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Judgment and Decision Making in School-Age Children

Juicio y Toma de Decisiones en Niños de Edad Escolar

Diego Fernandez-Duque[1], Jodie A. Baird[2]

RESUMEN

En los últimos cincuenta años, psicólogos y economistas han catalogado los errores que la gente adulta comete cuando toma decisiones. El objetivo de nuestro resumen narrativo es describir estos errores como ocurren en niños de edad escolar. Luego de una breve introducción a las teorías más importantes en economía comportamental (Utilidad Esperada, *Prospect*, Rastro Difuso, Proceso Dual) haremos un resumen de esta literatura, con énfasis en el período de edad escolar. Evaluamos si los niños comprenden el concepto de 'valor esperado', si sus respuestas cambian en base a como se hace la pregunta, y si prefieren arriesgar en vez de aceptar propuestas seguras. También describimos, desde una perspectiva del desarrollo, la tendencia a sobrevalorar las posesiones, a perseverar cuando el gasto es irrecuperable, y a tener diferentes cuentas mentales. Nuestra revisión indica que las tendencias que se ven en la adultez también suelen ocurrir en niños y niñas de edad escolar, y señala áreas en las que se carece de datos sólidos. Concluimos nuestro artículo sugiriendo futuras áreas de investigación.

Palabras clave: Toma de decisiones, Desarrollo, Niños escolares, Economía comportamental, Racionalidad.

ABSTRACT

Over the last half century, psychologists and behavioral economists have catalogued myriad mistakes that people make when making decisions. The way those mistakes are expressed in school-aged children is the focus of this narrative review. After a brief introduction to the main theoretical positions (expected utility theory, prospect theory, fuzzy-trace theory, dual-systems theory), we do a comprehensive review of the developmental literature. We start with children's understanding of expected value, their sensitivity to framing effects, and their tendency to favor risky choices over riskless options. Next, we describe developmental research on the endowment effect, sunk cost, and mental accounting. Our review indicates that biases observed in adults are often evident in school-age children too, and singles out areas of developmental research in which solid information is not available. We conclude by highlighting areas in need of future research.

Keywords: Decision making, Development, School-age children, Behavioral economics, Prospect theory, Rationality.

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[1]Villanova University. Psychological and Brain Sciences Department. Pennsylvania, United States. Email: diego.fernandezduque@villanova.edu
[2]Bryn Mawr College. Psychology Department. Pennsylvania, United States. E-mail: jabaird@brynmawr.edu

Do school-age children differ from adults in their decision making? Do they make the same kinds of mistakes? Do they rely on the same mental processes? In this article, we address these questions by reviewing the existing literature, and we highlight topics for future research, of which there are many.

Unlike other areas of cognition, such as language, number knowledge, or theory of mind, developmental research in Judgment and Decision Making (JDM) has yet to cohere into an integrated field of study. A factor that may explain why research on children's decision making has been neglected is that most decision making tasks fall into the category of 'higher cognition' tasks; good performance on them depends on more basic cognitive capacities, such as language, memory, number knowledge, and attention. In turn, each of these 'basic' cognitive capacities consists of a collection of multiple subsystems, each with its own developmental trajectory (Posner & Raichle, 1994). Since poor performance at the higher cognition task may stem from a variety of sources, poor performance would not be very informative. Adding to the problem, even adults fail on many of the tasks. According to this critique, it is more fruitful for research to focus on the development of the most basic cognitive processes. While this critique has merit, our review will make clear that sometimes researchers have been able to construct experimental paradigms that have yielded important and insightful findings on childhood decision making (Levin et al, 2007). Such studies are in the minority, but provide a proof of principle for the direction the field should take.

We start our review with a brief history of JDM and its main theoretical positions, including expected utility theory, prospect theory, fuzzy-trace theory, and dual-systems theory. Next, we review children's understanding of expected value, their sensitivity to framing effects, and their tendency to favor risky choices over riskless options. We also review the developmental literature on biases, such as the endowment effect, sunk cost, and mental accounting. We conclude by highlighting areas in need of future research.

