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PRACTICING POSSIBILITIES: THE ROLE OF PARENTS' VOCATIONS AND EXPLANATIONS IN THE DEVELOPMENT OF CHILDREN'S POSSIBILITY THINKING

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Charlotte Nolan Reyes

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The Dissertation of Charlotte Nolan Reyes
is approved:

_____
Professor Maureen A. Callanan, chair

_____
Professor Avril Thorne

_____
Professor Su-hua Wang

_____
Tyrus Miller
Vice Provost and Dean of Graduate Studies

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ABSTRACT

PRACTICING POSSIBILITIES: THE ROLE OF PARENTS' VOCATIONS AND EXPLANATIONS IN THE DEVELOPMENT OF CHILDREN'S POSSIBILITY THINKING

by

CHARLOTTE NOLAN REYES

How do children learn about *possibility*? About what is physically *impossible* versus what is merely *improbable* and could occur under the right imagined circumstances? Recent developmental research reveals that younger children are frequently *more* skeptical than older children about improbable, but not impossible, events. I provide further evidence that parents' explanations are a larger predictor than children's age for the variation found in children's judgments and justifications about the possibility of improbable events. Building on a prior study, the current study found variations in the frequencies of 62 parents' speculative, skeptical and requesting explanations during a picture book discussion with their 5-to-8-year-old child. These differences in parental talk were related to parents' artistic, scientific and other vocations. Parents with scientific vocations *requested* more explanations from their children than parents with artistic or other vocations. Additionally, both parents with scientific and parents with artistic vocations gave more speculative explanations than parents with other vocations. And interestingly, parents with other vocations gave more speculative explanations for impossible events than parents with scientific vocations. Importantly, parents' tendencies to be speculative, skeptical, or requesting were related to children's thinking about possibility; specifically to children's

tendencies to judge improbable events possible and also to their tendencies to make mechanistic justifications for their possibility judgments. The discussion focuses on why some differences in explanations among vocations were found, but also why parents' talk and not their vocations is the important predictor for differences in children's possibility thinking. Future directions look to a deeper examination of the reciprocal nature of parent-child conversations, the notion of habitual talk patterns as real individual differences related to everyday practice and identity, and the need for more research on creative communication genres such as practicing possibilities, as they relate to children's (and adults') understanding of fantasy, reality, and the boundaries in between.

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I dedicate this dissertation to the memory of my mother, Kathryn Edward Mansour, and to the future of my daughter Kathryn Elva Reyes, who lay nursing in my arms six years ago when the first of these ideas were being put on paper. Kathryn, you were just a baby then and now you are exactly the same age as the average of the children in this study. Thank you Princess Cupcake…Miss Katydid of the Bamboo Trapeze! Thank you for all the fun and laughter we're having together…practicing possibilities… everyday.

Practicing Possibilities: The Role of Parents' Vocations and Explanations in the Development of Children's Possibility Thinking

"The problem is not in distinguishing between the actual and the possible but in discerning the boundaries of the possible"- Carl N. Johnson, 2000, p. 200

The idea that young children might at times be overly *skeptical* goes against most common sense and much academic understanding of children's thinking. Instead, in the white middle class mainstream of America young children are frequently considered to be rather credulous and fantasy-oriented, and children's entertainment is often aimed at capitalizing on this supposed tendency. And while some scientists have claimed that children are particularly credulous, even gullible to the most ridiculous of suggestions (Dawkins, 1993; Gilbert, 1991) more recent developmental research shows that children clearly doubt and distrust, wisely demonstrating a preference for believing information provided by adults with histories of reliability, honesty, and accuracy over adults who have been unreliable, dishonest, or inaccurate (Birch, Vauthier, & Bloom, 2008; Koenig & Harris, 2005; Lee & Cameron, 2000). Children do believe in the supernatural (e.g. superheroes, "real magic", the Tooth Fairy, Santa Claus) and yet this seems related to the extent to which home and school contexts encourage such beliefs (Harris & Koenig, 2006; Hickling & Wellman, 2001; Jaswal & Malone, 2008; Woolley, Boerger, and Markman, 2004; Woolley, Ma, & Lopez-Mobilia, 2011). Importantly, where children and adults draw boundaries between fantasy and reality, and how these boundaries develop is still largely unknown.

A large body of academic research in developmental psychology since the time of Piaget has shown that even very young children frequently reason about the causal relationships behind everyday physical, biological and psychological events using causal and domain relevant explanations (Frazier, Gelman, & Wellman, 2009; Hickling & Wellman, 2001; Inagaki & Hatano, 2006; Keil & Wilson, 2000; Woolley, Cornelius & Lacy, 2011). Moreover, young children easily distinguish between impossible and ordinary mechanisms (Chandler & Lalonde, 1994; Rosengren & Hickling, 2000). For example, Rosengren and Hickling (2000) showed 4-5 year old children objects (e.g., a piece of string, a coloring book) and asked about the possibility of hypothetical mechanisms for changing the state of that object (i.e., making the string into two pieces by cutting it vs. coloring in a coloring book by just flipping the pages). When the children claimed that the hypothetical mechanism could not cause the change the researchers asked the child if they had an idea for a way that it could happen. Both 4 and 6-year olds claimed that the ordinary changes were possible and the impossible changes were not. When asked how they could accomplish the impossible events none of the children supposed magic as a possible mechanism unless adults primed the idea of magic or magicians (Hickling & Wellman, 2001). Even then, many 6-9 year old children did not believe in "real magic" and instead described it as some kind of unknown mechanism or "trick".

It seems that very young children are not so credulous after all. In fact, at times they may be unnecessarily dubious, doubting the possibility of weird-but-still-possible events in ways that older children and adults do not. Taking an overly

skeptical stance toward unusual events may keep children from gaining practice in generating the hypotheses to better understand surprising phenomena. This could lead to making less accurate distinctions between events that really are impossible (i.e. violate known physical laws) and those that are merely difficult, unusual or unexpected (Cornelius & Lacy, 2011; Kwong, Jeong, and Park, 2006; Shtulman, 2009). Although much research has focused on children's understanding of impossible vs. ordinary physical, biological and psychological events, there has been very little research on children's understanding of unusual or unexpected events that are merely improbable or unexpected (Mills, 2013; Nolan Reyes, Callanan, & Haigh, 2013; Shtulman, 2009 Shtulman and Carey, 2007).

In one important study, Shtulman and Carey (2007) examined children's reasoning about improbable events, which, though unusual or surprising, did not violate known physical laws (e.g., a lion for a pet, a mug-shaped building). Surprisingly, they found that children's tendency to judge improbable events to be possible increased linearly across the ages 4-8 years, and even 8 year olds judge only about 65% of improbable events to be possible. One likely reason for this, suggested Shtulman and Carey (2007), is that young children deny the possibility of unusual events not so much because they lack knowledge about the world, but because they *cannot imagine* the circumstances under which such events might occur.[1]

[1] One of Daniel Dennett's oft-used cautions: "Here I had committed the sin I had so often found in others: treating a failure of the imagination as an insight into necessity"(Dennett, 1985, p. 121).

The current study argues that parent-child conversations are an important setting for developing the ability to imagine just such unusual circumstances. Parents do not merely impart knowledge and facts to their children but also convey valued ways of considering various phenomena, scaffolding children's reasoning and verbalizations in the process (Callanan, Rigney, Nolan Reyes & Solis, 2012) Furthermore, there is evidence that parents' explanatory stance, either skeptical or speculative, is reflected in their children's reasoning about possibility. For example, Nolan Reyes et al. (2013) found that parents who more often suggested ways that an improbable event, such as having a lion for a pet, might actually happen (e.g. if the lion were young and tamed) had children who more often judged improbable events to be possible than parents who expressed more skepticism.

The current study aims to expand on these earlier findings with an expanded study of parents' explanations about impossible and improbable events and children's possibility thinking. In addition to replication the current study seeks a better understanding of the individual differences among parents who vary in their frequencies of speculative, skeptical, and requesting explanations. What, if any, individual differences are related to parents' tendencies to express these types of explanations and are these differences related to parents' personal identities or everyday cultural practices?

Integrating sociocultural, sociolinguistic and constructivist theoretical perspectives (e.g., Gelman, 2009; Rogoff, 1990, 1998, 2003; Vygotsky, 1978, 2004; Wells, 2007; Wertsch, 1991) alongside an individual differences emphasis I propose

parent *vocation* as a potentially meaningful cultural category from which to view variation in middle class parents' cognitive guidance. Parental work, and the degree to which they have identified with or invested themselves in that work could capture a meaningful everyday practice that shines light on cognition in speech and action. Moreover, due to the strong cultural roles associated with artists and scientists in terms of their knowledge and use of imagination, these vocations are a good place to begin studying the individual differences in explanation use that might be considered as potential communication genres.

To better provide background and justification for the current study I will first describe theory and research in children's possibility thinking as it is related to modal language, causal explanation, creativity, and abductive reasoning. Next I will describe some research on parent-child conversations from the developmental psychology literature, focusing on parents' explanations as an important mechanism for children's sociocognitive development. Finally I will explore parents' vocations as both everyday practices and meaningful identities, focusing on the small amount of research that suggests how participation in certain fields such as science and art may be correlated with certain thinking and speaking styles.

