



# The Contributions of Explanation and Exploration to Children's Scientific Reasoning

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**ABSTRACT**—Both explanation and exploration can foster causal learning, yet the mechanisms underlying these effects are largely unknown, especially in early childhood. In this article, I provide an overview of research on the relation among explanation, exploration, and the development of scientific reasoning. I propose that explaining and exploring operate in tandem as hypothesis-generating and hypothesis-testing mechanisms. I review evidence that supports this claim by demonstrating that inconsistency with prior knowledge selectively motivates children to construct explanations, guides discovery-oriented behavior, and drives the early-developing capacity to reason scientifically. I conclude with a discussion of the educational applications of research on the development of children's scientific reasoning in informal learning settings.

**KEYWORDS**—causal reasoning; children's museums; cognitive development; early childhood; early science learning;

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Young children are characteristically curious; they explain unexpected phenomena (Legare, Gelman, & Wellman, 2010) and explore causal connections through play (Legare, 2012; Schulz & Bonawitz, 2007). Explaining and exploring are crucial components of the scientific process, and determining how young children engage in early scientific reasoning is critical for teaching science at any level (Gelman, Brenneman, Macdonald, & Román, 2010).

Despite the often unstructured and unsystematic appearance of children's explanations and exploration, these behaviors facilitate learning (Amsterlaw & Wellman, 2006; Crowley & Siegler, 1999; Nicolopoulou, 2010; Rittle-Johnson, Saylor, & Swygart, 2007; Siegler, 1995; Singer, 2006). For example, generating explanations can improve causal learning and promote generalization (Lombrozo, 2006; Wellman, 2011). Children can also learn from spontaneous exploration (Baldwin, Markman, & Melartin, 1993; Bonawitz, van Schijndel, Friel, & Schulz, 2012). Children's exploration helps generate evidence relevant to disambiguating different causal variables (Cook, Goodman, & Schulz, 2011; Schulz & Bonawitz, 2007) and apparently is most effective when directed toward explaining inconsistent outcomes as opposed to confirming previous observations (Legare, 2012).

Although children can learn through both explanation and exploration, the mechanisms underlying these effects are largely unknown, especially in early childhood. In this article, I provide an overview of research on the relation among explanation, exploration, and scientific reasoning. First, I discuss evidence that generating explanations and engaging in exploration may uniquely and selectively benefit causal learning. Second, I provide evidence for the proposal that explaining and exploring are not mutually exclusive in spontaneous conversation and play, but instead may operate in tandem as hypothesis-generating and hypothesis-testing mechanisms. Finally, I suggest the need for research on the relation among explanation, exploration, and

causal learning, and review the educational applications of research on the development of scientific reasoning in informal learning settings.

### EXPLANATION AND CAUSAL LEARNING

We know relatively little about how explaining affects learning (i.e., how it differs from other processes) and how it is selective (i.e., whether and how effects are targeted to particular kinds of learning) in early childhood. In this review, I define explanation as an attempt to understand a causal relation by identifying relevant functional or mechanistic information (Kelemen, 1999; Legare et al., 2010; Lombrozo, 2006, 2009). Interest is growing about the extent to which the benefits to learning of self-explanation are unique compared to other cognitive processes (e.g., observation and description; see Lombrozo, 2012). Could self-explanation—that is, explaining to oneself or another person—exert effects by increasing general attention or engagement rather than recruiting mechanisms specific to the construction or evaluation of explanation (Chi, 2009)? New work supports the unique nature of the effects of explanation. For example, the benefits to learning of explanation may be unique from comparison activities that require similar amounts of time and effort (Legare & Lombrozo, in press; McEldoon, Durkin, & Rittle-Johnson, 2012; Rittle-Johnson et al., 2008; Walker, Lombrozo, Legare, & Gopnik, 2013).

What is responsible for these unique effects? One possibility is that engaging in explanation constrains children to focus selectively on identifying causal mechanisms (Keil, 2006; Legare, 2012) and making generalizations (Williams & Lombrozo, 2010). A prompt to explain can lead even young children to posit unobserved causes, internal mechanisms, and causal functions (Legare, Wellman, & Gelman, 2009; Legare et al., 2010) and favor generalizations that account for more observations (Walker, Williams, Lombrozo, & Gopnik, 2012), suggesting that prompts to explain might guide children toward underlying causal patterns (Walker et al., 2013).