A very brief history of Judgment and Decision Making

The precursors of the field of JDM can be traced back to the 17th century, when philosophers and mathematicians began to ask how to integrate probability and outcome into an expected value. Famously, the French philosopher Blaise Pascal argued that if asked to make a bet, a rational man should choose to believe in the existence of God. If right, Pascal argued, the believer would obtain infinite gains (eternity in Heaven) while if wrong he would only suffer finite losses (a life without certain pleasures); in contrast, the non-believer would stand to obtain only finite gains but risk infinite losses (Hell for eternity). These outcomes are so different –one is infinite, the other is finite- that no matter how low the actual probability of God's existence is, the expected value (outcome x probability) will always favor the believer (Keren & Wu, 2015)

In 1713, the Swiss mathematician Nicolas Bernoulli posed a related question: imagine a game of chance where you flip a coin and if it shows heads, you win $2 and a chance to flip the coin again. This second time, if the coin shows heads the prize doubles ($4) and the game continues this way until the coin shows tails, at which point the game ends. How much would you be willing to pay to play this game? Most people are willing to pay no more than a few dollars, which is far less than what a strict interpretation of expected value would recommend. To see why, it is useful to unpack the problem. The outcome prize for the first flip is $2, and the probability of winning is .5, for an expected value of $ 1 (EV = outcome x probability). The outcome of the second flip is doubled ($4) but the probability of winning is halved (.25), since flipping the coin a second time is contingent on having gotten heads in the first flip. Thus, the expected value of this second flip is also $1 ($4 x .25). The same logic applies to a third flip ($8 x .125) and so forth, all the way to infinity; adding up all those coin flips gives the game an expected value of an infinite amount of dollars. Following this logic, people should be willing to pay almost infinite amounts of money to play such a game; the fact that they don't suggests that the desirability –also known as *utility*- of the outcome is relative to the amount of wealth the person has. It was Nicolas' cousin, Daniel Bernoulli, who first had this insight of diminishing marginal utility and said that: "A gain of one thousand ducats is more significant to a pauper that to a rich man though both gain the same amount" (Bernoulli, 1738/1954), p. 24).

The next leap in the field of Decision Making had to wait until the middle of the 20th century, when the mathematician John von Neumann paired up with the economist Oskar Morgenstern to propose 'expected utility theory' (Von Neumann & Morgenstern, 1947). This theory, also known as 'rational agent theory', aimed to state how people *should* behave, following the principles of rationality, but it did not concern itself with how people did behave in actuality. It was a *normative* theory rather than a *descriptive* theory. It included axioms such as the principles of dominance (if A > B, choose A), cancellation (if A > B, then A + C > B + C), transitivity (if A > B and B > C, then A > C), and invariance (e.g., if you choose A over B, then you should be willing to pay more for A than what you pay for B). Most readers will agree that these are very reasonable principles. Nonetheless, scientists quickly discovered that Expected Utility Theory did not properly describe human decision making. From these findings, some concluded that humans were neither rational nor reasonable, while others concluded that Expected Utility Theory was not such a good theory of human behavior after all; everyone agreed that the theory was absent of any psychological mechanisms.

A first counterpoint to Expected Utility Theory was provided soon after by Herb Simon who stressed the importance of psychological mechanisms (Simon, 1959). Simon pointed out that, contrary to normative theory, people often settle for good-enough decisions instead of seeking optimal decisions; to use Simon's terminology, people are *satisficers* rather than *maximizers*. This view recognizes that the human mind has limited capacity, and that there are limits to the amount of time that can reasonably be devoted to a problem. Simon thought that a theory of rationality ought to acknowledge these limitations rather than dismiss them, and thus coined the term 'bounded rationality' as an alternative.

A second counterpoint to Expected Utility Theory was provided by Kahneman and Tversky's work on heuristics and biases (Tversky & Kahneman, 1974) as well by their work on prospect theory (Kahneman & Tversky, 1979). The research on heuristics and biases documented that people often use mental shortcuts that, while quick and computationally efficient, are also prone to systematic errors. The research on prospect theory showed that, contrary to expected utility theory, people assess outcomes not based on their total amount of wealth but rather based on changes from a reference point. Thus, the employee whose salary goes up from 90 to 92 will be happy with the 'gain', while the employee whose salary goes down from 100 to 98 will be quite unhappy with the 'loss', even if the latter accumulates more wealth that the former. We will revisit both of these literatures in their proper developmental context later in the article.

Dual-System Theory & Fuzzy Trace Theory

Influenced by the work of other cognitive scientists and social psychologists, decision making researchers quickly zeroed on a distinction between deliberate and experiential modes of decision making. The experiential system, charged with handling most of our daily decisions, acts quickly, effortlessly, and automatically, and we are often unaware of its activity. The experiential system is always 'on', processing information and interpreting it throughout the day. It is a system that relies on associative memory, perception, and affect, and as such we can say that it is intuitive. It makes extensive use of mental shortcuts –*heuristics*– to provide good-enough answers. It is sometimes referred to as System 1. In contrast, the deliberate system is slow, requiring conscious effort and attention. The goal of the deliberate system is not only to generate decisions in novel or important situations, but also to vet and inhibit the output from the experiential system. Unlike the experiential system, it is not always active: when we are tired, stressed, or distracted, we are less likely to engage the deliberate system and therefore are more susceptible to the biased output of the experiential system. The concept of the 'deliberate system' is closely related to the concept of the 'central executive system' (also known as *executive attention*), as it is known in cognitive development and cognitive neuroscience research. It often relies on laborious, computationally intensive use of algorithms, and as such it can be described as analytical. It is sometimes referred to as System 2 (Evans & Stanovich, 2013; Kahneman, 2011).