Children's Possibility Thinking

"In short, possibility in cognition means essentially invention and creation…"
-Jean Piaget, 1987, p. 4

The concept of *possibility* in cognitive development describes children's creative and inventive thinking generally (Cremin, Burnard, & Craft, 2006; Piaget, 1987) and children's modal reasoning (i.e., understanding of possibility and necessity,

fantasy and reality) specifically (Piaget, 1987; Shtulman & Carey, 2007; Shtulman, 2009). In the current study I borrow the term *possibility thinking* (Cremin et al., 2006) to highlight both children's understanding of the necessary and sufficient conditions that might allow an improbable event to actually happen, while also emphasizing the *creativity* necessary to making such inferences.

As a form of speculative *and* evaluative thinking, possibility thinking seems to sit at the crossroads of creative and scientific thinking and resembles both abductive reasoning of a highly imaginative kind, and explanation itself. Similar to both analogy and metaphor, abduction has been described as "inference to the best explanation" (Lombrozo, 2012; Peirce, 1955). It is the mental process of generating hypotheses in which an explanation or mechanism that is successful in one situation is borrowed and applied as a tentative or partial explanation in a new situation (Ahn & Kalish, 2000; Kwong et al. 2006; Lombrozo, 2012; Walton, 2004).

Traditionally, two types of logic or reasoning, induction and deduction, have been recognized and seen as important to science. Yet, another type of reasoning called retroduction or abduction (Kwong et al. 2006; Peirce, 1955; Walton, 2004) is argued to be a distinct form of reasoning that goes beyond the potentials of induction and deduction to actually create new symbols and possibilities of singular events in everyday life and which, through limited data are also common in science (Ahn & Kalish, 2000; Walton, 2004).

In the same way that abductive reasoning allows more than a new understanding of a problem or situation, possibility thinking attempts to understand a

unusual event (e.g., a person with a lion for a pet) utilizing prior experiences, beliefs, and causal mechanisms (e.g., what one knows or has experienced regarding lions, pets, wild animals, etc) hypothetically put together in new imagined circumstances. Importantly, these hypotheses must be reasonable or plausible (if the person had a big yard, got the lion when it was tiny, declawed it, and fed it lots of meat) and are selected on the basis of such judgments. Interestingly, possibility thinking, like abductive reasoning, may also be consistent with current widely accepted definitions of creativity as the generation of ideas (or things) that are both novel *and* appropriate (Amabile, 1996).

Much research in developmental psychology focuses on children's conceptual knowledge and reasoning, and not on creativity per se. However many researchers in cognitive development would suggest that creativity may be *necessary* to cognitive development (Gelman & Gottfried, 2006). For example, the classic Piagetian concepts of assimilation and accommodation require the constant updating of old ideas into expanded new ideas. Moreover, young children frequently struggle to provide naturalistic explanations for phenomena, at times being more reluctant to resort to supernatural explanations than adults (Woolley, Cornelius & Lacy, 2011)

Describing abductive inference in children's science learning, Kwong et al. (2006) described two main factors that influence hypothesis generation or abductive thinking *in children.* First, children need to have and be aware of their prior beliefs. Second, they must also be able to *make use of* those prior beliefs. For example, why do 4-7 year old children so often say that improbable events are impossible? Do they

just simply not have enough domain-relevant knowledge of causal constraints? Children likely have much of the life experience and knowledge they need to judge improbable events to be possible (Shtulman & Carey, 2007; Nolan Reyes et al. 2013). More likely, what children need guidance to accomplish is how the mechanisms hidden in their causal experiences reflect principled reasons that can apply in new ways. This is similar to Kwong et al.'s (2006) description of children's need to not only know, but also make use of and extend prior experience and beliefs in the development of successful abductive reasoning. Modal language is *context-dependent* (Johnson-Laird, 1978; Shtulman & Carey, 2007) and can be interpreted in multiple ways (e.g., may, might, could). When parents provide detailed explanations for why an event *could* o*r could not* occur they are also, simultaneously providing a frame that contextualizes modal uncertainty (as a search for reasons how or reasons why not). The explanatory snippets parents provide can then be "exported" to future ambiguous situations (Lombrozo, 2012). Said differently, it is not merely the *having* of prior beliefs and experiences that may influence future reasoning but instead abductively highlighting how to *use* prior experience and beliefs (one*s* own or another's) in combinatory ways to imagine or understand future situations (Kwong et al. 2006; Lombrozo, 2012; Walton, 2004)

Thus, rather than insisting that magical or logical modes of thinking are dominant in children, it is clear that children construct a semi-permeable boundary between the world of the actual and the world of the possible (Harris, 2000). Furthermore, evidence suggests that adults' explanations play a crucial role in the

facilitation of children's magical beliefs and in their inclination to speculate about improbable events. Therefore, we need to look more closely at the family and community discourse practices in which adults might guide children's imaginations and ontological understanding. In a recent chapter focusing on new directions in socialization research, Jacqueline Goodnow (2005) writes that, "In effect, both within and outside the family we can begin to give more attention to how a sense of the natural, the outrageous, and the impossible is developed" (p. 87). The next section explores the important role of adults in the development of children's possibility thinking.

Parents' Scaffolding of Children's Possibility Thinking: Practicing Possibilities

"She was not just informing me. She was, rather, negotiating the world of wonder and possibility." –Jerome Bruner, 1986, p. 126

Children are not passive receivers of the world, nor are they individual explorers of a deserted island. Instead they are members of families and communities and involved everyday in family conversations and events. Recent studies have investigated everyday parent-child conversations as an important source of children's learning through collaborative theory building (Blum-Kulka, 2002; Callanan & Jipson, 2001). During these collaborative conversations, Ochs, Rudolph, Taylor and Smith (1992) argue that children are learning values around *how to talk* more than they are learning any specific knowledge or lessons family theory building (although they may be learning these too!).

I argue that parent-child conversations are an important context whereby children may gain practice not only *retrieving* prior events and experiences, but also engaging with varying forms of practice and support from parents and other adult community members in the process of combining and making *use* of prior knowledge, beliefs and experiences as an important aspect of the development of abductive reasoning described by Kwong et al. (2006). For example, in a prior study (Nolan Reyes et al., 2013) some parents, while considering whether one can have a lion for a pet, focused their explanations on how such an event *could* be possible ("I guess she could if the lion were tame, like in the circus remember? You might be able to tame a wild lion if you are kind to it …and especially if you get it when it is very young"). Other parents' explanations were more dubious and focused on the fact that such an event is not possible or at least very unlikely ("Well a lion is usually *not* a pet, because they scratch and bite and hurt people!"). Both may be forms of abductive reasoning yet with a different focus, speculative vs. skeptical, and these might be epistemological stances that parents communicate to children.

Parents' social and cognitive orientations, such as pessimism and optimism, skepticism and credulity, future vs. past orientation and preferences for a concrete vs. an abstract focus of experience can be expressed to children through individual differences in word use and through habitual expressions (Pennebaker & King, 1999) These habitual expressions may reflect larger cultural values the parent has unconsciously adopted such as values placed on direct observation, experience, book learning, or appealing to experts or other authoritative sources (see Rogoff, 1998;

Wertsch, 1991). At the same time verbal expression may reflect individual attitudes and values consciously chosen and explicitly taught. For example, expecting a child to say "please" and "thank you" or to display clear attention and polite backchanneling to a dinner guest's story-telling are communicative values that many parents teach either implicitly through expectation or explicitly through direct exhortation. Parents also vary culturally and across contexts in the value they place on direct speech such as explanation or on more indirect forms of speech such as teasing or sarcasm to socialize children (Silva, 2011). And there can be communicative genres that are more specifically cognitive in nature. For example, parents vary in the degree to which they scaffold children's analogical reasoning and guide their attention to important causal features of museum exhibits (Valle & Callanan, 2006).

Frequently described as speech or communication genres, detailed ethnographic work reveals cultural and family differences in propensities for verbal speculation, humor and storytelling (Bakhtin, 1986; Mar'i & Karayanni, 1983; Ochs, 1990) Adults and children in many cultures engage in verbal speculation as a form of idea-generation and there is considerable variation in what people are willing to speculate about (Ochs, 1990). For example, verbal speculation about what other people are thinking and feeling is common in Western societies and exists as a "major pedagogical procedure" (Ochs, 1990, p. 299) in games with children such as "Twenty Questions" and "I Spy" which require children to verbally hypothesize what another person is thinking. In contrast, traditional Samoan communities discourage verbal speculation about the contents of others people's minds (Ochs, 1990) but do engage

in possibility thinking around the accuracy of reported events (e.g., witnessed gossip) and often "pose several possible accounts" for these events (p. 299). One way that verbal speculation is often indexed, Ochs states, is through linguistic forms indicating uncertainty, such as a rising intonation.

In a related claim Harris and Koenig (2006) propose that when parents discuss something with certainty (using a "matter-of-fact" tone) in their voice, such as the existence of germs, versus using a tone of uncertainty about something such as the existence of angels or Santa Claus, this may lead children to construct a boundary between things that can be empirically verified (those said with certainty) and those that cannot. But as Callanan (2006) points out, this is somewhat counterintuitive because children may also attempt to uncover proof for uncertain entities like Santa Claus by staying up all night to catch a glimpse of him!

