risks. Suspense, such as that concerning the ending of the story used in this experiment, could be one tool in fostering curiosity. As Reio (2010) suggests, students must find motivation to avoid maladaptive risk-taking. This risk-averseness could be enhanced by rewarding curious and exploration-oriented behaviors.

Finally, the methodological issues addressed above, specifically the use of the traditional BART, should be assessed to see if different measures of risk-taking might show a different pattern of results. Additionally, future studies should assess other types of curiosity, including the distinction between trait and state curiosity, more carefully.

### **Conclusion**

It is not possible to draw definitive conclusions from this study because of the lack of significant results. Future research should take into account the possible theoretical difficulties addressed here, such as different types of curiosity, and the methodological issues, such as a

different task to measure risk-taking. There may not be a causal relationship between curiosity and risk-taking, but more research should be done before coming to this conclusion.

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## Appendix A.

## Trivia Questions

1. What part of a woman's body were ancient Chinese artists forbidden to paint?
  - a. Her Foot
2. What is the only type of lizard that has a voice?
  - a. Gecko
3. What unfortunate handicap did Thomas Edison suffer?
  - a. Deafness
4. What animal's excrements are consumed as luxury food?
  - a. Bats
5. What breed of dog is the only animal whose evidence is admissible in American courts?
  - a. Bloodhound
6. What is the most shoplifted book in the world?
  - a. The Bible
7. What is the most sober school according to The Princeton Review?
  - a. Brigham Young University
8. What is the only type of animal besides a human that can get a sunburn?
  - a. Pig
9. What snack food is an ingredient in the explosive dynamite?
  - a. Peanuts
10. What instrument was invented to sound like a human singing?
  - a. Violin

## Appendix B.

### Adult Story Version

- It was just a Monday morning at a high school in the middle of nowhere. Patrick talked to his friends in front of his locker about his weekend. When the bell rang, he walked to his first period science class. What he didn't realize was the twenty-odd students were not the only things in the classroom that day. A stray banana had managed to find its way into the room as well. This wasn't just any banana though.
- It was the “No-one-wanted-to-eat-me-at-lunch-so-I-got-shoved-in-a-backpack” banana. It had had time to ferment in its inner squishiness for several days.
- After hearing about the banana, Mr. Hanlon (the science teacher) picked it up with a smile on his face, and a chuckle that meant he had a crazy idea. Usually this face meant the students were going to get out of doing the normal work of the 42-minute period.
- Last time, Mr. Hanlon had showed them the differences in gas densities by lighting an invisible gas on fire to show that it was lighter than normal air and travelled faster down a ramp. Another time, the students made bottle rockets with diet coke and mentos, only to find out that fruit mentos do not work as well as mint mentos.
- One of their projects in class had been to build a house from a cardboard box and wire the house for electricity. One group had tried to use solar electricity and one of the girls burned a hole in her thick cotton sweatshirt because she was standing too close to the solar lamp.
- Mr. Hanlon peeled the banana into three strips of peel, and placed each on the ground with the inside down, against the tile floor. He then told the students that the day's lesson was to test the action of friction and lubrication.
- Next, Mr. Hanlon called on three students to be the guinea pigs for the experiment—two to stand beside the peel in the event someone slipped and fell, and one to step on the banana peel and test its lubrication.
- Patrick, the class clown, immediately volunteered. His friends Mark and Gil were the catcher volunteers. Patrick was the first to step on the peel. He had heard of the extreme lubrication of banana peels, but mostly in the context of Saturday morning cartoons, so he had no idea whether it would actually make him fall.
- Patrick stepped up behind the first peel. Mark and Gil stood on either side of it waiting for whatever would happen. Patrick took a deep breath and looked over at Mr. Hanlon, who nodded with twinkling eyes.

Curious Ending (after BART, Curiosity Contingent participants read the control ending)

[The twenty-something students in that science class that Monday morning never forgot that day!]

Control Ending

[When Patrick stepped on the banana, it was like his foot was disconnected from the universe for a fraction of a second. He fell backward and into Mark and Gil, who kept him from hitting the ground. The whole class was in an uproar, ecstatically trying to be selected as the next one to slip on the peel. The entire class left with enough laughs to last a week's worth of class periods.]

## Appendix C.

DOSPERT (Weber, Blais, &amp; Betz, 2002)

For each of the following statements, please indicate your likelihood of engaging in each activity or behavior. Provide a rating from 1 to 5, using the following scale:

