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Learning psychology from riddles: The case of stumpers

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Abstract

Riddles can teach us psychology when we stop to consider the psychological principles that make them "work". This paper studies a particular class of riddles that we call *stumpers*, and provides analysis of the various principles (some familiar, some novel) that inhibit most people from finding the correct solution – or *any* solution – even though they find the answers obvious ex post. We restrict our analysis to four stumpers, propose the psychological antecedents of each, and provide experimental support for our conjectures.

Keywords: riddles; representation; situation models; Grice; cognitive economy; gender stereotypes

Table 1: The stumpers. (Try to solve them before reading on.)

Accountant: An accountant says: "That attorney is my brother", and that is true – they really do have the same parents. Yet that attorney denies having any brothers – and that is also true! How is that possible?

Speeding Car: A big brown cow is lying down in the middle of a country road. The street lights are not on, the moon is not out, and the skies are heavily clouded. A truck is driving towards the cow at full speed, its headlights off. Yet the driver sees the cow from afar easily, and avoids hitting it, without even having to brake hard. How is that possible?

Bus Ride: Individual bus rides cost one dollar each. A card good for five rides costs five dollars. A first-time passenger boards the bus alone and hands the driver five dollars, without saying a word. Yet the driver immediately realizes, for sure, that the passenger wants the card, rather than a single ride and change. How is that possible?

Potato Bags: In a Bangladesh market, a small potato bag costs 5 taka, a medium potato bag costs 7 taka, and a large potato bag costs 9 taka. Yet, a single potato in that market costs 10 taka. How is that possible?

1 Introduction

As with pornography, a riddle is harder to define than to recognize. Riddles share no more than a "family resemblance" (Wittgenstein, 1953). It would be hard to specify what critical features the following two questions share, but they are both clearly riddles.

i My mother is your mother's mother-in-law. Who am I?

ii Using just 6 identical matchsticks, construct 4 equilateral triangles.[1]

Perhaps it is the element of surprise in the solution that makes for a riddle – when it is funnier than expected, simpler than expected, or just different than expected. The surprise can lie in the very fact that a satisfying answer is even possible. A good riddle provides an unambiguously correct answer that lies within one's current knowledge. It is recognized as such with aesthetic or intellectual appreciation, and might well elicit responses such as "lovely!", "OMG!", "but of course!".

Riddles have a long and fruitful history in psychological research (e.g., Garth, 1920). Scholars studying human problem-solving used either stylized and carefully designed riddles, or ecologically valid problems in knowledge-rich domains. Some famous riddles include the nine-dot problem (Maier, 1930), about self-imposed solution constraints; the candle problem (Duncker, 1945), about functional fixedness; the fill-a-jar problems (Luchins, 1942), about solution mechanization; the 4-cards problem (or Wason's selection task, 1968), about intuitive logic; Tversky and Kahneman's (1983) Linda problem, about the representativeness heuristic in probabilistic reasoning; variants of the Monty Hall

We wish to thank the many people who helped us tread this new territory. Some pointed us to several challenging new stumpers. In particular, we thank Herb Clark, guide extraordinaire to the pragmatics of language, and Jon Baron, who – like the Beatles' Jude – takes a paper, and makes it better.

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[1] One solution to the first riddle is: I am your father. The solution to the second riddle is to build a regular tetrahedron.

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TABLE 2: Dominant construals, canonical solutions and general principles.

Stumper	The dominant construal (which inhibits solution).	The alternate construal (which yields solution).	What causes the dominant construal?
Accountant	The accountant is male.	The accountant is female.	Stereotypes: Some professions are (mentally) genderized.
Speeding Car	It is nighttime.	It is daytime.	Gricean norms: Denying sources of illumination implies darkness.
Bus Ride	Passenger paid with one $5 bill.	Passenger paid with five $1 bills.	Cognitive economy: It is easier to imagine a stated quantity as a single unit than as more.
Potato Bags	The potato bags were full of potatoes.	The potato bags were empty.	Priming: Containers described by specific content are imagined with it inside.

problem (e.g., Bar-Hillel & Falk, 1982), about conditional probabilistic reasoning; and the bat-and-ball problem (Frederick, 2005), about cognitive reflection. The present paper investigates a subset of riddles that we call *stumpers*. Unlike some of the aforementioned riddles, stumpers do not evoke a compelling, but wrong, intuitive answer. Rather, respondents are typically unable to summon any satisfying answer at all. Table 1 presents the ones we used.[2] When you attempted to solve them, were you stumped by any of them? Can you see why they might stump others? Can you find a common denominator?