In contrast to Harris and Koenig's (2006) view, it may be that the speech act of certainty fails to encourage speculation because it indicates what is culturally or personally "off the table," while uncertain tones may be more apt to invite a collaborative exploration of ideas. This is the idea at the heart of Feldman's study (cited in Bruner, 1986, p. 126) which revealed that teachers used more *modal* markers of uncertainty (e.g., might, could, etc) in discussions with other teachers than they did with their students, effectively presenting a far more factual world to students that is less open to speculation. As John Searle puts it (cited in Bruner, 1986, p. 127): "And if the teacher wishes to close down the process of wondering by flat declaration of fixed factuality, he or she can do so. The teacher can also open wide a topic of

locution to speculation and negotiation." Thus, it seems likely that studying linguistic forms of modal certainty and uncertainty might be importantly related to possibility thinking.

In another example that highlights the importance of cultural values in verbal speculation, Mar'i and Karyanni (1983) revealed Arab adolescents' strong possibility thinking (i.e., they gave many novel, speculative, and plausible responses) for the question, "What would happen if mules and other animals which help us plow the farm cease to exist?" However, when the same students were asked a religious question, "What would happen if worship places ceased to exist?" most either refused to answer the question or gave very minimal responses. Some topics, then, are likely to be seen as less appropriate for speculation. It is possible that these students would be willing to speculate about the scenario of no worship places within a more intimate family discussion about religion. Research suggests that some level of trust and intimacy, such as between friends and family, may be important for cognitive collaborations (Azmitia & Montgomery, 1993; Ochs, Taylor, Rudolph & Smith, 1992; Tizard, Hughes, Carmichael, & Pinkerton, 1983). The question of what seems to be a meaningful topic of exploration is also likely to vary. In many cases children may participate in more complex conversations at home than they do at school, not merely due to time, familiarity and increased comfort between parent and child but also because of a parent's greater intimate awareness and understanding of children's deeper interests and meaningful concerns (Tizard et al., 1983).

Conveying to a child that speculation is valued, that ideas can be verbally explored, changed and updated, and that they are invited to challenge or improve hypothetical scenarios may represent a distinct communication genre I have termed *practicing possibilities*. Children hear parents' habitual ways of talking about events, patterns of speculation and skepticism, and may learn to construct their own hypothetical explanations through their participation in conversations with a parent (Frazier et al., 2009). Parents' individual beliefs about fantasy and reality, the actual and the possible, and the values they place on skepticism and speculation may be related to the ways they collaborate with children and the verbal reasoning they model for their children in the here and now (Goodnow, 2005; Harrington, Block and Block, 1987, Woolley, Ma, & Lopez-Mobilia, 2011). These collaborative communication values may also be related to children's current and future reasoning, speech, and tolerance for ambiguity.

In one extensive longitudinal study with an ethnically diverse group of primarily middle-class families, Harrington et al., (1987) found moderate to large correlations between parents' verbal expression and children's creative behavior in later years. Their study showed that young children whose parents collaborated with them in a spirit of fun, both revealing their own ideas and encouraging the child's individual expression, were rated later that year and years later by their teachers as unusual thinkers with unique problem solving skills.

More research is needed into children's participation in everyday conversation and activities with their parents that may relate specifically to creative and flexible

reasoning. During everyday family activities such as book reading, dinner and car conversations, and visits to cultural events and institutions children ask questions and offer their own theories while parents provide explanations and reveal their own orientation to problems and phenomena in explicit and implicit ways (Callanan & Oakes, 1992; Frazier et al., 2009). Prior research has found parents' speculative explanations are an important predictor of children's judgments that improbable events are possible (Nolan Reyes et al. 2013). Whether parents' tendencies to engage in speculative and skeptical explanations are a reliable individual difference and how these differences may be related to their personal identities and meaningful everyday practices such as work an important hobbies is the focus of the next section.

Parents with Art and Science Vocations

The three areas of human culture—science, art, and life gain unity only in the individual person, who integrates them into his own unity…Art and life are not one, but become united through the unity and answerability of each to each, of inter-responsibility.
-Bakhtin, 1919 pp. 1-2

The study of daily work and how it relates to family life is an important way to study social cognition and the interweaving of cognitive, emotional and social life in human development (Goodnow, 2005; Rogoff, 1990). Moreover, considering parent occupation and vocation as an individual difference may be a particularly fruitful way to examine variation in many children's daily experiences outside of school, including how these experiences are related to children's thinking. Parents' everyday work, as a practice that is rooted in habitual and/or highly valued ways of approaching the world, reciprocally determined over time, may both reflect and shape

their personalities, including thinking and problem-solving orientations (Bakhtin, 1919; Holland, 1999). These differences in parents' cognitive attitudes are likely to be evident during parent-child conversations (Luce, Callanan, & Smilovic, 2013; Nolan Reyes et al., 2013; Valle, 2006). Beginning an investigation of parents' vocations focusing on scientists and artists seems particularly appropriate for a study of speculation, skepticism and requesting explanations about possibility for several reasons. First, speculation and skepticism have been associated with the practices of art and science learning respectively. One study found that experience in the performing arts increased students' abilities to generate new and novel ideas compared with students without this experience (cited in NTFAE, 2009). And strategic plans for arts education research and reform include calls for more longitudinal effects of the social, emotional, and cognitive factors related to aesthetic education, highlighting the important role of adults in such education (Greene, 2001; NTFAE, 2009). The arts, said Greene (2001, p. 116) promotes "thinking of things as if they could be otherwise." And professional adults and relatives of children have a valuable role to play in children's education through modeling of distinct attitudes, values and habits of mind (NTFAE, 2009).

Are scientists and artists systematically very similar or very different in the attitudes they express to children about unusual phenomena, or in the types of explanations they give? Stereotypes about artists and scientists are still quite prominent. Many people still consider scientists to be hard linear thinkers driven to "find facts" while all artists are "fuzzy thinkers" among whom one would be hard-

pressed to find a "skeptic" (Milbraith, 1998). But are these two forms of thinking necessarily distinct, or might they overlap and appear in the everyday speech patterns of both artists and scientists? Parents and other adults with more engineering and science training have been found to model more consistent logic and formal evaluation of evidence with children than non-scientist parents (Hogan & Maglienti, 2001; Valle, 2006). At the same time, parents who are artists may encourage their children to view the world from a number of different perspectives (Kogan & Kangas, 2006; Milbraith, 1998). Thus, parents who are artists and parents who are scientists may both be encouraging and modeling cognitive skills relevant to the task of positing imaginary-yet-plausible scenarios for improbable events, albeit somewhat differently.

Consideration of parents' vocation is consistent with the sociocultural view that variation is not related to ethnicity as mere category, but more importantly to the culturally meaningful practices related to those ethnicities (Rogoff, 2003). I argue that one potentially meaningful practice in the everyday lives of many American middle-class parents is their job or career. To the extent that this job has been practiced for a considerable time and/or involves work that is part of the parents' self-identified talents and preferences it is likely to be personally meaningful and a significant part of the parent's identity (Holland, 1999). Everyday practices that parents strongly identify with may be related to individual differences in speech. Searching for links between parents' everyday work and identity and the speech they use with their children is an important goal of the current study. Do parents with artistic vocations

differ from parents with scientific vocations or from parents with other vocations in their frequencies of speculative, skeptical and requesting explanations to children about ambiguous events? Furthermore, this study also examines whether differences in parent explanations are related to children's own possibility judgments and justification patterns about similar events.

Current Study Design and Predictions

A study of how parents with artistic, scientific and other vocations differ from one another in their causal explanations to children about surprising phenomena may provide important evidence about how, if at all, parents' vocations inform the everyday conversations and activities they participate in with their children. This study also seeks to shed light on how children's participation in everyday family conversations is systematically related to their cognitive development.

The first research question of this dissertation study asks whether and how the work, hobbies, and activities parents engage in most frequently and identify with most strongly (referred to from here on as vocations) are related to the frequency and type of explanations they give to their children about unusual events. Specifically, I ask whether artistic parents are more likely to take a speculative orientation with their children (i.e., emphasize *possibility)* and whether scientific parents are more likely to take a skeptical orientation (i.e., emphasize *impossibility or extreme doubt*)? I also ask how parents of different vocations differ in the ways they question children about unusual events (i.e., *request* explanations).

The second research question of this dissertation study asks how, if at all, parents' vocations and explanation styles might be related to children's own judgments and causal justifications about possibility? Furthermore, are parents' vocations sytematically related to their explanations and possibly serve as a mediating predictor for variation in children's possibility thinking? In addition, the current study attempts to replicate the earlier research finding that parents who give more speculative explanations have children who judge more improbable events to be possible (Nolan Reyes et al. 2013).

Method

Participants

Sixty-two parents (55 mothers and 7 fathers) of various occupations and their 5-to-8 year children (M = 6.4 years) participated in this study. Participants were predominantly European-American and middle-class, yet ranges of ethnicities were represented. Forty-seven parents (76%) were of European-American heritage, 12 parents described themselves as Mexican, Latino, or Hispanic ethnic heritage, and 3 parents stated another non-white heritage: one Chinese, one Indian, and one African-American parent. All of the parent-child pairs were living in California at the time the study was conducted, 56 from Santa Cruz, CA and 6 from the nearby cities of San Jose and Oakland, CA.

Recruiting artists and scientists. To recruit parents with arts and science occupations, recruitment fliers were placed in strategic locations with this goal in mind (e.g., school science departments and science fairs, local arts events for children

and adults, a free local family life/parenting publication, and a low-moderate income community live-work complex for full time artists and their families located in Santa Cruz). However, nothing on the fliers indicated our interest in artists and scientists as participants.