One series of studies (Legare & Lombrozo, in press) looked at how and why explanation influences learning in young children by investigating the unique and selective effects of explanation compared to other tasks that require equivalent cognitive engagement. In particular, the studies examined how explanation differs from the spontaneous processing of information that occurs during observation, and from other processes that require constructive engagement, such as description. This work addresses two questions. First, does explanation provide unique leverage in learning about a causal system? Second, to what extent does explanation result in general benefits for learning as opposed to selective benefits or even potential costs?

To examine these questions, the researchers gave preschoolers a novel mechanical toy with visible interlocking gears and assessed their learning using measures that looked at how the

children learned about the toy's functional–mechanical relations, how they learned about the toy's nonfunctional properties (e.g., color), and how they generalized the toy's function and mechanism in constructing a novel toy. In Study 1, differences in learning were compared between children who had been asked to explain versus children who had been asked to observe. In Study 2, learning was assessed as a function of type of verbal response, with children's spontaneous utterances coded for the presence of explanations. Dependent measures included the extent to which children understood the machine's functional–mechanical relations, remembered perceptual features of the machine, successfully reconstructed the machine, and, for Study 2 only, generalized the function of the machine in constructing a novel machine.

In both studies, children who provided an explanatory verbal response outperformed those who provided other verbal responses on measures of causal learning, but this benefit did not extend to memory for causally irrelevant details. When it came to generalizing a function from one toy to another, explainers outperformed nonexplainers. These findings suggest that effects of explanation are distinct from those of observation or other kinds of verbalization, and result in selective rather than general benefits for learning, even leading to impairments for younger children. The results demonstrate that constructing explanations is useful for learning about causal mechanisms and supporting generalization, but does not improve memory for functionally irrelevant, perceptual details. Moreover, they provide evidence that self-explanations facilitate children's learning in the absence of explanatory feedback from others. In previous studies on self-explanations, children were asked to explain the feedback of others (such as why an answer was correct or why a strategy was effective; Crowley & Siegler, 1999; Rittle-Johnson et al., 2008).

In research with older children and adults, the effects of explanation are also selective. Explanation can foster analogical transfer at the expense of memory for previous problems (Needham & Begg, 1991), and may lead to overgeneralization errors by privileging patterns over individual examples (Williams, Lombrozo, & Rehder, 2013) and consistency with data in justifying causal judgments (Berthold, Roder, Knorzner, Kessler, & Renkl, 2011; Kuhn & Katz, 2009). When adults are asked to explain an event, they often seek information about causal mechanisms (Keil, 2006), and prompting adults to explain can foster the discovery and generalization of broad patterns (Williams & Lombrozo, 2010, 2013) at the expense of individual examples (Williams et al., 2013).

### EXPLORATION AND CAUSAL LEARNING

As with explanation, we know relatively little about how exploration may benefit learning uniquely and selectively in early childhood, which is surprising because exploration is considered

crucial for cognitive development (Singer, 2006). Both infants and preschoolers can learn effectively from spontaneous exploration (Baldwin et al., 1993; Bonawitz et al., 2012; Needham, 2009; Schulz & Bonawitz, 2007) and learn more from their own intervention in a causal system than from those of others (Kushnir, Wellman, & Gelman, 2009).

Yet despite the relation between children's exploratory behavior and scientific reasoning (Gelman et al., 2010; Hirsh-Pasek, Golinkoff, Berk, & Singer, 2009; Singer, 2006), older children and adults have difficulty designing informative, controlled interventions and often fail to anticipate the type of evidence that would support or undermine causal hypotheses (Masnick & Klahr, 2003). However, much about formal science learning is unlike exploratory learning in early childhood (Bonawitz et al., 2012). Although the ability to engage in some of the precursors of scientific reasoning emerges in early childhood (Gopnik, 2007), some aspects of scientific thinking require extensive formal science education and remain difficult even in adulthood. Unlike many of the tasks used in science education research, which typically requires suspending prior beliefs and reasoning from statistical data, causal reasoning often requires integrating prior beliefs and evidence. Even preschool children can integrate prior knowledge with statistical information to make accurate causal judgments (Gopnik, 2007). Researchers should examine the relation between children's early developing and untutored proclivities for explanation and exploration, and the development of scientific skills that require formal education and training.

