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How reasoning, judgment, and decision making are colored by gist-based intuition: A fuzzy-trace theory approach

Jonathan C. Corbin[b,1], Valerie F. Reyna[a,*], Rebecca B. Weldon[b,2], Charles J. Brainerd[c,2]

[a] Cornell University, Human Neuroscience Institute, Department of Human Development, G331 Martha van Rensselaer Hall, Ithaca, NY 14853, United States
[b] Department of Human Development, G331 Martha van Rensselaer Hall, Ithaca, NY 14853, United States
[c] Department of Human Development, G77 Martha van Rensselaer Hall, Ithaca, NY 14853, United States

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ABSTRACT

Fuzzy-trace theory distinguishes verbatim (literal, exact) from gist (meaningful) representations, predicting that reliance on gist increases with experience and expertise. Thus, many judgment-and-decision-making biases increase with development, such that cognition is colored by context in ways that violate logical coherence and probability theories. Nevertheless, this increase in gist-based intuition is adaptive: Gist is stable, less sensitive to interference, and easier to manipulate. Moreover, gist captures the functionally significant essence of information, supporting healthier and more robust decision processes. We describe how fuzzy-trace theory accounts for judgment-and-decision making phenomena, predicting the paradoxical arc of these processes with the development of experience and expertise. We present data linking gist memory processes to gist processing in decision making and provide illustrations of gist reliance in medicine, public health, and intelligence analysis. We report the first evidence of a predicted link between false memory and framing biases in risky choice.

In this article, we discuss how qualitatively different mental representations influence judgment and decision making, and how the reliance on these differing representations changes with age and expertise. Specifically, we draw a distinction between literal representations that capture the surface form of information, called *verbatim*, although the term applies to non-verbal as well as verbal stimuli, and meaningful representations that capture the essential *gist* of the same information. Some materials, tasks, and people focus cognition more on verbatim as opposed to gist representations. Nevertheless, for most adults, cognition tilts toward gist, despite encoding verbatim representations along with the gist. That is, adults unconsciously gravitate toward using the simplest meaningful representations that they can (within the constraints of a task) in reasoning, judgment, and decision making.

In the following, we provide an overview of fuzzy-trace theory (FTT), which distinguishes verbatim and gist representations, and is the source of predictions about reasoning, judgment, and decision making. We update the theory in the light of recent findings, reporting the first evidence linking theoretically predicted gist-based biases in memory and in decision making. We also review developmental differences in verbatim and gist representations and their implications for judgment and decision making in real-world contexts, such as public health, medicine, and intelligence analysis. In particular, we discuss increases in reliance on gist representations with age and experience. By "age," we mean the mechanisms that unfold with biological maturation and environmental stimulation, such as the neurological changes that occur in the brain from childhood to young adulthood and from adulthood to old age (e.g., Reyna, 2012a; Reyna, Chapman, Dougherty, & Confrey, 2012). In FTT, then, development occurs because of both biology and experience; experience under the proper circumstances produces insight and, in turn, changes the brain (see also Stickgold, 2005).

1. Background

1.1. Mental representations of information in reasoning, judgment, and decision problems

FTT is a comprehensive theory of memory and reasoning that is grounded in psycholinguistic research on how information is represented, retrieved, and processed. The theory draws a

* Corresponding author. Tel.: +1 607 254 1504; fax: +1 607 255 9856.
E-mail addresses: jcc367@cornell.edu (J.C. Corbin), vr53@cornell.edu (V.F. Reyna), rbw92@cornell.edu (R.B. Weldon), cb299@cornell.edu (C.J. Brainerd).
[1] Tel.: +1 828 230 0671.
[2] Tel.: +1 607 254 1163; fax: +1 607 255 9856.

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distinction between two kinds of memory representations, verbatim and gist (Reyna, 2012a). Gist representations capture the bottom-line meaning, whereas verbatim representations capture precise detail of experiences. Gist and verbatim representations exist on a continuum (from the "fuzziest" gist to the most precise verbatim), and are encoded, stored, and retrieved separately and in parallel. With age and expertise comes an increased "fuzzy processing preference," meaning that adults and experts tend to rely on the simplest gist necessary to complete a task. According to FTT, reasoning based on gist processing – the intuitive, bottom-line meaning – underlies advanced cognition.

Mental representations of these relations range from literal mental models that preserve precise details derived from information (e.g., representations of magnitudes of size or distance, e.g., Kosslyn, Ball, & Reiser, 1978) to approximate ordinal representations (e.g., of relative magnitudes of "more" vs. "less; "higher" vs. "lower") to the simplest representations of all-or-none categorical gist (e.g., "some" vs. "none"; "high" vs. "low"). Research on memory for magnitudes, frequencies, and probabilities has shown that people encode these specific verbatim-to-gist level representations of quantity (e.g., for reviews, see Reyna & Brainerd, 1994, 2008).