Parents' vocations. Parents' vocations were determined by first pre-sorting their primary occupations into artistic (e.g., musician, singer/voice teacher, interior design, peace chorale accompaniment, pottery, landscape architect), scientific (e.g., research biologist, computer/electrical engineer, toxicologist, environmental/water analyst) or other (clerical, business owner, commercial driver, special education teacher).

Next, using a Holland Vocational Inventory (See Appendix A) which parents filled out at the end of the session, it was determined whether or not there was a match between their primary occupation or a significant hobby and a code represented in their top two Holland codes, either an A (Artistic) or I (Investigative (scientific)).[2] If a match existed between actual occupation (or hobby) and Holland code, the parent was placed in the respective category as their vocation. If no match existed they were placed in the Other vocation category.

Interestingly, in only one instance did a parent have an artistic or scientific job (or significant hobby) and not also have an A or an I in their top two codes. There

[2] The inventory used in the current study was adapted from the Self Directed Search (SDS) based on Holland's theory of vocations. Holland's theory is the basis for many career inventories used today and suggests that most people can be loosely categorized into two or three out of six vocational types—Realistic, Investigative, Artistic, Social, Enterprising, and Conventional. Work occupations and work environments also can be classified by combinations of these categories. People who choose careers that match their own strongest propensities are often found to be happy and successful (Holland, 1966; 1973; 1999)

were 4 cases of participants having both an A and an I in their top two codes and an artistic/scientific split (i.e., a scientist with an artistic hobby). In these cases the parent was placed in the category with the highest Holland percentage. This was not an ideal solution but four people were not seen as enough for a mixed/both category.

The primary occupation was determined by choosing the job/occupation engaged in for the longest period of time for the most hours per week. If, however the parent had an *other* occupation but listed a scientific or artistic "significant hobby" (e.g., knitting for sale in local shops) or if the primary occupation and hobby were less easily determined (e.g., occupation-laborer, significant hobby of model building/painting) *and* the participant had an A or and I in the top two letter-codes, then the default was to place them in the A or I category using the Holland code as the basis. The sorting process was conducted with the full data set independently by the primary investigator and a trained research assistant, resulting in 58/62 (94%) simple agreement, Cohen's Kappa = .90. Disagreements were finalized by the primary investigator, resulting in a data set of 18 parents with Artistic vocations, 18 parents with Scientific vocations, and 26 parents with Other vocations.

Materials

Picture Books. The 16 unusual events (8 improbable and 8 impossible) were distributed equally and randomly across two book versions; the events for each book version are listed in Table 1. Children who saw events from set A in the parent-child book task saw set B events in the child judgment task, and vice versa. Parent-child books contained 8 unusual-event images (4 impossible and 4 improbable). Child

books contained 8 unusual-event images (4 impossible and 4 improbable), as well as 4 ordinary events (wearing a baseball hat, cleaning out a closet, washing a car, and meeting a clown), which were randomly distributed to assess any possible response, bias from the child. The images used were the same 16 unique llustrations used in Nolan Reyes et al. (2013).[3] Figure 1 and 2 depicts four sample illustrations, two from each book version. All of the books had a three-page pattern for each event. For example, page one of the parent-child book A reads, "The person in the next picture is eating pickle-flavored ice cream." Page two depicts the event and page three reads, "Could a person eat pickle-flavored ice cream in real life?"

Figure 1. Illustrations of an improbable event (having a lion for a pet) and an impossible event (opening a window with his mind).

[3] Rex Wesley Reyes, artist and designer created the illustrations for this study using modified photographs not available in the public domain. Used by permission.

Figure 2. Illustrations of an improbable event (a mug shaped building) and an impossible event (walking on water).

Table 1

Order of Unusual Event Images by Book Versions (A or B) and Study Task

Books	Parent-Child Picture Book	Child Judgments & Justifications
A	A1	A2
	eat pickle-flavored ice cream	open a window with his mind
	have a money tree	make a car vanish
	jump through a brick wall	drink onion juice
	have a lion for a pet	find an alligator under bed
	have a mug-shaped building	get struck by lightning
	have a polka-dot airplane	have a beard down to his toes
	go back in time	walk on water
	eat lightning for dinner	turn applesauce back into an apple

B	B1	B2
	open a window with his mind	eat pickle-flavored ice cream
	make a car vanish	have a money tree
	drink onion juice	jump through a wall
	find an alligator under bed	have a lion for a pet
	get struck by lightning	have a mug-shaped building
	have a beard down to his toes	have a polka-dot airplane
	walk on water	go back in time
	turn applesauce back into an apple	eat lightning for dinner

Note. Each child judgment and justification task book also included 4 ordinary event images (wash a car, clean a closet, wear a baseball hat, meet a clown) that were randomly interspersed throughout the book.

Questionnaires. Parents answered questions regarding their own number of years of formal schooling and any higher education or degrees earned, their current and past occupations and the length of times of these occupations, as well as any significant hobbies they have engaged in for at least 10 hours per week for 5 years or more. Parents also described family and child ethnicity, favorite family activities and favorite individual activities of the child. They also filled out a Holland Interest Inventory (see Appendix A) based on Holland's theory of interests, vocations and personalities (Holland, 1999) and two Big-5 inventories (John, Neumann, & Soto, 2008). These Big-5 inventories will not be analyzed in the current study and were included for exploratory and future research purposes.

Child creativity measures. The *Torrance Tests of Creative Thinking-Verbal* for children (Torrance, Ball and Safter, 1992) consists in part of two parallel forms A and B with 5 individual child activities to be administered either verbally or in writing to children by a researcher. For the current study only 3 of the 5 activities were administered to the children: Activity 4 'Product improvement', Activity 5 'Unusual

Uses' and Activity 7 'Just Suppose'. The TTCT-Verbal activities are scored on three subscales: Fluency, Flexibility, and Originality. Children's frequency of yes judgments for improbable were correlated with their TTCT Flexibility scores, a measure that was included for the purposes of future research and will not be analyzed or interpreted more in the current study.[4]

Procedure

Parent-child pairs were invited to participate in a two-part study lasting approximately 45 minutes to take place either in their own homes or in a university family playroom/research lab. Five parents elected to participate in their homes and 57 came to the university playroom. The procedure was the same in both cases, yet additional care was taken when visiting family homes to follow the parents' leads in finding a comfortable and accommodating place to set up the camera in a place with two adjoining rooms.

The researcher began by engaging in warm-up talk with the pair and inviting the child to play with markers and paints while the parent filled out a consent form. Next the researcher explained that, "We've put together a book of fun photographs that we made with a computer, and it might turn into a real children's book one day. We'd really love to know what both of you think about them. Just read and talk together like you normally would at home. Take as long as you want, and let us know when you're finished with a small knock on the door and then can go on to the next

[4] Children's flexible thinking scores on the TTCT were significantly correlated with their frequency of yes judgments for improbable events, , $r(48) = .37$, $p < .05$. This interesting finding will be further explored in future research.

part. Is that ok with you? (first to the child for some kind of verbal or non-verbal agreement, and then to the parent) Great, ok, have fun!"

The researcher then asked the parent and child to sit together across from a video camera on a tripod in full view and left the room. When the parent-child pairs had finished with the picture book (M = 22 minutes) the researcher returned, asked if they had enjoyed the book and what they thought, and then turned to the child and said, "Now I'm going to show you a few toys and ordinary objects and play a few little games with each one. I'll also show another book of pictures kind of like the one you just looked at with your [mom or dad] , and ask you a couple of questions about each picture. There are no right or wrong answers, …you just tell me what you think. Does that sound ok with you?" The researcher waited for the child's agreement to be clearly indicated, and then explained to the parents that she or he would fill out the questionnaires sitting in a nearby chair.

The researcher then began the second part of the study with the child, administering either the TTCT or the Child Judgment and Justification task, in counterbalanced order. First, to both engage and relax the child, the researcher engaged in a Torrance TCAM warm-up activity (Torrance, 1995) in which children were asked to stretch, imitate some animals etc, and demonstrate different ways to throw a paper cup into a waste-paper basket. All of the children enjoyed these fun physical activities, laughing and visibly relaxing, which was the intended effect.

When administering the Child Judgment and Justification task, the researcher phrased the interview questions as was done in prior research (Nolan Reyes et al.,

2013; Shtulman, 2009; Shtulman & Carey, 2007) proceeding through the picture book saying to the child, for example, "This picture shows a person opening a window with his mind. Could a person open a window with their mind in real life?" The child answered yes, no, or I don't know. The researcher then asked, "How could a person open a window with his mind?", "Why couldn't a person open a window with his mind?" or "Can you tell me about that?" respectively.

Both parts of the study, the Parent-Child Discussion and the Individual Child activities were videotaped. The parent filled out questionnaires outside the scope of the camera nearby while the individual child activities were being administered. Transcriptions of these video sessions were thorough for both parent and child and included both verbal and non-verbal aspects of the conversations, including the number, order and duration of each partner's conversational turns. However for the current study only verbal utterances *of the parents* were coded and analyzed.

Coding

Coding parents' explanations. The coding scheme developed for the current study was adapted from the scheme used in Nolan Reyes and Callanan (2013) to capture the most common and salient explanations parents gave to children about the real life possibility of each of the 8 unusual (4 Improbable and 4 Impossible) events. First, all parent talk that specifically addressed the real-life possibility of the illustrated unusual events (whether, why or how these events could or could not happen often using the words because, how or so) was marked as an explanation.