Given what we know about the protracted development of executive functions (Moriguchi, Chevalier, & Zelazo, 2016), it is fair to assume that young children are over-reliant on System 1 and have to wait until adulthood to acquire the full capacity of System 2. If so, children should be more susceptible to the errors and biases previously documented in the adult literature. However, the available developmental literature is mixed on this question as children occasionally out-perform adults in JDM tasks. This paradoxical finding has led some researchers to propose an alternative theory known as fuzzy-trace theory (Reyna & Brainerd, 2011; Reyna & Ellis, 1994) according to which children –and novices– rely primarily on verbatim knowledge while adults –and experts– rely mostly on gist-based processing.

Fuzzy-trace theory argues that people encode both the verbatim information, which is quantitative and logical, as well as the gist information, which is qualitative and experiential. Verbatim representations capture the exact words and numbers needed to solve a problem, while gist representations capture the bottom line meaning of the problem. As an example, imagine you have to decide whether to have surgery to prevent a 22% risk of stroke and are told that the risk of dying from the surgery is 2%. While the exact numbers will initially be encoded in memory as verbatim knowledge, as an adult you will also encode the main idea, namely that surgery is much less risky than the alternative but does carry some risk nonetheless. It is usually this gist representation, rather than the verbatim representation, that decision making is based upon.

Fuzzy-trace theory makes the further claim that verbatim-based analysis and gist-based intuition are processes that develop somewhat independently with greater reliance on gist-based intuition during adulthood than during childhood. That is, fuzzy-trace theory claims that children –and novices– start with quantitative information, and only later in development –or with increased expertise– acquire the intuitive qualitative gist that allows them to reason more efficiently and effectively. Fuzzy-trace theory shares with classic dual theories the belief that gist-based intuitive processes are carried out automatically and effortlessly while analytical verbatim-based processes are carried out slowly and with effort. But, critically, fuzzy-trace theory disagrees with classic dual theories on how error-prone the gist-based intuitive process is. While they acknowledge the perils of mindless impulsive reactions, advocates of fuzzy-trace theory distinguish that mindless response from the insightful intuition that reflects understanding. In the words of its lead proponent, "there are two kinds of fast and simple ways of thinking: a stupid kind that represents the most primitive type of thinking and a smart kind that represents the highest form of thinking, insightful intuition" (Reyna & Brainerd, 2011, p. 187).

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Decision Making: Developmental Research

Do children differ from adults in their decision making? Do they make the same kind of mistakes? Do they rely on the same mental processes? To answer these questions, it is helpful to use as a framework the economic theories (expected utility, prospect theory) and psychological theories (dual-system, fuzzy-trace) already described.

Expected Utility

Expected utility theory (EUT), the normative theory of decision making, provides a good place to start. Central to EUT is the concept of 'expected value', defined as the value of the outcome weighted by is probability. In other words, the appeal of a lottery depends not only on the prize but also on the likelihood of winning. At a relatively young age, children grasp the idea that outcomes and probabilities should be combined multiplicatively. For example, in one study, 5-year-olds were presented with two lotteries of different expected value and asked to report how happy a puppet would feel to play one of the lotteries. Five-year-olds correctly reported increased levels of happiness at the prospect of playing a lottery of higher expected value than the alternative (Schlottmann & Wilkening, 2011). This early development of the concept of expected value contrasts with children's understanding of other multiplicative concepts, such as the concept of area (length x width), which does not develop until 8 years of age (Anderson & Cuneo, 1978). One possible explanation for this developmental asynchrony is that for area the two dimensions (length, width) combine to form a qualitatively new dimension, while for expected value one dimension (probability) simply modifies the other (value) without changing it conceptually (i.e., expected value is still a value). Thus, the concept of 'expected value' requires less conceptual abstraction than the concepts of 'area', and that might explain its earlier development.