Our account of these stumpers is as follows. A situation is verbally described, and while constructing the mental model of that situation (Zwaan & Radvansky, 1998), some missing details are filled in (Kosslyn, 1980). The text is akin to a movie script, and the listener to the director who sets the stage. A given script leaves room for the director's interpretation of the words in the script (note that a Google-image search for words like "party" or "athlete" yields many related, but not identical, pictures). Yet, despite the fact that a word is worth a thousand pictures, most people will construe a scene in much the same way, and the dominant construal can sometimes blind them to alternatives. Stumpers exploit this by placing the solution outside of the dominant construal. Insofar as the common construal inhibits other construals, the respondent is stumped.

Within this general process, the dominant instantiation is caused by a different specific principle in each stumper (Table 2). It is easy to see that gender bias drives the Accountant vignette. The principle driving the Speeding Car is conversational norms. The final two principles are novel. To elaborate:

[2]The actual wording was somewhat different in Study 1 (see Appendix 1), but our claims pertain to both versions.

Accountant: Accountants are gender-typed as male (row 1, Table 5). However, a variation of this riddle does not even require gender-biased professions, since the English language itself is manifestly sexist in how it references a generic person (e.g., Martyna, 1978). For example, the male pronoun "he" is used to refer to a single person of unknown sex, and the phrase "you guys" is indiscriminately used to refer to groups of people of both sexes. Indeed, people are even stumped by this variant: *A is the son of B, but B is not the father of A. How is this possible?* (from https://www.riddles.com/u/riddle/3708).

Speeding Car: One of Grice's (1975) conversational maxims is "Do not make your contribution more informative than is required" (p. 45). Hence, when a narrative bothers to mention the absence of light sources, darkness is evoked (since those light sources are otherwise irrelevant). In this way, this stumper (unlike the others) might arguably be accused of "trickiness". This is our only stumper where the script induces an atypical construal, as most would ordinarily visualize a car during daytime (row 3, Table 5); our mind's eye apparently needs light as much as our physical eye.

Bus Rides: We hypothesize that it is mentally easier to conjure a representation of a single item than of multiple items. Thus, a five dollar bill is easier to "see" than five singles (row 11, Table 5). This principle is a novel twist on Rosch's familiar principle of cognitive economy (e.g., Rosch, 1978).

Potato Bags: Although the purpose of containers (bottles, boxes, jugs, bags) is to contain, we hypothesize that they will be represented as empty unless referencing specific contents (e.g., wine bottle, cereal box, milk jug). Hence, in one's

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TABLE 3: Design of questionnaire in Study 1.

	Group 1	Group 2	Group 3	Group 4	Group 5
Lead stumper	Accountant	Speeding Car	Bus Ride	Potato Bags	Farmer Joe
Imagine instructions	Please take a moment to imagine [the suitable inserts appear below]. Form a picture in your mind. What did you see in your mind's eye?				
First Imagine task*	a black asphalt road	eggs being laid	an accountant	a gallon of water	five dollars
Modified vignette**	Five dollars are replaced by six dollars (in the Bus Ride).	The potato bag is replaced by a shopping bag.	No mention of lights at all (in the Speeding Car).	The attorney is replaced by an actress.	The attorney is replaced by an actress and brother is replaced by sister.
Second Imagine task	a shopping bag.	4 pounds of unpackaged strawberries.	a potato bag.	a black asphalt road, with no streetlights on.	a cereal box.
Fifth task	". . . list animals whose eggs people eat."	Imagine a transparent glass water pitcher.	Imagine a room with all the lights turned off.	Farmer Joe variant.	Imagine a car speeding with its headlights turned off.
Recall task	In the text box, please write down the very first question you were asked. in this study (the one about [insert vignette's name]) as closely to the exact original wording as you can remember it.				