### EXPLANATION AND EXPLORATION WORK IN TANDEM

I propose that explanation and exploration operate synergistically: Explanation serves as a mechanism for generating, constraining, and evaluating hypotheses, and exploration serves as a mechanism for testing them. These two components of scientific reasoning seem to be connected in the context of causal learning settings (Bonawitz et al., 2012; Legare, 2012). One reason for this may be that explanation and exploration are especially powerful in early childhood because they serve as mechanisms by which children succeed in going beyond concrete appearances to recognize abstract structure, such as causal relations.

Despite evidence that anomalous or inconsistent information motivates both explanation (Legare, 2012; Legare et al., 2010) and exploration (Schulz & Bonawitz, 2007), the way in which the two processes jointly facilitate or drive causal knowledge acquisition remains underspecified. In addition, we know little about the extent to which children spontaneously generate and test hypotheses in the context of free play (Legare, 2012). Does the process of constructing a causal explanation of inconsistent outcomes inform and constrain children's exploratory behavior? Do causal explanation and exploratory behavior operate syn-

ergistically as hypothesis-generating and hypothesis-testing mechanisms? Is this process associated with tangible learning outcomes?

I propose that encouraging children to explain inconsistency confronts children with the inconsistent evidence most likely to foster theory revision, guides the hypothesis-testing process, and promotes learning. These explanatory intuitions may constrain learners to focus on some aspects of what they are trying to understand over others. Young children readily form expectations for causal regularities based on prior knowledge (even when sparse; Gopnik, 2007), which may motivate them to attend to irregular or discordant information. Information that is inconsistent with how they expect things to happen is especially informative because it indicates that their prior knowledge about a causal relation or outcome is incomplete or inaccurate. Therefore, children may be attentive to, and more likely to attempt to explain, disconfirmatory outcomes. Engaging in explanation allows children the opportunity to examine and reconcile inconsistent information in the context of prior beliefs through a dynamic process of testing and revising hypotheses.

Consistent with this proposal, children learn more effectively when their exploration uncovers knowledge as opposed to confirming information they have already observed (Legare, 2012; Sobel & Sommerville, 2009). Children explore more when shown ambiguous data (Schulz & Bonawitz, 2007) and explore in systematic ways to resolve ambiguity (Cook et al., 2011), seemingly trying to discover explanations for unusual or unexpected events (Legare et al., 2010). In addition, explaining inconsistency informs the process of acquiring knowledge by guiding exploratory behavior; for inconsistent outcomes only, the kind of explanation children generate differentially predicts the kind of exploratory behavior children engage in. The kind of explanation children provide also predicts the rate of spontaneous, hypothesis-testing exploratory behavior and the tendency to modify existing explanatory hypotheses in the face of disconfirming evidence (Legare, 2012).

Explanation and exploration may operate in tandem in many ways. One possibility is that children alternate between exploration and explanation to test the truth value of their explanatory hypotheses, making explanation and exploration complementary. For example, generating explanations may lead to more targeted subsequent exploration and thus produce the kind of feedback necessary to revise hypotheses (Legare, 2012). Prior knowledge and learning goals may play roles in how information is interpreted and how conclusions are drawn, as well as influence the optimal temporal sequence of these behaviors, such as "explain first, then explore." Thus, examining the reciprocal and complementary contributions of explanation and exploration to the development of scientific reasoning requires understanding what motivates children to engage in the discovery process, what their prior task-relevant knowledge is, and what they hope to learn. Researchers should examine the conditions under which direct instruction can be integrated with discovery learning in

educationally optimal ways. Under certain conditions, children benefit from direct instruction as much as they do from both self-explanation (Crowley & Siegler, 1999) and self-discovery (Dean & Kuhn, 2007; Klahr & Nigam, 2004). Researchers should also examine the extent to which exploration and explanation operate differently across different domains. For example, the kind of evidence children have access to through direct exploration may differ for physical versus biological or psychological processes.