Researchers have also explored whether children are able to use expected value to adaptively change their decision making. To convey information about probability in a way that young children understand, researchers have designed the 'cups' task. Many variants of the task exist. For example, in one variant, a child might be asked to choose between two options of equal expected value: a sure gain of one coin and a .20 chance of winning 5, this latter option illustrated by five cups, of which one contains 5 coins and the other four contain zero (Levin & Hart, 2003). Each trial always presents a riskless option (e.g., a coin worth a quarter of a dollar) and a risky choice, which in different trials may vary in its probability (e.g., .2, .5) and/or its outcome (e.g., 2 quarters, 5 quarters), and therefore in its expected value. In most studies, the two options presented in a given trial have the same expected value, but in some experiments the two options in a trial have different expected values; options of different expected values allow researchers to assess whether participants are choosing advantageously. Finally, individual trials can be blocked together based on whether the trials offer the opportunity to win (gain frame) or instead only offer the chance to not lose (loss frame). This variable becomes important in the study of risky choice framing and its developmental trajectory, a topic to which we will return in a later section.

As it should be clear from our description, the 'cups' task affords great a degree of flexibility to researchers interested in the development of risky decision making. Studies using this methodology have shown that children as young as age 5-7 are able to partly adjust their choices on the basis of both probability and outcome information. In other words, by this age children have at least some understanding of expected value and can use that information somewhat competently. However, the skill further develops in the subsequent years: the younger children are not as responsive to differences in expected value as children in the 8-to-10 group, and those kids in turn are not as responsive as their adult parents (Levin, Weller, Pederson, & Harshman, 2007). Interestingly, both groups of children also make more risky choices than adults, and this is true even when risky choices are disadvantageous. In other words, children seem inclined to gamble even when the riskless choice has a higher expected value (Levin, Hart, Weller, & Harshman, 2007).[1]

Interestingly, children's risk proneness in the 'cups' task is positively correlated with their parents' risk proneness in the same task ($r = .29$). Furthermore, children's risk proneness is also correlated to individual differences in temperament, as measured by the Child Behavior Questionnaire (CBQ) (Rothbart, Ahadi, & Hershey, 1994). In particular, risk seeking behavior is positively correlated to Surgence, a factor that includes impulsivity, approach, high intensity pleasure, high activity level, and lack of shyness. Risk seeking is also greater for boys than for girls. Finally, and importantly, the risk seeking behavior of children is stable over time. In a longitudinal study, children were tested on the cups task at the age of 6-to-8 years and a second time 3 years later. There was a positive correlation between risk-seeking behavior at time 1 and time 2 ($r = .38$) (Levin, Hart, et al., 2007).

Another core feature of Expected Utility Theory is the additivity of outcomes: the total expected value of an event consists of the sum of all its component. For example, a lottery that offers a 1-in-10 chance to win \$10 and 1-in-2 chance to win \$1 has a total expected value of \$1.5 (0.1 x 10 + 0.5 x 1). At what age do children start to grasp this idea? To start answering these questions, it is useful to first look at the issue for judgments under conditions of certainty about the outcomes (i.e., riskless context).

In one study, children between the ages of 5 and 10 were given the option of playing with one or two toys (Butzin & Anderson, 1974). In the single toy condition, there was an attractive toy A and a boring toy B. For the two-toy condition, a medium value toy M was introduced, and was either paired with the attractive toy (M + A) or

[1]A judgment is said to be riskless when the outcome is certain, and risky when the outcome probability is less than 1. This technical meaning is different from the ordinary meaning that equates 'risky' with 'dangerous.'

with the boring toy (M + B). Not surprisingly, children judged the attractiveness of the mediocre and boring pair (M + B) higher than they had judged the boring toy alone (B). This is normatively correct, as toy M provides additional value. More interestingly, children judged the pairing of a mediocre and attractive (M + A) *lower* than the attractive toy alone (A). This goes against the normative model and it's akin to favoring a lottery's big prize alone over the combination of both big and small prizes. A parsimonious explanation of this finding is that children compute the average of the two values instead of computing the sum (Butzin & Anderson, 1974). Adults can be found to make the same mistake. For example, participants in one study were willing to pay more money for a 24-piece set of dinnerware than for a 40-piece set that had those same 24 pieces, and in addition had other pieces that were broken (Hsee, Loewenstein, Blount, & Bazerman, 1999).

The question of additivity has also been studied for judgment under risk. In one study, adults and children aged 7 and 10 years old were introduced to roulette-type spinner games and told about a puppet who liked to play those games. If the spinner landed on a particular color (e.g., red) the puppet would win a toy prize, but if it landed on the other color (e.g., blue) the puppet would win nothing. For some games, there was a single spinner and a single prize; for other games, there were two spinners and two different prizes. The probabilities of winning each prize was varied. To probe children's assessment of expected value, participants were asked how happy the puppet would be with each game. Children of both ages relied on the average; they thought the puppet would be very happy playing a game in which a single spinner offered a high probability to win a prize, but not as happy playing a game that included that the very same spinner and another spinner that provided an additional small chance of winning a second prize. Adults provided the normative answer, that is, they reported the puppet would be happiest playing the game with highest expected value (i.e., the one with the additional small chance of winning a second prize) (Schlottmann, 2000).