Counted explanations were utterances that either ended in a verbally punctuated full stop or continued over across a maximum of two turns (the child interjected or contributed a statement or question but the parent continued his or her explanation in the next turn). If the explanation continued past two parent turns it was counted as additional explanation. Words tangentially related to the explanation (e.g., talking about having seen something similar, recalling an associated memory) were not counted as possibility explanations unless they specifically addressed the question of real-life possibility or requested an explanation regarding real-life possibility. These explanations were then coded as Skeptical, Speculative or Requesting (see Table 2) by the primary investigator and an undergraduate research assistant blind to the study hypotheses. The codes were mutually exclusive categories. Inter-rater reliability achieved 90% simple agreement, with a Cohen's kappa = .88. This is considered to be an excellent level of agreement (Landis & Koch, 1977).

Table 2

Categories of Parents' Event Possibility Explanations

Category	Definition	Example
Speculative	Explanations focused on how the event would, could, or might occur in real life. Usually using the words if, could, maybe, might, or because.	"If they got a lion when it was a little baby and tamed it, it could be a pet!" "Maybe you could [*walk on water*] if you run fast enough!"
Skeptical	Explanations focused on how the event would not (or probably would not) could not,	"Well a lion isn't usually a pet because they

	or should not occur in real life. Usually using the words not, couldn't, wouldn't, or because.	scratch and bite !" "No…I don't think…that wouldn't work [child suggested thinking very hard about the window] because objects need to be….touched by other objects in order to move.
Requesting	Asking the child to provide a causal explanation often using the phrases How could…or why couldn't ….[also "Why not?", "Why?", and "How?" [as a clearly specific response to either the book prompt or a child's possibility claim]	"How could that happen?" "Why wouldn't that happen?" "Why not?", "Why?", and "How?"

Note. Includes examples of parents' explanations during the parent-child picture book discussion.

Coding child judgments. Children's judgments of possibility were identified as yes, no, or I don't know, with the relevant non-verbal gestures included (i.e. nodding head yes, shaking head no, and shrugging). Two coders independently coded 30% of these judgments independently, discussing and resolving any discrepancies, with over 99% simple agreement, and Cohen's kappa = .98.

Coding child justifications. Children's first responses to the researcher for why an event could or could not happen were taken without further prompting. A randomly selected 30% of the participants' full set of justifications (for both their yes and no judgments of improbable events) were coded independently by the principal investigator and a trained research assistant blind to both the age of the children and the study hypotheses. Differences were resolved by discussion and the remaining 70% of the data were divided equally and coded by the two coders. Inter-rater reliability was 92% simple agreement, and Cohen's kappa = .90. Justifications were coded into one of three categories below and can be seen in Table 3.

Table 3

Categories of Children's Justifications

Category	Definition	Example
Causal Mechanistic Full	Mention a process of 2 or more antecedent conditions or steps that need to occur causing something to happen.	"They could chop up the pickles real small and mix them into plain vanilla ice cream." [How could a person have pickle-flavored ice-cream?]

Causal Mechanistic Partial	Mentions a single antecedent condition that needs to occur to make something happen.	"When they're outside in a big storm." [How could a person could get hit by lighting?]
Causal Consequence	Describe what would happen as a consequence of the proposed the event	"You would just sink!" [Why couldn't a person walk on water?] "He would trip!" [Why couldn't a person have beard to their toes?]
Non-Causal Relevant	Claims about certain conditions that either precludes consideration of how the event could occur or make the event seem obvious, or mention magic.	"Onions don't have juice." "Lions are wild animals." "If you were a magician."
Redundant	Justifications that just restate the question or do not provide an explanation of how the event could or could not occur	"I don't know." "That's just a joke." "You can't walk on water." "It can't happen."

Note. Includes examples of children's justifications during the judgment and justification task.

Causal Mechanistic. Mechanistic justifications were either full or partial mechanisms. Full mechanisms were procedure-like causal justifications explaining a process of two or more steps by which something could happen. Partial mechanisms

were somewhat incomplete mechanisms that only mentioned an event or condition that occurred prior to or as a partial cause or explanation but without chaining together two or more steps.

Consequence. Consequence justifications were explanations that described an event or state that would or would not occur as a causal consequence of the asked-about phenomenon. They don't explain why they could or couldn't happen, but instead what would happen if they did.

Non-causal relevant. Claims were sometimes made about certain conditions or given states of the world that would preclude consideration of how the event in question could or could not occur. Other claims made the event seem obvious and not in need of explanation. This category also included references to magic or fantasy that violates physical laws.

Redundant. Justifications that just restated the question, didn't answer the question, or did not provide explanations of how the event could or could not occur were coded as Redundant.

Results

The first research question asked how parents of different vocations discussed the possibility of two types of extraordinary events with their children during a picture book discussion session. To fully answer this I first analyzed all 62 parents' causal explanations by explanation type, event type, and parent vocation. To answer the second research question, regarding whether or not there are links between parents' explanations or vocations and children's possibility thinking (judgments

and/or justifications), correlations and regressions were used to determine the patterns and strengths of these relationships. In addition to the expected predictor of child age, parents' explanations and vocations were hypothesized to predict differences in children's possibility thinking.

Parents' Causal Explanations about Event Possibility

Parents' mean frequencies for each of the 3 coded causal explanation types were submitted to a 3 (Explanation Type: Speculative, Skeptical, and Requesting) x 2 (Event Type: Improbable or Impossible) x 3 (Vocation: Scientific, Artistic, and Other) mixed ANOVA with Explanation Type and Event Type as within-subjects factors and Parent Vocation as the between subjects factor[5].

This ANOVA revealed a main effect of Event Type $F(1, 59) = 25.23$ $p < .001$, $\eta_p^2 = .300$, where parents gave more causal explanations overall to discuss improbable events ($M = 5.774$) than to discuss impossible events ($M = 4.389$). This ANOVA also revealed a main effect of Explanation Type $F(1, 59) = 123.40$ $p < .0001$, $\eta_p^2 = .677$. As shown in Table 4, Bonferroni pairwise comparisons of parents' mean frequencies of explanation type collapsed by event type were all significantly different from each other, $p = .001$. Parents gave the most 'requesting' explanations followed by 'speculative' explanations and then 'skeptical' explanations. Parents' mean frequencies for each of the 3 Explanation types collapsed across event and separated by event type can be see in Table 4.

[5] There were no significant main effects or interactions of parents' explanations by book version (A or B), child gender or child age in initial ANOVAs so these variables were removed from subsequent analyses to increase power.

There was also a significant interaction between Event Type and Explanation Type, $F(2, 118) = 31.93$, $p = .000$, $\eta_p^2 = .351$. Bonferroni pairwise comparisons revealed that parents provided a higher frequency of coded explanations for improbable events than for impossible events for each of the explanation types except for skeptical explanations, where they provided more explanations for impossible events than for improbable events. These means can also be viewed in Table 4.

Table 4

Mean Number of Parents' Explanations by Type and Event (N = 62)

Explanation Type	Event Type	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Requesting	Improb	9.298	.460	8.377	10.218
	Imposs	7.957	.626	6.705	9.209
		8.62**	.467	7.693	9.562
Speculative	Improb	6.551	.364	5.826	7.276
	Imposs	2.681	.218	2.282	3.079
		4.62**	.213	4.189	5.043
Skeptical	Improb	1.474	.299	.876	2.073
	Imposs	2.528	.312	1.827	3.076
		2.00**	.252	1.496	2.507

Note: Denotes a significant difference between frequency of explanations for the two event types **$p < .01$.

Parents' Explanation Types by Vocation: Artistic, Scientific, and Other

The same ANOVA also explored whether parental explanation types differed according to their Vocation types and revealed a main effect of Vocation Type $F(2,$

59) = 3.376 p =.041, η_p^2 = .103. Post Hoc Bonferroni comparisons revealed that parents with Scientific vocations used more explanatory talk overall (M = 5.815) than did parents with Other vocations (M = 4.449); p =.035, but not significantly more than parents with Artistic vocations (M = 4.981). This ANOVA also revealed a marginally significant interaction between Explanation Type and parent Vocation $F(4, 118) = 1.996$ p = .10 Given this interaction, and the interaction between Event type and Explanation type, a further exploration of 6 individual One-Way ANOVAs (one for each combination of event type and explanation type) seemed warranted. These ANOVAs revealed 3 significant main effects of Vocation across the six distinct types of explanation. The first of these significant one-way ANOVAs revealed an effect of Vocation on the frequency of parents' Requesting explanations for Improbable events, $F(2,59) = 12.33$, p = .000, η_p^2 = .295. Post hoc Bonferroni pairwise comparisons revealed that parents with Scientific vocations requested significantly more explanations for Improbable events (M = 12.44) than did parents with Artistic vocations (M = 8.33) and parents with Other vocations (M = 7.12).

The second significant ANOVA revealed an effect of Vocation on the frequency of parents' Speculative explanations for Improbable events, $F(2,59)$ = 12.358, p = .000, η_p^2 = .295. Post hoc Bonferroni ($p < .001$) pairwise comparisons revealed that both parents with Scientific vocations (M = 7.72) and parents with Artistic vocations (M = 7.78) gave more speculative explanations for improbable events than did parents with Other vocations (M = 4.15).