### EXPLANATION AND EXPLORATION IN EARLY SCIENCE LEARNING ENVIRONMENTS

In laboratory-based studies, young children have sophisticated capacities to both explain and explore. However, the extent to which these capacities translate to formal or informal learning environments is understudied. Preschoolers do not consistently test hypotheses systematically, do not understand consistently the relation between data and conclusions, and do not design unconfounded tests of causal relations (Dean & Kuhn, 2007; Klahr & Nigam, 2004). The learning objectives of informal science learning environments include the development of intuitive understanding of content knowledge in science—concepts, explanations, models, and facts—through an increased store of firsthand experience. Examining how to use explanation and exploration to structure engagement with learning environments to optimize learning, reasoning, and problem solving is beneficial. I propose that explanation provides a means to practice reasoning scientifically, thinking logically, and connecting new ideas to prior knowledge. Explanation elucidates relations by constraining and guiding exploration, and provides opportunities for making predictions and formulating new hypotheses (Legare, 2012; Legare et al., 2010). Conducting studies in children’s science museums also allows researchers to examine the extent to which using explanation in the context of informal learning increases intuitive understanding of basic natural science and engineering concepts.

Given the proposed interaction between explanation and exploration, the informal learning environments of children’s museums provide an ideal setting for research on this topic. Children’s museums are designed to promote exploration (Gaskins, 2008) and conversations between parents and children (Callanan & Jipson, 2001). Research in informal learning environments allows scientists to study the interaction between children’s cognition and the social context of family interactions and conversations (Benjamin, Haden, & Wilkerson, 2010; Callanan & Jipson, 2001; Callanan & Oakes, 1992; Frazier, Gelman, & Wellman, 2009; Gaskins, 2008). Museums also provide opportunities to investigate diversity in children’s social learning experiences, providing information needed to advance our understanding of how to broaden participation in learning science.

Working with children’s science museums can make both basic contributions to our understanding of causal learning and

scientific reasoning, and applied contributions to our understanding of how to use explanation and exploration to maximize engagement in informal learning contexts. Researchers should link the social nature of exploration and explanation with measures of children’s conceptual understanding by focusing on interactions in families. They also should examine how explanation and exploration interact in informal settings and how they relate to children’s learning (Cobb, Confrey, Lehrer, & Schauble, 2003).

### SUMMARY

The way children gather evidence through exploration and understand it through explanation provides insights into the development of scientific reasoning. Recent developmental research sheds light on the cognitive processes by which explanation and exploration work in tandem to lead to novel understanding. Inconsistency with prior knowledge selectively motivates children to construct explanations (Legare & Gelman, 2014; Legare et al., 2010), guides discovery-oriented behavior, and constrains the early-developing capacity to reason scientifically (Legare, 2012). Although questions remain, new findings help lay the foundation for a comprehensive understanding of the contributions of explanation and exploration to the development of scientific reasoning, and inform design-based research on how to harness the potential of each process for more effective early science education. This research can be applied in informal learning environments such as children’s museums and should be informed by examining the occurrence of explanation and exploration in children’s learning across a variety of socio-cultural settings.

### REFERENCES

- Amsterlaw, J., & Wellman, H. M. (2006). Theories of mind in transition: A microgenetic study of the development of false belief understanding. *Journal of Cognitive Development, 7*, 139–172. doi:10.1207/s15327647jcd0702\_1
- Baldwin, D., Markman, E., & Melartin, R. (1993). Infants’ ability to draw inferences about nonobvious object properties: Evidence from exploratory play. *Child Development, 64*, 711–728. doi:10.1111/j.1467-8624.1993.tb02938.x
- Benjamin, N., Haden, C. A., & Wilkerson, E. (2010). Enhancing building, conversation, and learning through caregiver–child interactions in a children’s museum. *Developmental Psychology, 46*, 502–515.
- Berthold, K., Röder, H., Knörzer, D., Kessler, W., & Renkl, A. (2011). The double-edged effects of explanation prompts. *Computers in Human Behavior, 27*, 69–75. doi:10.1016/j.chb.2010.05.025
- Bonawitz, E. B., van Schijndel, T., Friel, D., & Schulz, L. (2012). Balancing theories and evidence in children’s exploration, explanations, and learning. *Cognitive Psychology, 64*, 215–234. doi:10.1016/j.cogpsych.2011.12.002
- Callanan, M. A., & Jipson, J. L. (2001). Explanatory conversations and young children’s developing scientific literacy. In K. Crowley, C. D. Schunn, & T. Okada (Eds.), *Designing for science:*