In sum, developmental research on expected theory has shown that conceptual understanding of expected value (outcome x probability) is already present at the age of 5, preceding the acquisition of other multiplicative concepts, such as the concept of area (length x width). Five-year olds are also capable of adaptively changing their decision making according to changes in expected value, although this skill continues to develop well into elementary and middle-school age. Children of all ages tend to prefer the risky choice over the riskless choice. Children also have difficulties understanding the additivity of outcomes (good toy + bad toy > good toy), a deficit that is observed even in adulthood.

Prospect Theory

It was Daniel Bernoulli in 1738 who first articulated the limitations of expected value as a description of people's judgments and highlighted the concept of diminishing marginal utility (i.e., diminishing sensitivity). Prospect theory retained Bernoulli's insight about the reduction of marginal utility, but introduced a baseline reference point against which changes in wealth were to be compared (Kahneman & Tversky, 1979). In other words, prospect theory stated that people evaluate outcomes in terms of gain and losses. When combined with the reduction in marginal utility, the introduction of a reference point creates an inflexion point in the value curve, as illustrated in Figure 1. Importantly, prospect theory also stated that losses loom larger than gains: the pain of losing 100 dollars is larger than the pleasure of winning that same amount, a phenomenon known as 'loss aversion'.

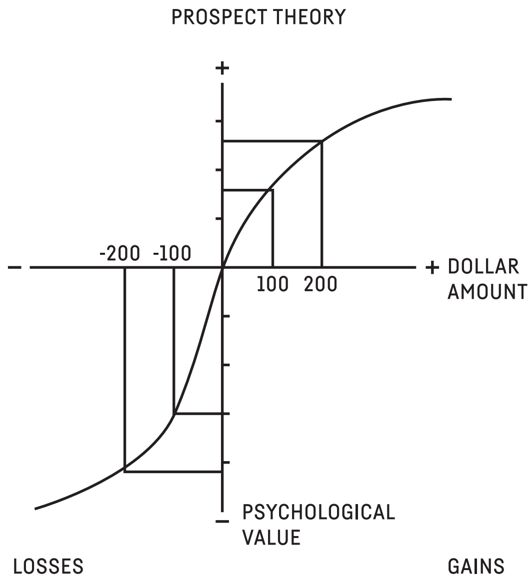

Figure 1. The function represents the relation between the objective gains and losses (e.g., measured in dollars) on the *x*-axis, and the subjective psychological value a person places on such gains and losses on the *y*-axis.

Armed with these new tools (baseline reference, loss aversion), prospect theory has been able to explain a wide variety of behaviors that were not easily explained by expected utility theory. These include the framing effect, the endowment effect, and the sunk cost effect, among others.

Framing

A central tenet of rational decision making is that people's preferences should not be influenced by superficial changes in how the options are described. Nevertheless, there are many examples showing that how the problem is framed can systematically bias people's preferences. This *invariance* principle is violated, for example, when people prefer a treatment with 97% survival rate to a treatment with a 3% mortality rate. This type of framing effect is called attribute framing because what is manipulated is the description of a stimulus's attribute.

Preferences can also be reversed when a problem is framed as a gain rather than a loss. When options are

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framed negatively as losses, people are inclined to gamble in pursuit of a potentially better outcome; in other words, they become risk seeking[2]. When options are framed positively as gains, people prefer the "sure thing", that is, they become risk averse. As a consequence, this type of preference reversal is called 'risky choice framing'.

The most famous example of risky choice framing is the Asian disease problem (Tversky & Kahneman, 1981). Participants are asked to "imagine your country is preparing for the outbreak of an unusual tropical disease that is expected to kill 600 people. Two alternative programs to combat the disease have been proposed and you have to choose which one to adopt:

- Program A: "200 people will be saved"
- Program B: "there is a 1/3 probability that 600 people will be saved, and a 2/3 probability that none will be saved".

When framed as 'lives saved', most people prefer the sure-thing (program A). However, the identical problem can be framed as a loss, by stating that for:

- Program A': "400 people will die"
- Program B': "there is a 1/3 probability that nobody will die, and a 2/3 probability that 600 people will die".

When frame as a loss, most people choose to gamble (program B'). This reversal of preference violates the invariance principle, challenging expected utility theory and its principles of rationality. It shows that adults are risk-averse for gains, and risk seeking for losses.