* The two options presented appear verbatim in Table 5.

** We will not report further on the modified vignette.

mind's-eye, a potato bag will be full of potatoes, but a shopping bag will be empty (rows 27, 30, Table 5).

In our experiments, we tested our hypotheses about why these five riddles stump in two different ways. In a direct task, we specified a concept in the abstract (i.e., without the additional details which the stumper narrative provides) to assess the scene that respondents would organically summon. In the indirect task, we asked them to recall their stumper, to assess how much the typical instantiation corrupted their memory of the stumper's verbatim text.

2 Method

We ran two similar studies on Mturk, 18 months apart, both on a Thursday between 9:00am and 12:00pm. The first had 499 subjects, 55% of whom were male, with an average age of 36. The second had 516[3] subjects, 56% of whom were female, with an average age of 38. All but seven were native English speakers. Respondents were randomly assigned to the experimental groups described below, and were paid a dollar each for their participation. They answered a multi-screen questionnaire, administered individually through Qualtrics.[4]

We now describe the flow of this questionnaire, screen by screen (respondents could not return to previous screens). It is also summarized in Tables 3 and 4. The uninterested reader can skip directly to the Results (and refer back as needed).

2.1 Questionnaire design

The opening screen gave the instructions (reproduced in full in Appendix 2). Subjects then indicated their age, sex, and native language, before proceeding to the study. First they received the lead stumper[5] (referred to throughout the questionnaire only as a "vignette"). On the following screen they

[3]Forty six additional respondents dropped out before completing the computerized questionnaire, and are not counted. One subject was removed for giving gibberish answers to the free form questions.

[4]We gathered more data than we report on in this paper. (1) We omit a fifth "stumper" about Farmer Joe (see Appendix 1) because it didn't sufficiently stump people (though you can still see its residues in parts of Tables 3 and 4). (2) We omit analysis of a task called "Modified Stumper" (see Tables 3 and 4), in which critical words from the original were replaced, with intent to facilitate solution – which they generally did. (3) We omit an analysis of confidence ratings respondents provided for their offered solutions to the standard and the modified stumpers. These were omitted to streamline an already data-heavy paper. None change the reported picture, and the interested reader can find them in the accompanying raw data.

[5]In Study 2, the stumper was prefaced with some words meant to encourage respondents to admit to being stumped. These appear in Appendix 2.

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TABLE 4: Design of questionnaire in Study 2.

	Group 6	Group 7	Group 8	Group 9	Group 10
Lead stumper	Accountant	Speeding Car	Bus Ride	Potato Bags	Farmer Joe
Imagine instructions	Imagine [the inserted words are shown below]. Spend some time forming a picture in your mind. Embellish it with detail.				
First Imagine task*	a white man all dressed in white on a white gravel road.	five keys	a bag of potatoes	ornamental painted eggs.	a water pitcher.
Second Imagine task	"Please list contemporary U.S. currency bills in ascending order."	a nurse.	a black man all dressed in black on a black asphalt road.	four ounces of pure gold.	five ounces of Camembert cheese.
Modified vignette**	The potato bag is replaced by a shopping bag.	Five dollars are replaced by two dollars (in the Bus Ride).	Second Farmer Joe variant.	No mention of lights at all (in the Speeding Car).	The attorney is replaced by a nurse.
Third Imagine task	a bell ringing.	a wine bottle.	an ounce of pure gold.	a water bucket.	a parked car.
Fourth Imagine task	a bottle of wine.	a pound of pure gold.	a wine decanter.	two dollars.	a bottle.
Recall	In the text box, please write down the first vignette you read (the one about [insert vignette's name]). Use words as close to the original words as you possibly can.				

* The two options presented appear verbatim in Table 5.