The third significant ANOVA revealed an effect of Vocation on the frequency of parents' Speculative explanations for Impossible events, $F(2,59) = 7.719$, $p = .001$, $\eta_p^2 = .207$. Post hoc Bonferroni ($p < .05$) pairwise comparisons revealed that parents with Other vocations gave significantly more speculative explanations for impossible events ($M = 3.65$) than did parents with scientific vocations ($M = 1.83$), $p = .003$, but only marginally significantly more than parents with artistic vocations ($M = 2.56$), $p = .072$. There were no other significant differences by vocation for the three remaining types of explanation by event type. Significant means can be viewed in Figure 3.

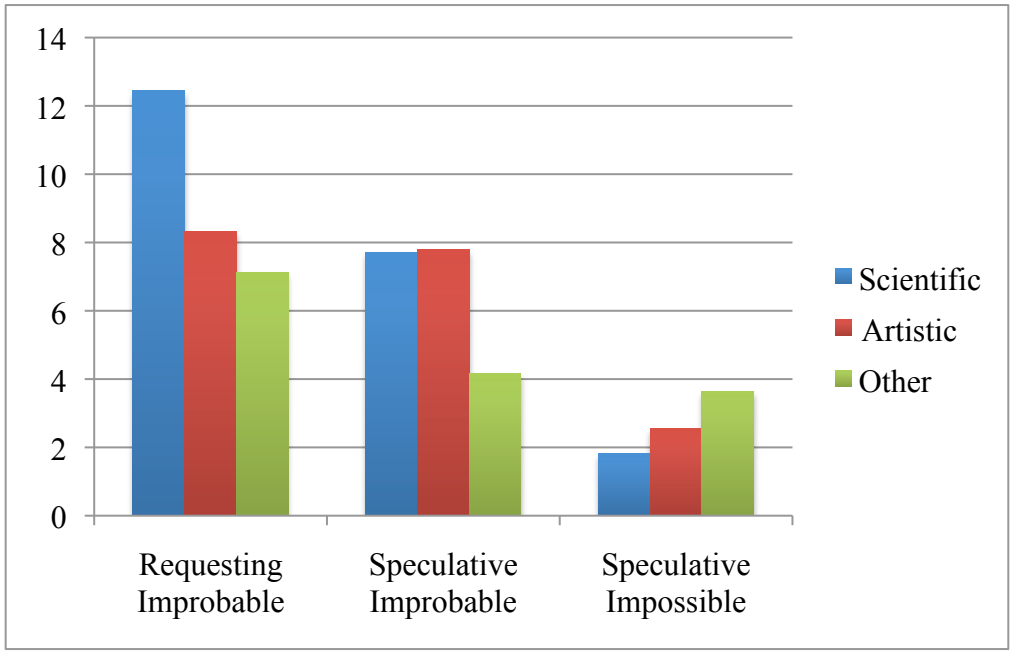

Figure 3. Significant Differences in Mean Explanation Types by Parent Vocation

Links between Parents' Vocations and Explanations and Children's Possibility Thinking

The second research question asks whether or not parents' explanation types better predict children's reasoning about possibility than does child age, replicating an

earlier finding (Nolan Reyes et al., 2013). In addition, this question goes beyond the prior research in also asking whether or not parent vocation might be a predictor for children's reasoning about possibility.

To address this question two hierarchical regressions were used. The first hierarchical regression analyzed parent explanation types and parent vocations as predictors for children's judgments about whether an improbable event is possible. The second hierarchical regression analyzed parent explanation and vocation as predictors of children's mechanistic justifications for their judgments of improbable events.

Due to our relatively small sample size ($N = 62$) and large number of hypothesized predictors we first examined intercorrelations among our 11 potential predictors with the dependent measures of child judgments (yes judgments for improbable events) and justifications (mechanistic justifications for judgments of improbable events). These intercorrelations can be viewed in Table 5.

A discussion of the significant variables chosen to enter as predictors into the two regression models will appear in the respective regression sections.

Table 5
Summary of Intercorrelations of Potential Predictors for Regressions

	REQU IMPRO	SPEC IMPR	SKEP IMPRO	REQU IMPOS	SPEC IMPOS	SKEP IMPOS	AGE MOS	YRS EDUC	MECH JUSTI	SCI VOC	ART VOC	JUDGE IMPRO
REQU IMPROB	1.0	.42**	.213	.4**	-.13	.078	-.31*	.161	-.2†	.53**	-.11	-.08
SPEC IMPROB	.42	1.00	.249	.06	-.17	.162	-.01	.292*	.23*	.29*	.30*	.330*
SKEP IMPRO	.213	.249	1.00	.03	.164	.37**	-.203	.093	-.2†	.195	-.01	-.26*
REQU IMPOS	.392	.063	.028	1.0	.124	.072	-.3*	.29*	-.2	.004	-.02	-.22*
SPE C	-.13	-.17	.164	.12	1.00	.225	-.070	.108	.09	-.4**	-.10	-.08
SKEP IMPO	.078	.162	.4**	.07	.225	1.00	-.175	-.013	.024	.058	-.15	-.03
CHIL D	-.301	-.10	-.20	-.3	-.07	-.18	1.00	.110	.163	-.03	.086	.37**
YRS EDU	.161	.29*	.093	.29*	.108	-.01	.110	1.00	-.03	.033	.26*	.04
ME CH	-.23	.11	-.19	-.23	-.05	-.03	.285*	-.231	1.0	-.13	-.04	.36**
SCI VOC	.53**	.29*	.195	.004	-.4**	.058	-.013	.033	-.16	1.0	.4**	.01
ART VOC	-.11	-.31*	.004	-.02	-.10	.153	.086	.257*	.003	-.41	1.00	.18†
JUDGE IMPRO	-.01	.3**	-.26*	-.2	-.1	-.03	.37**	.04	.5**	.02	.18	1.0

*Note. Justif abbreviates justifications, Improb abbreviates improbable events; Imposs abbreviates impossible events; *p < .05 (two-tailed), p**< .01(two-tailed) p†< .08 (marginal)*

Parents' explanations and vocations as predictors of children's judgments.

Examining intercorrelations in Table 5, as expected, age was significant and entered into the regression as the first block of the regression. Next, three types of explanation were significant and entered as a second block, parents' speculative and skeptical explanations for improbable events and parents' requesting explanations for impossible events. Finally, as a third block of predictors, Scientific and Artistic vocations were entered because of their importance to the research questions. These 6 variables were regressed on children's frequency of yes judgments for improbable events. The model as a whole was significant, $R^2 = .38$ $F(2, 55) = 12.36$, $p < .001$ and can be seen in Table 6 on the next page. Replicating and adding to results from Nolan Reyes et al. (2013), in addition to child age, two significant predictors emerged: (a) parents' speculative explanations for improbable events and (b) parents' skeptical explanations for improbable events. Frequency of parents' speculative explanations for improbable events was the strongest predictor, Beta = .446, $t = 4.108$, $p = .001$, $Sr^2 = .1858$, uniquely contributing 18.58% of the variance in children's judgments of improbable events variance above and beyond the smaller predictor of child age. Children of parents who more often explained how improbable events might actually occur judged a greater number of improbable events to be possible in real life.

Table 6.

Summary of Hierarchical Regression Analysis for Variables Predicting Children's Frequency of Yes Judgments for Improbable Events (N = 62)

Variable	Model 1			Model 2			Model 3		
	B	SE B	β	B	SE B	β	B	SE B	β
Child Age	.03	.01	.38**	.023	.009	.305**	.02	.009	.31**
Speculative Improb				.146	.036	.45**	.15	.043	.47**
Skeptical Improb				-.14	.051	-.3**	-.14	.052	-.3**
Requesting Imposs				-.03	.03	-.15	-.03	.025	-.150
Voc-Sci							-.14	.31	-.06
Voc-Art							-.03	.32	-.01
R^2	.134			.372			.375		
F for the change in R^2	9.322**			7.195**			.115		

Note: $*p < .05$ $**p < .01$ $p† < .08$ (marginal)

Frequency of parents' skeptical explanations for improbable events was the second strongest predictor, negatively related to children's judgments, Beta = -.307, $t = -2.78$ $p = .007$, $Sr^2 = .0942$, uniquely contributing 9.42% of the variance in children's judgments of improbable events. Children of parents who talked about why improbable events could *not* occur were likely to judge *fewer* improbable events to be possible in real life. The third (and smallest) predictor was child age in months, Beta = .305, $t = 2.72$ $p = .009$, $Sr^2 = .0841$, uniquely contributing 8.41% of the variance in children's judgments. Older children judged more improbable events to be possible than did younger children. Neither model 3 as a whole nor the two vocations were

significant predictors of children's possibility judgments when entered as a third block of potential predictors.

Parents' explanations and vocations as predictors of children's mechanistic justifications. A second hierarchical regression model examined whether and how parents' explanations predicted children's possibility thinking in terms of their explanatory abilities. Children's Causal Mechanistic justifications for their (both yes and no) judgments of improbable events were the dependent variable used. Again, first examining intercorrelations in Table 5, only one type of parent explanation was significantly correlated with children's Mechanistic justifications: parents' Speculative explanations for improbable events. However, Requesting explanations and Skeptical explanations were marginally significant and also included. Art and Science vocations were included in the model as a second block of predictors because of their importance to the primary research questions. These 5 variables were regressed on children's frequency of Mechanistic justifications. This model as a whole was significant for the first block of predictors only $R^2 = .203$, $F(3, 58) = 4.935$, $p = .004$ and can be viewed in Table 7.