Prospect theory explains this pattern of results by appeal to its value function (see Figure 1). Due to diminishing marginal returns, saving 600 people is not three times as attractive as saving 200. Thus, a one-in-third chance of saving 600 is not as appealing as saving 200 for sure. The mirror situation happens with losses: the death of 600 does not feel three times as bad as the death of 200. Thus, 1/3 probability of everyone dying seems worth the risk to try to get no one to die. Prospect theory is the leading theoretical explanation of the framing effect.

Fuzzy-trace theory explains the framing effect by proposing that adults form a gist of the options. In the gain frame, it is "better to save some lives for sure than maybe saving none". In the loss frame it is "better if maybe none die than some people dying for sure". From these gists, reversal emerges. Fuzzy-trace theory is not as prominent as prospect theory, but its links to development research merit its inclusion in this review.

Before trying to adjudicate between these two theoretical accounts, the Asian disease paradigm had to be simplified so it could be communicated effectively to young children. Toward this goal, researchers introduced several helpful modifications. For example, spinners with colored areas helped communicate the outcome probabilities, small toys served as prizes the child could visualize, and a list of smiley faces offered participants a way to express the strength of their preference. With these modifications at hand, fuzzy-trace theory researchers invited children ages 5, 8, and 11 to play a game of "pick the one you want", in which they had to choose between a sure option and a risky one (Reyna & Ellis, 1994). Outcome probability and prize size were varied in a factorial design, and one block of trials was framed as a gain (opportunity to win some prizes), and the other was framed as a loss. Fuzzy-trace theory poses that at a young age, children use verbatim information and thus are less susceptible to biases, while older children and adults integrate information into gists, and thus are more susceptible to framing and other biases. The results aligned best with these predictions from fuzzy-trace theory, as the youngest group (5 year olds) was not affected by the frame.

Other studies have found a framing effect for 6 year olds as big as for older children, a result inconsistent with fuzzy-trace theory. In one such study, 6- and 9-year-olds had to choose between a sure gain and a gamble, or between a sure loss and a gamble, both of the same expected value. Children favored the sure thing more in the positive frame than in the negative frame, consistent with a standard framing effect as the one observed in adults (Schlottmann & Tring, 2005).

The framing effect has also been studied with the 'cups' task discussed earlier in the article. During 'gain' trials, children ages 5 to 7 had to choose either a sure gain of a single prize, or a .50 chance to win two prizes. During the 'loss' block trials, children had to choose between a sure loss of one prize or a .50 chance of losing two prizes. Children were more risk seeking than the adults. Furthermore, children showed the typical framing effect: they were more risk seeking for losses than for gains (Levin & Hart, 2003). Interestingly, risk-taking decreases from childhood to adulthood in the gain domain, but is relatively constant across ages in the loss domain (Weller, Levin, & Denburg, 2011).

In sum, the available data are inconclusive on whether the framing effect weakens, strengthens, or remains unchanged as children grow. More importantly, there is substantial evidence to support the claim that the standard framing effect is present as early as 8 years of age, and possibly earlier. These results indicate that the mechanisms of prospect theory are active in children.

Endowment

Adults who own a good value it more than people who do not. In other words, the amount an owner demands to relinquish a good is larger than the amount a buyer is willing to pay (Kahneman, Knetsch, & Thaler, 1991). Similarly, people are more inclined to keep the goods they have than to trade them for other goods. At what point in development does this endowment bias emerge?

To answer this question, researchers tested children and adults in a very simple protocol (Harbaugh, Krause,

[2]The term 'risk' as used in behavioral economics refers to 'uncertainty'. A 'risky' outcome is a probabilistic outcome, while a riskless outcome is a certain one. To say that a person is risk seeking is to say that she favors the uncertain option (e.g., a .5 chance of winning $8) instead of the certain option (e.g., winning $4 for sure). It does not mean that the person seeks dangerous choices.

& Vesterlund, 2001). Participants were given one good (e.g., a highlighter) and asked if they wanted to keep it or trade it for another (e.g., a mechanical pencil). There were three trials, and approximately 20 participants in each age group (ages 5, 8, 10, and 20-year-olds). The endowment effect was present in every age group, and there were no significant age differences in the effect size. This null result is difficult to interpret given the relatively small sample size for that analysis.

Over the years, many explanations have been offered for the endowment effect, but the most prominent ones are loss aversion and ownership. Loss aversion is the claim, central to prospect theory, that losses loom larger than gains. According to loss aversion, the owner of a mug who trades it away for a pen will feel a large loss, which the gain of acquiring a new pen will fall short from compensating. Of course, for the pen owner the situation is the mirror image: trading away the pen is a loss that is not worth the acquisition of a new mug.

