

IN TWO MINDS: DUAL-PROCESS THEORIES OF REASONING AND RATIONALITY

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Dual Processes in Reasoning and Decision Making:
Fuzzy Rationality

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Abstract

In this talk, I discuss the commonalities and distinctions between fuzzy-trace theory and other dual-process approaches to reasoning, judgment, and decision making. The commonalities include the acknowledgment that adult reasoning encompasses alternative modes of processing: one that is analytical, quantitative, and operates on precise memory representations toward the verbatim end of a continuum and another that is intuitive, qualitative, and operates on gist representations toward the fuzzy end of the continuum (e.g., Reyna, Lloyd, & Brainerd, 2003). The detailed experimental and modeling data gathered under the rubric of fuzzy-trace theory (e.g., Brainerd, Reyna, & Mojardin, 1999; Reyna & Brainerd, 1995) provide additional, independent evidence favoring a general dual-process perspective (e.g., Evans, 2003, in press; Klaczynski, 2005). These dual-process data include paradoxical memory effects and troubling, but theoretically predictable, variability in human reasoning performance in a wide range of tasks, such as logical reasoning (e.g., difficulties with modus tollens reasoning in the Wason card problem; Falmagne, 1975; Reyna, 1991) and judgment and decision making (e.g., heuristics and biases in probability judgment; Gilovich, Griffin, & Kahneman, 2002; Reyna & Brainerd, 1991, 1994).

In the domain of memory, fuzzy-trace theory subsumes contradictory findings from both the constructivist (i.e. schema memory) and learning theory traditions. For example, it was shown in numerous experiments with different age groups that verbatim and gist memory representations are encoded, stored, and retrieved roughly in parallel, contradicting semantic integration predictions of traditional psycholinguistic theory. These dual representations account for schematic memory effects, such as false recognition in sentence verification tasks (Brainerd & Reyna, 2005; Bransford & Franks, 1971; Loftus, 1979) as well as seemingly conflicting findings that verbatim and gist memories can be accessed independently (Alba & Hasher, 1983; Reyna & Kiernan, 1994, 1995).

In the domain of reasoning, three assumptions accommodate the findings: (a) people encode both verbatim and gist representations for any meaningful stimulus (e.g., pictures, words, numbers, sentences, narratives, and events, all of which have been studied); but (b) they have a fuzzy-processing preference, which means that they rely on the least precise gist representations that can be used to accomplish a task (regardless of whether the task is called memory or reasoning); and (c) this tendency to operate on fuzzy memory representations increases with experience (e.g., with age from childhood

to adulthood and, in adulthood, with increases in expertise; Reyna & Adam, 2003). Hence, fuzzy-trace theory is the only developmental theory that predicts that intuition develops into adulthood and represents an advanced form of mature reasoning (Jacobs & Klaczynski, 2002; Reyna, 2004; Reyna et al., 2003; Reyna, Adam, Poirier, LeCroy, & Brainerd, 2005).

Fuzzy-trace theory has been applied to diverse tasks, including classic Piagetian (e.g., class-inclusion, conservation, probability judgment), verbal reasoning (e.g., syllogistic reasoning, transitive inference, spatial reasoning, metaphorical interpretation), and judgment and decision making tasks (e.g., framing effects, hindsight bias, base-rate neglect, conjunction, and disjunction fallacies), as well as older findings from Gestalt theory involving transfer and learning theory involving transposition effects (see Reyna, 2005; Reyna et al., 2003; Reyna & Brainerd, 1995, 1998 for overviews; Wolfe, Reyna, & Brainerd, 2005). Fuzzy-trace theory has also been the source of new, counterintuitive findings, such as mere memory testing (non-suggestive recognition tests foster false memories of gist), false memory persistence (false memories are more consistent across memory interviews than true memories), non-numerical framing effects (removing numbers in decision scenarios increases framing biases), reflection (gain-loss) effects in early childhood, reductions in risk-taking preference from childhood to adulthood, developmental shifts from trading off risks and rewards in childhood to gist-based categorical thinking in adulthood, and selective processing effects that disconfirm expectancy based theories (e.g., prospect theory).

Results of process-level analyses of these tasks support both coherence and correspondence criteria for rationality, and support the further idea that these criteria are distinct (e.g., Reyna & Farley, press). That is, reasoners can excel in achieving good outcomes in the world, accurately discriminating reality (correspondence), but nevertheless evince failures of coherence (violations of internal coherence according to semantics, logic, or probability), and vice versa (e.g., Adam & Reyna, 2005; Reyna & Brainerd, 1994). These detailed, process-level analyses of tasks also support the claim that there are degrees of rationality (that map onto different underlying processes), and that goal achievement is not sufficient for rationality (i.e., that goals themselves are fair game in evaluating rationality; see also Doherty, 2003; Stanovich, 2005).

In addition to discussing the theoretical and empirical developments that underlie fuzzy-trace theory, I will also address findings from traditional dual-process tasks, such as matching in the Wason card problem (Evans, 2003), and differences among dual – process theories' assumptions relating to memory representations versus processing, intuition versus association (Sloman, 2002), and the role of emotions in reasoning and decision making (Stanovich, 2004).

Adam, M. B., & Reyna, V. F. (2005). Coherence and correspondence criteria for rationality: Experts' estimation of risks of sexually transmitted infections. *Journal of Behavioral Decision Making*, 18, 169-186.

Alba, J.W. & Hasher, L. (1983). Is memory schematic? *Psychological Bulletin*, 93, 203-231.

Brainerd, C. J., & Reyna, V. F. (2005). *The science of false memory*. New York: Oxford University Press.