- Implications from everyday, classroom, and professional settings* (pp. 21–49). Mahwah, NJ: Erlbaum.
- Callanan, M. A., & Oakes, L. M. (1992). Preschoolers' questions and parents' explanations: Causal thinking in everyday activity. *Cognitive Development, 7*, 213–233. doi:10.1016/0885-2014(92)90012-G
- Chi, M. (2009). Active-constructive-interactive: A conceptual framework for differentiating learning activities. *Topics in Cognitive Science, 1*, 73–105. doi:10.1111/j.1756-8765.2008.01005.x
- Cobb, P., Confrey, J., Lehrer, R., & Schauble, L. (2003). Design experiments in educational research. *Educational Researcher, 32*, 9–13. doi:10.3102/0013189X032001009
- Cook, C., Goodman, N., & Schulz, L. (2011). Where silence starts: Spontaneous experiments in preschoolers' exploratory play. *Cognition, 120*, 341–349. doi:10.1016/j.cognition.2011.03.003
- Crowley, K., & Siegler, R. S. (1999). Explanation and generalization in young children's strategy learning. *Child Development, 70*, 304–316.
- Dean, D., & Kuhn, D. (2007). Direct instruction vs. discovery: The long view. *Science Education, 91*, 384–397. doi:10.1002/scs.20194
- Frazier, B. N., Gelman, S. A., & Wellman, H. M. (2009). Preschoolers' search for explanatory information within adult-child conversation. *Child Development, 80*, 1592–1611. doi:10.1111/j.1467-8624.2009.01356.x
- Gaskins, S. (2008). The cultural meaning of play and learning in children's museums. *Hand to Hand, 22*, 8–11.
- Gelman, R., Brennen, K., Macdonald, G., & Román, M. (2010). *Preschool pathways to science (PrePS): Facilitating scientific ways of thinking, talking, doing, and understanding*. Baltimore, MD: Brookes.
- Gopnik, A., & Schulz, L. (Eds.). (2007). *Causal learning: Psychology, philosophy, and computation*. Oxford, UK: Oxford University Press.
- Hirsh-Pasek, K., Golinkoff, R. M., Berk, L. E., & Singer, D. G. (2009). *A mandate for playful learning in preschool: Presenting the evidence*. New York, NY: Oxford University Press.
- Keil, F. (2006). Explanation and understanding. *Annual Review of Psychology, 57*, 227–254. doi:10.1146/annurev.psych.57.102904.190100
- Kelemen, D. (1999). The scope of teleological thinking in preschool children. *Cognition, 70*, 241–272. doi:10.1016/S0010-0277(99)00010-4
- Klahr, D., & Nigam, M. (2004). The equivalence of learning paths in early science instruction effects of direct instruction and discovery learning. *Psychological Science, 15*, 661–667. doi:10.1111/j.0956-7976.2004.00737.x
- Kuhn, D., & Katz, J. (2009). Are self-explanations always beneficial? *Journal of Experimental Child Psychology, 103*, 386–394. doi:10.1016/j.jecp.2009.03.003
- Kushnir, T., Wellman, H. M., & Gelman, S. A. (2009). A self-agency bias in children's causal inferences. *Developmental Psychology, 45*, 597–603. doi:10.1037/a0014727
- Legare, C. H. (2012). Exploring explanation: Explaining inconsistent information guides hypothesis-testing behavior in young children. *Child Development, 83*, 173–185. doi:10.1111/j.1467-8624.2011.01691.x
- Legare, C. H., & Gelman, S. A. (2014). Examining explanatory biases in young children's biological reasoning. *Journal of Cognition and Development*. Advance online publication. doi:10.1080/15248372.2012.749480
- Legare, C. H., Gelman, S. A., & Wellman, H. M. (2010). Inconsistency with prior knowledge triggers children's causal explanatory reasoning. *Child Development, 81*, 929–944. doi:10.1111/j.1467-8624.2010.01443.x
- Legare, C. H., & Lombrozo, T. (in press). The selective benefits of explanation on learning in early childhood. *Journal of Experimental Child Psychology*.
- Legare, C. H., Wellman, H. M., & Gelman, S. A. (2009). Evidence for an explanation advantage in naïve biological reasoning. *Cognitive Psychology, 58*, 177–194. doi:10.1016/j.cogpsych.2008.06.002