A different explanation of the endowment effect appeals to the sense of ownership: people value the things they own because they are *theirs* (Morewedge & Giblin, 2015). According to this view, people project their self-perception onto the objects they own; since most people hold a positive view of themselves, the goods they own become imbued with positive value. In other words, the good is incorporated into the self-concept of the owner. A recent study, using a paradigm that required children to focus their attention onto themselves, found an endowment effect in 3-4 year olds, a result consistent with the sense of ownership explanation (Hood, Weltzien, Marsh, & Kanngiesser, 2016). Supporting this possibility is the fact that preschoolers have a well-developed concept of ‘ownership’. For example, they consider objects people own to be non-fungible (i.e., not interchangeable) even if they are superficially identical (McEwan, Pesowski, & Friedman, 2016), and they prefer toys that have been given to them as new over toys owned by somebody else (Gelman, Manczak, & Noles, 2012).

Sunk Cost:

Imagine that after working on a research question for several months, you read an article that solves that very same question in a more elegant way than the one you were proposing. What do you do next? Do you continue with your project or do you abandon it? Many of us would have the urge to continue, under the belief that otherwise our previous effort would go to waste. That is, we fail to appreciate that our effort is *already* wasted and thus cannot be recovered, a *sunk cost* that should be ignored. Instead, we would be better off by basing our decision exclusively on the future-oriented consequences: choose the project with the best chance of success today, whether you have spent 5 minutes or 5 months developing it.

The sunk cost fallacy is observed whether the resource is money, effort, or time, and whether the investor is an individual or a corporation. It has been shown in the lab as well as in the field. For example, people are more likely to attend the theater if they had paid full price for their season tickets than if such payment was waived at the moment of purchase (Arkes & Blumer, 1985). Cab drivers who pay a daily fee to rent the cab from the garage tend to work longer hours in days in which there is little business to avoid ending the day in debt, even though the normative behavior to maximize income would be to work longer hours in days in which there is a lot of business (Camerer, Babcock, Loewenstein, & Thaler, 1997).

Just as in the case of the endowment effect, the sunk cost can be explained by loss aversion. To see why, refer again to Figure 1. At the beginning of a project, the person is at the intersection of the *x* and *y*-axis, and the prospect of losing $100 would be quite aversive. In contrast, after having lost $100, the prospect of losing another $100 is not nearly as bad as the initial loss, due to diminishing marginal utility. In fact, it pales in comparison to the value of recovering that initial loss (i.e., going from -100 to zero).

There are only a handful of studies on the development of the sunk cost fallacy. While the specific vignettes vary across studies, they all share the same basic similarities. Here is an illustrative example:

You bought a cinema ticket from your pocket money. You paid $10. You start to watch the movie, but after 5 minutes you are bored and the film seems pretty bad. How much longer would you continue to watch it?

(a) 10 more minutes
(b) 30 more minutes
(c) watch until the end

In the control condition, the movie is free rather than paid (no cost). The normative answer is to ignore the sunk cost, and thus the answer should not vary by condition. One study tested a total of 63 children, from kindergarten to 6th grade, and found that half of them exhibited sunk cost fallacy; that is, children chose to stay longer in the movie if they paid for it. This effect was not modulated by age (Baron, Granato, Spranca, & Teubal, 1993). A more recent study of 90 elementary school children shows the same pattern when divided into three groups (1-2nd grade, 3-4th grade, 5-6th grade) (Morsanyi & Handley, 2008). And a third study on 90 older children (ages 8, 11, and 14) also showed large sunk cost effects that remained constant through development (Klaczynski & Cottrell, 2004). It is important to note that the studies lack the statistical power to draw strong conclusions about developmental trajectories based on these null effects.

Another interesting finding is that by the age of 9, children, like adults, endorse the rule of ‘waste not’, which when over-applied serves as the guiding principle for their sunk cost fallacy. Adults have been successfully trained to avoid this over-generalization (Larrick, Morgan, & Nisbett, 1990), a remarkable result considering how rare it is for de-biasing attempts to succeed. It would be interesting to test the efficacy of such training in the elementary and middle school setting. Finally, there have been no studies yet assessing behavioral evidence for sunk costs in children in the field, akin to the data collected on theater attendance; this remains an area open for future investigation.

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Mental accounting:

Although money is interchangeable (i.e., fungible), businesses and other organizations often establish separate accounts with budgets that cannot be shared across accounts. These accounts help monitor and control the spending, but they also create inefficiencies. Similar to actual accounts, people create mental accounts to monitor and control their spending; also similar to actual accounts, these mental constructs help control spending but also create inefficiencies (Thaler, 1999). As such, they are a departure from the normative model of rationality. One way in which these mental accounts exercise their effect is by leading people to allocate expenses into different accounts, and to evaluate their costs by account.