Table 7

Summary of Hierarchical Regression for Variables Predicting Children's Mechanistic Justifications (N = 62)

	Model 1			Model 2		
Variable	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Requesting Improb	-.087	.342	-.324*	-.076	.038	-.29*

Speculative Improb	.143	.035	.421**	.192	.049	.567*
Skeptical Improb	-.109	.044	-.228†	-.107	.057	-.225†
Voc-Art				-.733	.349	-.301*
Voc-Sci				-.608	.380	-.250†
R^2		.203**			.267†	
F for change in R^2		4.935			4.077	

Note: *$p < .05$. **$p < .01$. † $p < .10$ (marginal)

Describing model 1, frequency of parents' speculative explanations for improbable events was the strongest predictor, positively related to children's causal mechanistic justifications, Beta = .421, $t = 3.207$ $p = .002$, $Sr^2 = .1414$, uniquely contributing 14.14% of the variance in children's causal mechanistic justifications. Children of parents who talked about how improbable events could occur were likely to justify their judgments of improbable events using mechanistic justifications.

The second strongest predictor was parents' requesting explanations for improbable events, in a negative relationship with children's overall causal mechanistic justifications, Beta = -.324, $t = -2.492$ $p = .016$, $Sr^2 = .0853$, uniquely contributing 8.53% of the variance. Surprisingly, children of parents who requested more explanations about improbable events gave fewer overall causal mechanistic justifications. The pattern for parents' explanations as predictors was similar in Model 3. Intriguingly, but counter to predictions, there was also a significant negative

correlation between parents' artistic vocations and children's causal mechanistic justifications. This correlation is difficult to explain and requires replication, but some possibilities are explored in the discussion.

Discussion

Summary of Results

The major results of this study revealed interesting differences in the frequencies of three causal explanation types for parents of three different vocations. Other interesting findings detected robust links between parents' explanation types and children's patterns of talk that were more predictive of differential possibility thinking than were differences in the children's ages. Importantly, several of these links replicated prior research, suggesting a phenomenon itself in need of explanation and for which some potential mechanisms can be suggested. However, before exploring theses links between parents' and children's talk in more detail, I first discuss the differences found in explanation types among the three vocations, suggesting some deeper interpretations of these results.

Parents with Different Vocations Explained Possibility Differently

Compared to parents with artistic or other vocations, parents with scientific vocations *requested* more explanations from their children about improbable events. It might be the case that parents with scientific vocations expect their children to readily answer questions and/or provide more of their own explanations than do parents with artistic or other vocations (Frazier et al. 2009; Luce et al., 2013; Valle, 2006). Specifically, scientific parents may be modeling the inquisitive and

explanatory stances toward unexpected phenomena that are often valued in scientific practice (Luce et al. 2013; Valle, 2006).

Second, both parents with scientific vocations *and* parents with artistic vocations gave more speculative explanations for improbable events than did parents with other vocations. However, differences across vocations in the amount of skeptical explanations given to children were not significant. These findings are particularly interesting as they both support and denounce popular and academic notions about scientists and artists. Supportive of stereotypes regarding the creativity of both artists and scientists, a preponderance of speculative explanations may suggest that both artistic parents and scientific parents are modeling an attitude of wonder and openness towards surprising phenomena. Parents may also help their children understand and appreciate the non-quotidian nature of such events by speculating about them and communicating that there is more than one than one way to understand them. The idea that understanding is individual and collaborative, necessarily open to shared, public evaluation is an important value in the arts and in science, and these values are supported by these findings (Amabile, 1996). Furthermore, despite stereotypes that scientists are skeptical, parents with scientific vocations were no more likely than parents with artistic or other vocations to give skeptical explanations for improbable events. In general, scientists may not express more staunchly skeptical explanations than people with other vocations, and at least with early elementary-aged children these parents did not seem to be engaging in mere doubting-for-doubting sake.

Surprisingly, parents with Other vocations gave more speculative explanations for *impossible events* than did parents with scientific vocations (and marginally more than parents with artistic vocations). This requires replication, but it is reasonable to suggest that parents with scientific vocations may be concerned with misleading their children (at least when they are young) about the immutability of physical laws. One reason for this may be that the body of domain knowledge regarding physical laws is emphasized in the everyday lives of many scientific parents, leading them to emphasize to their children that physical laws and principles exist and should be respected. One way to communicate respect for the importance of these laws is by not talking, even in play, about how they might be broken. However, the concern that playing with physical laws in story and fantasy could be detrimental to young children's scientific understanding might be unfounded. Recent evidence suggests that young children who watch magical and fantasy themed movies (e.g., Harry Potter) make more sophisticated distinctions between fantasy and reality than children who do not (Subbotsky and Slater, 2011).[6] More research is needed to explore this intriguing and somewhat counterintuitive finding.

Results from the current study provide some preliminary evidence that parents with artistic and scientific vocations, in particular, may value speculative and abductive type reasoning more than parents with other vocations, who may value speculative talk focused more on non-ordinary fantasy. More research is needed to

[6] Fantasy here was specified by Subbotsky & Slater (2011) as *non-ordinary fantasy* (violation of physical laws, dragons, talking animals etc) not *ordinary fantasy* (talking to an imaginary companion, dreaming that mom and dad buy a special toy)

determine the frequency and specific situations that evoke speculative explanation styles with parents who vary vocationally, culturally and individually. Research should also explore whether these differences in talk may be real individual differences related to personality factors such as Openness to Experience (Costa & McCrae, 1992; Pennebaker & King, 1999) and whether these differences are reciprocally developed across the lifespan through participation in communities that value speculative communication genres and expressive imagining (Holland, 1999; McCrae, 2009; Roberts & Robins, 2004).

Parents' Explanations Predicted Children's Possibility Thinking

Two types of parent explanations added to the variance in children's possibility judgments for improbable events, above and beyond age. Parents who focused more on speculative explanations for improbable events had children who judged more improbable events to be possible, replicating Nolan Reyes et al (2013). This finding suggests that hearing and co-constructing speculative explanations about improbable events might allow children to more often imagine possibility in ambiguous situations and openly display credulity in the face of some doubt than children who do not participate in such conversations. Furthermore, this supports the idea, first suggested by Shtulman and Carey (2007) that children with more practice imagining the necessary circumstances might judge more Improbable events to be possible in real life. In supportive contrast to findings about speculation, parents' skeptical explanations for improbable events were *negatively correlated* with children's possibility judgments. This pattern was not found in a previous study

(Nolan Reyes et al., 2013) and suggests that hearing and co-constructing skeptical explanations might frame these types of context-dependent modal events as a skeptical search for children, who are then inclined to view future unexpected events with more doubt.

Children's justifications reveal more about their thinking regarding the distinction between the impossible and merely improbable than do their judgments alone. Parents' speculative explanations for why unusual or improbable events could happen predicted children's own tendency to give Mechanistic justifications for both their yes and no judgments. This finding suggests the important role of adult explanation styles to children's own verbal, causal and flexible reasoning.

Interestingly, parents' tendencies to request explanations about ambiguous events was negatively correlated with children' tendency to give Mechanistic justifications. This could be interpreted as supportive of children's need to hear fuller explanations in order to learn how to give them. Or it may simply reflect parents' tendency to ask more questions of children who tend to be more taciturn in order to try to encourage more talk. Future research could examine this possibility with overall word counts for children in addition to parents, and by investigating relationships between parents requesting explanations and children's extraversion scores on the Big-5.

Finally, contrary to suggested scientific and artistic parents' speculative tendencies and positive relationships with children's judgments, the counterintuitive finding that scientific vocations were negatively correlated with children's

mechanistic justifications needs further exploration and demands replication. It may be the case that comparing children's yes judgments for improbable events with their yes *and* no justifications is related to this finding. Are children of scientific parents (and possibly artistic parents) more discriminating than other parents in their use of mechanism? Are mechanisms for yes judgments more similar to abductive reasoning while mechanisms for no judgments are more like induction using known laws or facts?

Of course, it is important not to make causal assertions about these correlational findings. It is certainly possible that characteristics of the children and or differences in the children's talk could influence parents to speak differently to their children. Parents might be attuned to interests in their child suggesting joy or aptitude for speculation and this is in fact what the parents are responding to. However, there are important reasons to doubt this. Foremost, children make a slightly higher proportion of possibility judgments in studies that include parent-child conversations than in studies of individual children (Shtulman & Carey, 2007; Shtulman, 2009). Yet children in the current and prior studies are unlikely to be very different than the children in Shtulman and Carey (2007) and Shtulman (2009). Furthermore, similar, but less pronounced age-related patterns were found in children's possibility judgments in parent-child studies. At least age is less pronounced when considering the stronger predictor of parental explanations. These findings might suggest something important about variation in *parents,* not children.

Finally, it is important to acknowledge that the relationships between parents' explanations and children's verbal reasoning, even if it is causal and unidirectional from parent-to-child, might represent a kind of priming that is merely an artifact of the study or might not be a stable change. A future study that could be done rather simply would be to bring some percentage of the same participants back in to the lab and test them on a new set of improbable and impossible events. It would be informative to ask whether specific children change their tendency to engage in possibility thinking over time, or whether these patterns are indeed more long lasting.