Brainerd, C. J., Reyna, V. F., & Mojardin, A. H. (1999). Conjoint recognition.

- Psychological Review*, 106(1), 160-179.
- Bransford, J.D., & Franks, J.J. (1971). The abstraction of linguistic ideas. *Cognitive Psychology* 2, 331-350.
- Doherty, M. E. (2003). Optimists, pessimists, and realists. In S. L. Schnieder & J. Shanteau (Eds.), *Emerging perspectives on judgments and decision research* (pp. 643-679). New York: Cambridge University Press.
- Evans, J. St. B. T. (2003). In two minds: Dual-process accounts of reasoning. *Trends in Cognitive Sciences*, 7, 454-459.
- Evans, J. St. B. T. (in press). Dual system theories of cognition: Some issues. *Proceedings of the Cognitive Science Society*.
- Falmagne, R. J. (1975). *Reasoning: Representation and process in children and adult*. Hillsdale, NJ: Erlbaum Associates.
- Gilovich, T., Griffin, D.W., & Kahneman, D. (2002). *Heuristic and biases: The psychology of intuitive judgment*. New York: Cambridge University Press.
- Jacobs, J. E., & Klaczynski, P. A. (2002). The development of judgment and decision-making during childhood and adolescence. *Current Directions in Psychological Science*, 11, 145-149.
- Klaczynski, P. (2005). Metacognition and cognitive variability: A dual-process model of decision making and its development. In J. Jacobs & P. Klaczynski, (Eds.) *The development of judgment and decision-making in children and adolescence* (pp. 39-76). Mahwah, NJ: Erlbaum.
- Loftus, E.J. (1979). The malleability of human memory. *American Scientist*, 67, 312-320.
- Reyna, V.F. (1991). Class inclusion, the conjunction fallacy, and other cognitive illusions. *Developmental Review*, 11, 317-336.
- Reyna, V. (2004). How people make decisions that involve risk: A dual-processes approach. *Current Directions in Psychological Science*, 13, 60-66.
- Reyna, V. (2005). Fuzzy-trace theory, judgment, and decision-making: A dual-processes approach. In C. Izawa & N. Ohta (Eds.), *Human learning and memory: Advances in theory and application; the 4th Tsukuba International Conference on Memory* (pp. 239-256). Mahwah, NJ: Erlbaum Associates.
- Reyna, V. F., Adam, M. B. (2003). Fuzzy-trace theory, risk communication, and product labeling in sexually transmitted diseases. *Risk Analysis*, 23, 325-342.
- Reyna, V. F., Adam, M. B., Poirier, K., LeCroy, C. W., & Brainerd, C. J. (2005). Risky decision-making in childhood and adolescence: A fuzzy-trace theory approach. In J. Jacobs & P. Klaczynski (Eds.), *The development of judgment and decision-making in children and adolescents* (pp. 77-106). Mahwah, NJ: Erlbaum.
- Reyna, V. F., & Brainerd, C. J. (1991). Fuzzy-trace theory and framing effects in choice: Gist extraction, truncation, and conversion. *Journal of Behavioral Decision Making*, 4, 249-262.
- Reyna, V.F., & Brainerd, C.J. (1994). The origins of probability judgment: A review of data and theories. In G. Wright & P. Ayton (Eds.), *Subjective probability*. (pp. 239-272). New York: Wiley.
- Reyna, V. F., & Brainerd, C. J. (1995). Fuzzy-trace theory: An interim synthesis. *Learning and Individual Differences*, 7, 1-75.
- Reyna, V. F., & Brainerd, C. J. (1998). Fuzzy-trace theory and false memory: New frontiers. *Journal of Experimental Child Psychology*, 71, 194-209.

- Reyna, V. F., & Ellis, S. C. (1994). Fuzzy-trace theory and framing effects in children's risky decision making. *Psychological Science, 5*, 275-279.
- Reyna, V. F., & Farley, F. (in press). Risk and rationality in adolescent decision-making: Implications for theory, practice, and public policy. *Psychological Science in the Public Interest*.
- Reyna, V. F., & Kiernan, B. (1994). The development of gist versus verbatim memory in sentence recognition: Effects of lexical familiarity, semantic content, encoding instruction, and retention interval. *Developmental Psychology, 30*, 178-191.
- Reyna, V. F., & Kiernan, B. (1995). Children's memory and metaphorical interpretation. *Metaphor and Symbolic Activity, 10*, 309-331.
- Reyna, V. F., Lloyd, F. J., & Brainerd, C. J. (2003). Memory, development, and rationality: An integrative theory of judgment and decision making. In S.L. Schneider & J. Shanteau (Eds.), *Emerging perspectives on judgment and decision research* (pp. 201-245). New York: Cambridge University Press.
- Sloman, S. A. (2002). Two systems of reasoning. In T. Gilovich, D. Griffin, & D. Kahneman (Eds.), *Heuristics and biases: The psychology of intuitive judgment*. (pp. 379-396). New York: Cambridge University Press.
- Stanovich, K. E. (2004). *The robot's rebellion: Finding meaning in the age of Darwin*. Chicago: University of Chicago Press.
- Stanovich, K. E. (2005). Commentary: Development and decisions. In J. Jacobs & P. Klaczynski, (Eds.) *The development of judgment and decision-making in children and adolescence* (pp. 107-113). Mahwah, NJ: Erlbaum.
- Wolfe C. R., Reyna, V. F., & Brainerd, C. J. (2005). Fuzzy-trace theory: Implications for transfer in teaching and learning. In J. P. Mestre (Ed.), *Transfer of learning from a modern multidisciplinary perspective* (pp. 53-88). Greenwich, CT: Information Age Publishing.