1	2	3	4	5
Very Unlikely	Unlikely	Not Sure	Likely	Very Likely

1. Admitting that your tastes are different from those of your friends. (S)
2. Going camping in the wilderness, beyond the civilization of a campground. (R)
3. Betting a day's income at the horse races. (G)
4. Buying an illegal drug for your own use. (H)
5. Cheating on an exam. (E)
6. Chasing a tornado or hurricane by car to take dramatic photos. (R)
7. Investing 10% of your annual income in a moderate growth mutual fund. (I)
8. Consuming five or more servings of alcohol in a single evening. (H)
9. Cheating by a significant amount on your income tax return. (E)
10. Disagreeing with your father on a major issue. (S)
11. Betting a day's income at a high stake poker game. (G)
12. Having an affair with a married man or woman. (E)
13. Forging somebody's signature. (E)
14. Passing off somebody else's work as your own. (E)
15. Going on a vacation in a third-world country without prearranged travel & hotel accommodations. (R)
16. Arguing with a friend about an issue on which he or she has a very different opinion. (S)
17. Going down a ski run that is beyond your ability or closed. (R)
18. Investing 5% of your annual income in a very speculative stock. (I)
19. Approaching your boss to ask for a raise. (S)
20. Illegally copying a piece of software. (E)
21. Going Whitewater rafting during rapid water flows in the spring. (R)
22. Betting a day's income on the outcome of a sporting event (e.g. baseball, soccer, or football). (G)
23. Telling a friend if his or her significant other has made a pass at you. (S)
24. Investing 5% of your annual income in a conservative stock. (I)
25. Shoplifting a small item (e.g. a lipstick or a pen). (E)
26. Wearing provocative or unconventional clothes on occasion. (S)
27. Engaging in unprotected sex. (H)
28. Stealing an additional TV cable connection off the one you pay for. (E)
29. Not wearing a seatbelt when being a passenger in the front seat. (H)
30. Investing 10% of your annual income in government bonds (treasury bills). (I)
31. Periodically engaging in a dangerous sport (e.g. mountain climbing or sky diving). (R)
32. Not wearing a helmet when riding a motorcycle. (H)
33. Gambling a week's income at a casino. (G)
34. Taking a job that you enjoy over one that is prestigious but less enjoyable. (S)
35. Defending an unpopular issue that you believe in at a social occasion. (S)
36. Exposing yourself to the sun without using sunscreen. (H)
37. Trying out bungee jumping at least once. (R)
38. Piloting your own small plane, if you could. (R)
39. Walking home alone at night in a somewhat unsafe area of town. (H)
40. Regularly eating high cholesterol foods. (H)

Note: E = ethical, I = investment, G = gambling, H = health/safety. R = recreational, and S = social items.  
CEI (Kashdan, Rose, & Fincham, 2004)

## Appendix D.

## Curiosity and Exploration Inventory (adapted from Kashdan et al., 2004)









For each of the following statements, please indicate your likelihood of engaging in each activity or behavior. Provide a rating from 1 to 5, using the following scale:



1	2	3	4	5
Very Unlikely	Unlikely	Not Sure	Likely	Very Likely

1. Actively seeking as much information as you can in a new situation.
2. Losing track of time when you get heavily involved in a task.
3. Looking for new opportunities to grow as a person.
4. Not probing deeply into new situations or things.
5. Being so actively interested in something, it takes a great deal to interrupt you.
6. Being "extremely intense" when in the middle of something.
7. Looking for new things or experiences everywhere.

## Appendix E.

## Child Story Version (with Pictures)

<p>1</p> 	<p>It was Monday again! Patrick talked to his friends about his weekend. When the bell rang, he walked to his science class with everyone else. But there was a surprise waiting for them. Someone left a banana in their cubby over the weekend. This wasn't</p>	<p>2</p>  <p>It was the "No-one-wanted-to-eat-me-at-lunch-so-I-got-shoved-in-a-cubby" banana. It had had time to rot in its squishy ickiness for several days.</p>
<p>3</p> 	<p>After hearing about the banana, Mr. Hanlon (the science teacher) picked it up with a smile on his face, and a chuckle that meant he had a crazy idea. Usually this face meant</p>	<p>4</p>  <p>Last time, Mr. Hanlon let the students make bottle rockets with diet coke and Mentos, only to find out that fruit Mentos do not work as well as mint Mentos.</p>
<p>5</p> 	<p>One of their projects in class had been to build a house from a cardboard box and wire the house for electricity. One group had tried to use solar electricity and one of the girls burned a hole in her thick cotton sweatshirt because</p>	<p>6</p>  <p>Mr. Hanlon peeled the banana into three strips of peel, and placed each on the ground with the inside down, against the tile floor. He then told the students that</p>
<p>7</p> 	<p>the students were going to do something exciting!</p> <p>the day's lesson was to test the action of friction and slipperiness.</p> <p>Next, Mr. Hanlon called on three students to be part of the experiment. Two to stand beside the peel to catch anyone if necessary, and one to step on the banana peel and test how slippery it was.</p>	<p>8</p>  <p>Patrick, the class clown, immediately volunteered. His friends Mark and Gil volunteered to catch him. Patrick had heard of the slipperiness of banana peels, but mostly on cartoons, so he had</p> <p>no idea what would happen in real life.</p>

	<p>Patrick stepped up behind the first peel. Mark and Gil stood on either side of it waiting for whatever would happen. Patrick took a deep breath and looked over at Mr. Hanlon, who nodded with twinkling eyes.</p>	<p>The story is not over yet! Just wait until you hear what happened next!</p> 
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On a scale of 1 to 5, with 1 being not at all and 5 being very much, indicate how much you would like to hear what happened to Patrick.



Now you are going to play a game. If you score enough points on the game, you will be told the end of the story!



When Patrick stepped on the banana, it was like his foot was disconnected from the universe for a fraction of a second. He fell backward and into Mark and Gil, who kept him from hitting the ground. The whole class was in an uproar, excitedly trying to be selected as the next one to slip on the peel. The entire class laughed for the rest of the day!