Future Directions

These findings regarding parents' explanations and vocations and children's possibility thinking may have important implications for the roles of parents and families in the development of children's knowledge, reasoning and creative potential. This may be consistent with a recent national emphasis on recruiting the greater participation of professional adults in children's arts and science education and which may also help not just teaching creative *techniques* to children but actually fostering the cognitive and socio-emotional *dispositions* that can lead to a more creative, meaning-making engagement with the questions and problems of our world (Claxton, Edwards, & Scale-Constantinou, 2006).

It would also be compelling to examine how professional adults talk with children, perhaps in informal learning situations outside of schools, such as in art studios and science labs. It would be informative to see whether using speculative and skeptical forms of explanation have an effect on children's thinking when non-parent

adults are trained to give these explanation. And it would also be important to systematically study children's *responses* to these types of explanations (Frazier et al., 2009) to better understand the development of co-constructed explanation.

Another readily available and potentially very fruitful direction to follow from the current study would be to further examine how the data may add to the cognition literature. For example, a re-coding of the parents data to focus on how they specifically judged and justified possibility (which many parents did for a majority of the events) could be compared to what is known about how adults judge possibility. Like the adults used as a comparison with children in prior research (Shtulman & Carey, 2007) there was even greater variation in how parents judged and explained possibility (at least in how they judged and explained out loud to their child). The differences in the adults' judgments with their children vs. solo adults judgments could be analyzed more systematically in future work.

Differences in how middle class adults judge and explain possibility (emerging adult undergraduate students vs. adult parents with young children) underscores an issue of deeper importance highlighted by developmental research in conversation and communication. Adults reason and problem solve about real world problems with multiple individual agendas under competing circumstances in different sociocultural contexts. Identifying some of these individual and social contextual variations, rather than ignoring or masking them, could represent be an important way forward in more productively addressing long-standing disputes in psychology between universalist and cultural perspectives.

Not all theoretical and methodological perspectives are compatible, nor should they be. But comparing adults of different ages across contexts, with children and without children using similar (yet culturally relevant) measures and activities could provide a better view from which to potentially distinguish cultural distinctions that "matter" from variations that might at times obscure larger universal patterns. I believe such work, if we stay open, is possible.

Conclusions

Practicing possibilities as a communication genre suggests different forms of exploratory dialogue with adults as a way that some children may be socialized to engage in collaborative idea generation through co-constructed explanation. As an everyday communication genre practicing possibilities likely shares some aspects of storytelling (in particular the genre of tall-tales), dialogic inquiry, and sociable argumentation), and yet it is different from all of these too (Blum-Kulka, 2002; Schiffrin, 1984).

We need longitudinal studies of adults of various vocations and identities across different communities and contexts, as they engage in meaningful idea exploration with children. In accordance with sociocultural theories these contexts are typically culturally meaningful as communities of practice for the family (Rogoff, 2003). For example, a family might generate hypothetical possibilities planning a future vacation (Cooper, Grotevant & Condon, 1982), suggesting and selecting ideas for a child's science fair project or "invention convention", suggesting ways to

improve a family business (Korin, 1989), engaging in community service or organizing, and simply learning to be resourceful at home or while camping or travelling.

At the same time, much of children's social-emotional and cognitive socialization occurs during cultural activities that are more "everyday" then emblematic. For example, commuting in a car has been suggested as a place likely to be as or more fruitful than the family dinner table (at least in many suburban and urban areas of the US) for family conversation and theory building (Callanan & Oakes, 1992; Ochs et al. 1992). Car commuting may be important for an additional reason beyond amount of naturalistic time spent. Commuting is also a place many urban and suburban children may increasingly be exposed to metaphysically complex and sophisticated billboards and advertisements (e.g., I saw a very large photo in a store window at the base of my campus last year depicting a person getting hit by lightning, one of the improbable events in this study). These types of signs and billboards might spark metaphysically complex conversations in families about fantasy and reality or about possibility and necessity.

In conclusion, investigating possibility thinking as a communication genre could promote better understanding of the interrelations among children's cognitive development, emotional development, and creative potential, and how these are mediated by conversations with adults who differ individually and culturally. As such, possibility thinking may also have practical importance for parents, educators, and clinical practitioners. And finally, while beyond the scope of this study,

practicing possibilities in a world where many families have increasing exposure to other cultures via media, tourism and immigration, highlights other areas of potential research (albeit somewhat different). That is, how do different parents talk to children about the values of culturally and individually variable practices, including how to construct meaning in life through all of the possibilities of work and play?

Appendix A: Holland Vocational Interest Inventory

Holland Occupational Themes

Based on the theory of John Holland, Ph.D., people with the same or similar interests are often found in the same work environments. To discover the work environments suited to your interests, abilities, and personality, consider the following categories/themes.

Step 1: For each theme, check those items that describe you.

REALISTIC				**R** Total =	
Are You:		**Can You:**		**Like To:**	
	Practical		Fix electrical things		Tinker with mechanics
	Athletic		Solve mechanical problems		Work outdoors
	Straight forward		Pitch a tent		Be physically active
	Mechanically inclined		Play a sport		Use your hands
	A nature lover		Read a blueprint		Build things
	Good with tools and machinery		Work on cars		

INVESTIGATIVE				**I** Total =	
Are You:		**Can You:**		**Like To:**	
	Inquisitive		Think abstractly		Explore ideas
	Analytical		Solve math problems		Use computers
	Scientific		Understand physical theories		Work independently
	Observant		Do complex calculations		Perform lab experiments
	Precise		Use a microscope		Read scientific or technical magazines
	Good with tools and machinery		Work on cars		
			Analyze data		

ARTISTIC				**A** Total =	
Are You:		**Can You:**		**Like To:**	
	Creative		Sketch, draw, paint		Attend concerts, theaters, art exhibits
	Intuitive		Play a musical instrument		Read fiction, plays, poetry
	Imaginative		Write stories, poetry, music, sing, act, dance		Work on crafts
	Innovative		Design fashions or interiors		Take photographs
	An individualist				Express yourself creatively

SOCIAL					S Total =
Are You:		**Can You:**		**Like To:**	
	Friendly		Teach/train others		Work in groups
	Helpful		Express yourself clearly		Help people with problems
	Idealistic		Lead a group discussion		Participate in meetings
	Insightful		Mediate disputes		Do volunteer service
	Outgoing		Plan and supervise an activity		Work with young people
	Understanding		Cooperate well with others		Play team sports

ENTERPRISING					E Total =
Are You:		**Can You:**		**Like To:**	
	Self-confident		Initiate projects		Make decisions affecting others
	Assertive		Convince people to do things your way		Be elected to office
	Sociable		Sell things or promote ideas		Win a leadership or sales award
	Persuasive		Give talks or speeches		Start your own political campaign
	Enthusiastic		Organize activities and events		Meet important people
	Energetic		Lead a group		

CONVENTIONAL					C Total =
Are You:		**Can You:**		**Like To:**	
	Well groomed		Work well within a system		Follow clearly defined procedures
	Accurate		Do a lot of paper work in a short time		Use data processing equipment
	Numerically inclined		Keep accurate records		Work with numbers
	Methodical		Use a computer terminal		Type or take shorthand
	Conscientious		Write effective business letters		Be responsible for details
	Efficient				

Step 2: Total the items checked for each theme/category. Identify the top 3 categories/themes that create the most accurate picture of you.

My top 3 categories/themes are: _____, _____, _____.

Step 3: How accurately do you believe your (3) top themes describe your personality and interests?

REALISTIC people are characterized by competitive/assertive behavior and by interest in activities that require motor coordination, skill, and physical strength. People oriented toward this role prefer situations involving "action solutions" rather than tasks involving verbal or interpersonal skills. They like to take a concrete approach to problem-solving rather than relying on abstract theory. They tend to be interested in scientific or mechanical rather than cultural and aesthetic areas.

INVESTIGATIVE people prefer to think rather than to act, to organize and understand rather than to persuade. They are not apt to be very "people oriented."

ARTISTIC people value self-expression and relationships with others through artistic expression. They dislike structure, prefer tasks involving personal or physical skills, and are more prone to expression of emotion than others. They are similar to investigative people, but are more interested in the cultural-aesthetic than the scientific. SOCIAL people seem to satisfy their needs in teaching or helping

situations. In contrast to investigative and realistic people, social types are drawn more to seek close interpersonal relationships and are less apt to engage in intellectual or extensive physical activity.

SOCIAL people have high interest in other people and are sensitive to the needs of others. They perceive themselves as liking to help others, understanding others, and having teaching abilities. Social people value social activities, social problems, and interpersonal relationships. They use their verbal and social skills to change other people's behavior. They are generally cheerful, scholarly, and verbally oriented.

ENTERPRISING people are verbally skilled and use this skill in persuasion rather than support of others. They also value prestige and status and are more apt to pursue it than conventional people.

CONVENTIONAL people don't mind rules and regulations and emphasize self-control. They prefer structure and order to ambiguity in work and interpersonal situations. They place value on prestige or status.

Step 4: Visit *Career Briefs* to view a sample of occupations that match your three Holland themes. (Look for your 3-letter code in all its configurations, for example: ASE, AES, SAE, etc.)

Based on John L. Holland's *Making Vocational Choices: A Theory of Careers* (Englewood Cliffs, NJ; Prentice Hall, 1973). The formal validated assessment instrument using John Holland's theory is the Self-Directed Search, available from PAR, Inc.

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