** We will not report further on the modified vignette.

were told: "If you can think of a good answer, please enter it in the text box [they could take their own time entering their free form answer]. If you can't come up with what seems like a satisfying answer, then please just write the words "I am stumped." They then indicated whether they had ever heard this riddle before.[6]

This was followed by "Imagine" tasks or some ad hoc task, as specified in Tables 3 and 4. "Imagine" tasks pertained to a different vignette than the lead stumper.[7] Subjects were told: "Imagine [target item – e.g., "an accountant", or "five dollars", etc.]. Form a picture in your mind." They then indicated which of two mutually exclusive possibilities they had envisioned. The presentation order of these two options was counterbalanced, as was the order of the Imagine tasks.

Following the Imagine tasks, subjects were requested to "please write down the very first question you were asked in this study (the one about the [lead stumper's reference here]), as closely to the exact original wording as you can remember it."[8] The hope (which was fulfilled; see Results) was that respondents would recall aspects of that riddle that were not present, providing additional evidence for the dominant visualization.

3 Results and Discussion

Table 6 shows the types of answers given to the stumpers. Though most respondents failed to come up with correct solutions, not all admitted to feeling stumped; a substantial fraction offered unexpected answers of varying quality. We should note that, since our subjects were deprived of the normal exchange that usually accompanies the oral presentation of riddles, as Mturk "workers" they might have regarded it as their job to provide *some* type of answer,[9] rather than admit defeat (see Appendix 3 for an amusing list of these "inventive" accounts).

[6]Overall only 20 subjects said they had. We elected to retain their data nonetheless, because it turned out that stated familiarity did not guarantee that they would solve correctly.

[7]With the sole exception of Group 8, third Imagine task.

[8]By mistake the Accountant stumper in Study 1 was mislabeled in this task, and so we have no data for it in Table 7.

[9]Indeed, almost all respondents turned out to be serious, diligent, workers, who gave us trustworthy data.

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TABLE 5: Imagine tasks, their binary options, and their popularity.

Imagine	"What did you see in your mind's eye?"		N
Accountant Stumper			
1. An accountant	A male accountant 71%	A female accountant 29%	102
2. A nurse	A female nurse 95%	A male nurse 5%	99
Speeding Car Stumper			
3. A parked car	A view by day 91%	A view by night 9%	100
4. A bell ringing	It happened in the light 82%	It happened in the dark 18%	99
5. A black asphalt road	A day-time view of the road 82%	A night-time view of the road 18%	96
6. A black man all dressed in black on a black asphalt road	A view by day 61%	A view by night 39%	101
7. A white man all dressed in white on a white gravel road	A view by day 93%	A view by night 7%	99
8. A black asphalt road with no streetlights on	A night-time view of the road 81%	A day-time view of the road 19%	93
9. A room with all the lights turned off	A dark room 95%	A bright room 5%	102
10. A car speeding with its headlights turned off	A night-time scene 68%	A day-time scene 32%	99
Bus Ride Stumper			
11. Five dollars	A five dollar bill 88%	Five single dollar bills 12%	99
12. A gallon of water	A single large container filled with water 100%	Several small containers filled with water 0%	94
13. An ounce of pure gold	A single lump of gold 90%	More than one lump of gold 10%	101
14. A pound of pure gold	A single lump of gold 84%	More than one lump of gold 16%	99
15. Four ounces of pure gold	A single lump of gold 60%	More than one lump of gold 40%	95
16. 4 pounds of unpacked strawberries	One large pile of strawberries 78%	Several small piles of strawberries 22%	108
17. Five keys	A key ring with all the keys on it 63%	Loose keys 37%	99
18. Five ounces of Camembert cheese	A single piece of cheese 65%	More than one piece of cheese 35%	100
19. Two dollars	A couple of singles 83%	One $2 bill 17%	95
20. List contemporary U.S. currency bills in ascending order:	*53% forgot to list $2 bill*		99
Potato Bag Stumper			
21. A bag of potatoes	A bag with potatoes in it 99%	An empty bag 1%	101
22. A bottle of wine	A bottle with wine in it 97%	An empty bottle 3%	99
23. A cereal box	A full box with cereal in it 94%	An empty box with nothing in it 6%	98
24. A water pitcher	A pitcher with water in it 85%	An empty pitcher 15%	100
25. A wine bottle	A bottle with wine in it 84%	An empty bottle 16%	99
26. A water bucket	A bucket with water in it 83%	An empty bucket 17%	95
27. A potato bag	A full bag with potatoes in it 82%	An empty bag with nothing in it 18%	101
28. A transparent glass water pitcher	A full pitcher with water in it 74%	An empty pitcher with no water in it 26%	108
29. A wine decanter	A decanter with some wine in it 68%	Just the decanter, nothing in it 32%	101
30. A shopping bag	An empty bag with nothing in it 67%	A full bag with things in it 33%	96
31. A bottle	Just the bottle, nothing in it 61%	A bottle with some liquid in it 39%	100