To study mental accounting during development, children are first presented with some general information such as: “Here are two dollars. Pretend you are going to the fair. You want to go on your favorite ride”. Next, children are read the experimental manipulation, as follows: “You bought a ticket for the ride with one of your dollar bills. When you go to the ride, your ticket blows away and you cannot get it back. Would you use your other dollar to buy another ticket?” In the control condition, the script would read “When you go to buy a ticket, you find that you’ve lost one of your dollar bills. Would you use the other dollar to buy a ticket to go on the ride?” Despite their superficial differences, the experimental and the control condition are identical in their deep structure. In both cases, a child who wants to experience a ride will end up two dollars poorer. Despite this functional similarity, adults treat the two situations very differently. The ticket blowing away makes people question whether the ride is really worth twice its ticket value; as a consequence, people become disinclined to purchase another ticket. In contrast, when the piece of paper lost is a dollar bill, people deem it unrelated to the cost of the ticket they are about to purchase; as a consequence, they decide to go ahead.

Only two studies have explored mental accounting in children, and both suffer from methodological limitations. The first study used a within-subject design to test 1st, 3rd, and 6th graders (n = 30 per group) in both versions of the vignette. The use of a within-subject design is questionable, because within-subject designs highlight the difference between the two vignettes, and once alerted participants might rectify the mistake. Sixth graders showed signs of sunk cost fallacy, in that they were more reluctant to purchase a second ticket after the first one blew away than to purchase a ticket after losing a dollar (Krouse, 1986). The younger groups showed no statistical difference between the two vignettes, but the group means are not reported in the article, so it is hard to know whether this is truly an absence of an effect or instead it is the result of an under-powered experimental design.

A second study tested three age groups (ages: 5-6, 8-9, and 11-12), with type of loss (ticket, money) as a between-subjects factor (Webley & Plaisier, 1998). There were only 10 participants per cell, so great caution should be exercised in the interpretation of these results. When told to imagine they had lost the dollar bill, the vast majority of children of all ages chose to buy the ticket, a result that mimic the pattern in adults. When told to imagine the loss was in the same account (i.e., ticket) the older group of children was reluctant to buy a new ticket, and the middle group was split. The youngest group remained inclined to purchase. The primary conclusion to draw from these studies is that this is an important research area that has been underexplored and is in need of more data.

Final Thoughts and Future Directions

When it comes to the literature on children’s decision making, the usually trite refrain that ‘more research is needed’ becomes very good advice. As our literature review shows, for many topics, the number of studies –and the number of participants in those studies– is insufficient to draw strong conclusions about developmental trajectories. One might speculate about the reasons why studies on the development of judgment and decision making are few and far between.

Maybe the dearth of research in this field is an unfortunate part of Piaget’s legacy, with its emphasis on stages and the belief that formal operational concepts such as the understanding of probability and expected value cannot by acquired until adolescence. However, this seems unlikely, as decades of research have documented cognitive achievements at early ages (Baillargeon, 1987), and few –if any– developmental psychologists still subscribe to Piaget’s timeline. Furthermore, some of the main ideas of Piaget’s theory –if not its timeline– seem to align well with some of the theoretical models used by decision making researchers. For example, according to Piaget, cognitive development consists of a growth in reasoning capacities and rationality: children’s thinking starts by relying on intuitions and it becomes more analytical and rational as we reach adulthood. This intuitive/analytical dichotomy meshes well with dual-system models that have been used to interpret the ‘biases and heuristic’ research program in adult decision making (Kahneman, 2011). We suspect that a more likely reason for the absence of cross-pollination of ideas between decision making and cognitive development is that its practitioners inhabit different research circles.

Whatever the reason for the lack of integration of decision making research and developmental psychology, we believe this is a path worth pursuing. A first obvious step would be to collect more data. While some topics (e.g., expected value) have been systematically explored and have amassed considerable evidence, for other topics (e.g., sunk cost, mental accounting, etc.) the data come from pioneering studies that should be thought of merely as proof of concept on feasibility. Thankfully, many of these tasks can be administered in just a few minutes, which is well suited for young children. Admittedly, careful consideration should be taken to design age-appropriate stimuli, but this is exactly an area in which developmental researchers excel.

Besides collecting more data, it is also necessary to gain a better understanding of the underlying mechanisms that lead to impaired performance, as we have previously alluded In sum, there is fertile soil for researchers interested in integrating these two fields of Decision Making and Development. We hope this review will provide the impetus for a new generation of developmental psychologists to explore this possibility. We think it would be the right choice (probably).

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