- Lombrozo, T. (2006). The structure and function of explanations. *Trends in Cognitive Sciences, 10*, 464–470.
- Lombrozo, T. (2009). *Explanation and categorization: How "why?" informs "what?"* *Cognition, 110*, 248–253. doi:10.1016/j.cognition.2008.10.007
- Lombrozo, T. (2012). Explanation and abductive inference. *Oxford Handbook of Thinking and Reasoning*, 260–276.
- Masnick, A. M., & Klahr, D. (2003). Error Matters: An initial exploration of elementary school children's understanding of experimental error. *Journal of Cognition and Development, 4*, 67–98. doi:10.1080/15248372.2003.9669683
- McEldoon, K. L., Durkin, K. L., & Rittle-Johnson, B. (2012). Is self-explanation worth the time? A comparison to additional practice. *British Journal of Educational Psychology, 83*, 615–632. doi:10.1111/j.2044-8279.2012.02083.x
- Needham, A. (2009). Learning in infants' object perception, object-directed action, and tool use. In A. Needham & A. Woodward (Eds.), *Learning and the infant mind* (pp. 208–226). Oxford, UK: Oxford University Press.
- Needham, D. R., & Begg, I. M. (1991). Problem-oriented training promotes spontaneous analogical transfer: Memory-oriented training promotes memory for training. *Memory & Cognition, 19*, 543–557. doi:10.3758/BF03197150
- Nicolopoulou, A. (2010). The alarming disappearance of play from early childhood education. *Human Development, 53*, 1–4. doi:10.1159/000268135
- Rittle-Johnson, B., Saylor, M., & Swygart, K. E. (2007). Learning from explaining: Does it matter if mom is listening? *Journal of Experimental Child Psychology, 100*, 215–224.
- Rittle-Johnson, B., Saylor, M., & Swygart, K. E. (2008). Learning from explaining: Does it matter if mom is listening? *Journal of Experimental Child Psychology, 100*, 215–224. doi:10.1016/j.jecp.2007.10.002
- Schulz, L. E., & Bonawitz, E. (2007). Serious fun: Preschoolers engage in more exploratory play when evidence is confounded. *Developmental Psychology, 43*, 1045–1050. doi:10.1037/0012-1649.43.4.1045
- Siegler, R. S. (1995). How does change occur: A microgenetic study of number conversion. *Cognitive Psychology, 28*, 225–273.
- Singer, D. G., Golinkoff, R. M., & Hirsh-Pasek, K. (Eds.). (2006). *Play=learning: How play motivates and enhances children's cognitive and social-emotional growth*. New York, NY: Oxford University Press.
- Sobel, D. M., & Sommerville, J. A. (2009). Rationales in children's causal learning from others' actions. *Cognitive Development, 24*, 70–79. doi:10.1016/j.cogdev.2008.08.003
- Walker, C., Lombrozo, T., Legare, C. H., & Gopnik, A. (2013). Explaining to others prompts children to favor inductively rich properties. *Proceedings of the 35th Annual Meeting of the Cognitive Science Society*, Berlin, Germany.
- Walker, C. M., Williams, J. J., Lombrozo, T., & Gopnik, A. (2012). *Explaining Influences Children's Reliance on Evidence and Prior*

- Knowledge in Causal Induction*. In N. Miyake, D. Peebles, & R. P. Cooper (Eds.), Proceedings of the 34th annual conference of the Cognitive Science Society (pp. 1114–1119). Austin, TX: Cognitive Science Society.
- Wellman, H. M. (2011). Reinvigorating explanations for the study of early cognitive development. *Child Development Perspectives*, 5, 33–38. doi:10.1111/j.1750-8606.2010.00154.x
- Williams, J. J., & Lombrozo, T. (2010). The role of explanation in discovery and generalization: Evidence from category learning. *Cognitive Science*, 34, 776–806. doi:10.1111/j.1551-6709.2010.01113.x
- Williams, J. J., & Lombrozo, T. (2013). Explanation and prior knowledge interact to guide learning. *Cognitive Psychology*, 66, 55–84. doi:10.1016/j.cogpsych.2012.09.002
- Williams, J. J., Lombrozo, T., & Rehder, B. (2013). The hazards of explanation: Overgeneralization in the face of exceptions. *Journal of Experimental Psychology: General*, 142, 1006–1014. doi:10.1037/a0030996