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TABLE 6: Types of stumper responses, in percents. (Rates may not sum to 100 due to rounding.)

Stumper	Study	N	Solved the riddle	Gave non canonical "solution"	Gave unacceptable responses	Admitted to being stumped
Accountant	1	96	35	33	6	25
Accountant	2	99	48	0	26	25
Speeding Car	1	108	34	24	26	16
Speeding Car	2	99	39	20	20	20
Bus Ride	1	102	1	33	54	12
Bus Ride	2	101	12	19	41	28
Potato Bags	1	94	13	56	3	28
Potato Bags	2	95	38	26	20	16

3.1 Direct test – The "Imagine" tasks

The psychological accounts for the dominant instantiations lie at the heart of this study. We aimed to prove that respondents who were stumped were victims of a common instantiation determined by a predictable psychological principle. In the Introduction, we proposed specific accounts for why each of our vignettes stumps respondents.

The various Imagine tasks were meant to test these accounts.[10] Respondents were asked to imagine some target (Table 5, Imagine column), without any context or setting, without action, and without being asked to explain anything. The two possibilities presented for their choice are shown verbatim in Table 5's next two columns. The results consistently confirm our hypotheses: the hypothesized option, in the middle column, is always the more popular one.

Specifically:

Accountant: Most respondents imagined "an accountant" as male (row 1).

Speeding Car: The results show that, although by default scenes are seen in daytime (rows 3–7),[11] explicit denial of light sources (rows 8–10) overcomes the default, triggering dark.

Bus Rides: Imagining a single item is easier than imagining multiple items, even holding overall quantity of the variable constant (rows 11–18). This is true for liquids and solids alike; for small quantities and larger ones; for units that integrate into a "new" form, like a $5 bill; or congeal into a single piece, like cheese or gold; or stay loose, like strawberries; or which, like keys, require an imaginary ring to bind them; and regardless of frame – 4 ounces or a pound.[12]

It seems that we're on to a valid new psychological principle. Further exploration (e.g., its boundary conditions) falls outside the present scope of this paper, which is limited to discovery and demonstration of existence.

Potato Bags: The table confirms that, if a container is described along with its potential content (rows 23–29), the dominant visualization will include that content – but otherwise not. "Shopping" is not a specific content, and, hence, a "shopping bag" is mostly seen empty. One might ask when content is specific enough to be seen (e.g., "Laundry bag"? "Sewing box"?), but this, too, is subject for future research. The form "container of content" (e.g., bag of potatoes, bottle of wine), is necessarily full, for syntactical reasons (rows 21–22).

Indirect test – The Recall task

Respondents were asked to recall the lead stumper verbatim.[13] We searched their protocols for words missing from the original stumper that might betoken the influence of the dominant instantiation that is impeding solution, such as masculine pronouns in the Accountant; "night" or "dark" in Speeding Car; "five dollar bill" or "fiver" in Bus Ride; or "bag of potatoes" in Potato Bag. The incidence of such overt "tells" is shown in Table 7 (these are, of course, underestimates of the dominant instantiations, since respondents don't articulate everything that they visualize.)

[10]Since we dropped Farmer Joe, we shall also not report the data pertaining to our account of Farmer Joe – except to say that, not surprisingly, it indeed confirmed that "eggs" are visualized as "chicken eggs".

[11]Note that three mentions of "black" in a row were visualized "by day" (61%, row 6) at a lesser rate than three mentions of "white" (93%, row 7), or than a single mention of "black" (82%, row 5). This could be subject to further research.