Decision-makers encode multiple representations at differing levels of specificity. Reliance on simplified representations in decision making is exemplified by the following paradox discovered by Allais (1953, 1997), called the "common consequence effect" in Kahneman and Tversky's paper which developed prospect theory (1979). Decision makers are given the following prospects, choosing either between A and B or between C and D:

A: $1 million for sure
B: .89 probability of $1 million, .10 probability of $5 million, .01 probability of $0
C: .11 probability of $1 million, .89 probability of $0
D: .10 probability of $5 million, .90 probability of $0

When deciding between A and B, many decision-makers prefer option A. However, option D is typically preferred over option C. Note that both A and B include a .89 probability of $1 million, leaving the comparison of an additional .11 probability of $1 million in option A, and a .10 probability of $5 million in option B—the same choice found between C and D. A decision-maker relying on a precise representation of the task would make consistent choices, choosing both A and C or B and D. Choices in tasks such as the Allais paradox predict everyday decisions such as making financial investments, buying insurance, or making medical decisions (e.g., Reyna, Nelson, Han, & Pignone, 2015b).

Fuzzy-trace theory predicts that decisions makers process multiple representations of these options, including verbatim words and numbers, but give greater weight to the simplest gist representation (Reyna, 2012b). The simplest representation of quantities is categorical (i.e., nominal scale). That is, the first two options A and B boil down to a categorical gist of A—gaining something–versus B—gaining something or gaining nothing. This categorical representation leads to a preference for A, avoiding the possibility of gaining nothing (although computing the numbers, which is done in parallel, leads to a competing preference for B; see below). When deciding between C and D, the categorical comparison of something versus nothing does not produce a clear preference because both options are represented as gaining something or gaining nothing. The next simplest representation for C versus D is ordinal: C involves a low probability of gaining *less* ($1 million) versus a similar low probability of gaining *more* ($5 million), leading to a preference for D, the option with more money.

The verbatim representation involves taking the numbers in these choices at face value—taking them literally rather than gistifying them. Using the precise numbers, and computing what is called "expected value" (e.g., 1.0 probability × $1 million = $ 1million) reveals that options B and D are mathematically superior to options A and C. Even little children apply a rule like expected value, multiplying probabilities and outcomes (for a review, see Reyna & Brainerd, 1994). Combining each of these representations (categorical gist, ordinal gist, and literal numbers), produces conflicting preferences for A versus B, but a clear preference for D over C, which is the pattern of results that is usually observed (Reyna & Brainerd, 2011). The example using the Allais paradox underscores the fact that FTT is a model in which multiple representations are encoded simultaneously, all influencing final preferences.

Implicit in our discussion of preferences is the idea that people apply values and moral principles regarding money and other objects of choice. FTT assumes that people have such basic values stored in long-term memory (e.g., money is good, so more money is better than less money), and they retrieve those values to apply them to representations of options (Reyna, 2008; Reyna & Mills, 2014). Retrieval is a variable process and depends on external cues, as with retrieving anything stored in long-term memory. Therefore, preferences can differ depending on which values are retrieved in a decision-making situation (for details, see Mills, Reyna, & Estrada, 2008; Reyna et al., 2011).

Further, the specificity requirements of a judgment or decision task dictate which level of representation is relied on for a response. Thus, decision-makers *calibrate* the specificity of the mental representation to the demands of the task (e.g., choices, rankings, or numerical estimates). As illustrated with the Allais paradox, it is possible to make choices using simple categorical representations. However, categorical representations would not be sufficient to estimate how much money a person would be willing to pay for rent; monetary estimates require more fine-grained representations (Reyna & Brainerd, 1995).

Finally, variation in judgment and decision making can also be attributed to the diligence with which individuals monitor the quality of their thinking (Liberali, Reyna, Furlan, Stein, & Pardo, 2012). Research has shown that individual differences in monitoring are distinct from the basic processes that produce biases or paradoxes in judgment and decision making (e.g., Stanovich & West, 2008). In other words, monitoring thinking (and, consequently, mental subtraction) can lead to the realization that a $10 discount on a $100 plane ticket is equal to a $90 ticket that just got marked down by $10 from $100 (all else being equal; see also Frederick, 2005). As we outline in more detail below, each of these concepts – representation (calibrated to each task), retrieval, and monitoring – offers insight into the processes underlying judgment and decision making.

1.2. Effects of the task and context on reasoning, judgment, and decision making

1.2.1. Task calibration

As we have discussed, the concept of task calibration in FTT is that individuals match the specificity of mental representation that they rely on with the specificity of the task demands (e.g., Reyna, 2012a). Adults use the simplest mental representations that they can to accomplish the task; the task itself presents constraints (e.g., Reyna, 2012a). A task could be *choosing* between two options, *ranking* options in terms of their perceived probability, or providing *exact* numbers from memory (e.g., memory for frequencies of events; Miller, Valsangkar-Smyth, Newman, Dumont, & Wolford, 2005). More specific questions require calibration to more precise representations, such as when asked what the temperature is today, an appropriate reply is numerical (e.g., 80 degrees). However, the question about whether today is hotter than yesterday requires only an ordinal distinction (e.g., hotter than). Finally, when asked if it is hot today (a categorical question), a distinction between hot or not hot is sufficient.