[12]One exception was predicted. The $2 bill is the rarest of US bills, to the point where when asked to "list contemporary US currency bills", 53% of our respondents did not even mention it. Correspondingly, 83% of our respondents saw two singles. Apparently, at the extremes, statistical considerations also weigh in.

[13]In Study 1, our instructions said "Please write down the very first question you were asked" and nearly 25% interpreted this literally as referencing only the final question ("How is that possible?"), rather than the riddle. In Study 2, we changed the phrasing of this inquiry and only 6.5% misinterpreted it this way.

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TABLE 7: Results of the "Recall the first vignette" task. Cell entries are numbers (except in parentheses).

Stumper	Study	How many did not give the canonical answer?	Of those, how many recalled the stumper?	Of those, how many included dominant visualization "tells"?
Accountant	1	62	(Data missing due to technical error.)	
Accountant	2	51	44	15 (34%)
Speeding Car	1	71	52	23 (44%)
Speeding Car	2	60	55	35 (64%)
Bus Ride	1	101	75	19 (25%)
Bus Ride	2	89	81	29 (36%)
Potato Bag	1	82	55	24 (44%)
Potato Bag	2	59	58	44 (76%)

4 General Discussion

The premise of this paper is that riddles can teach us psychology by focusing attention on the psychological principles that make them "work". We chose a particular class of riddles, *stumpers*, which all follow a similar format. A verbal scenario is presented, which typically evokes a visual scene. Among the possible scenes compatible with the text, one predominates. The stumper is designed so that the dominant instantiation does not contain the answer. As a result, those who cannot break free of the first scene they imagine remain stumped.

We explore the psychological principles that determine the dominant instantiation in each of a set of four stumpers. The Accountant relies on representing an unspecified protagonist as a male. The Speeding Car relies on Gricean norms, according to which mentioning the absence of minor light sources implies that that the major one – the sun – is not present. The Bus Ride relies on instantiating five dollars as a single bill, due to cognitive economy. The Potato Bag relies on representing the bag as full of potatoes, because containers referenced by the contents they hold are visualized as full of those contents.

These accounts were supported by two means. First, respondents were asked to imagine target objects or events, devoid of context or narrative setting, and report their mental imagery directly. Second, respondents were asked to recall their stumper verbatim, and we searched for "tells" that revealed what they had imagined.

As noted earlier by Tversky and Kahneman (1982), prototypical visualization is not driven solely by statistical frequency or base rates. (1) Although the prototypical accountant is apparently male, the typical accountant actually is not (as of 2015 in the U.S., nearly 60% of all U.S. accountants were female – http://www.bls.gov/cps/cpsaat11.pdf). (2) Driving and most other human activities predominantly occur during daytime, yet the speeding car was visualized at night. (3) Although one $5 bill is easier to imagine than five $1 bills, $1 bills outnumber $5 bills by more than 5 to 1 (http://www.cnbc.com/2015/04/21/100s-closing-in-on-1s-for-most-common-currency.html). (4) Since empty potato bags are usually thrown away, one can argue that base rates do contribute to the dominant visualization here. But the prototypical image does not reflect statistical incidence alone: e.g., a wine decanter rarely contains wine, but is typically imagined with wine in it.

Recall that we began our paper by declining to define riddles. Stumpers are a particular kind of riddle, to which a common reaction is puzzlement. We did not aim for, nor do we offer, a general theory of what stumps people, whether in riddles or in other forms of problem solving. Our focus was on what determines how people visualize a scene to fit the stumpers we used, but we could instead have focused on linguistic stumpers, such as those below

i What gets wet as it dries?

ii How can a boat be full of people, without a single person on it?

These riddles work because people interpret a polysemic word in a way that creates semantic conflict. They imagine the *same* object is getting both wet and dry, and that *full* and *single* both reference the number of the boat's occupants. Had we focused on this class of riddles, we might have sought to understand the psychological impediments to interpreting words differently.

Our focal riddles work because the construal evoked by the scenario dominates attention in a way that prevents other construals that are required to solve the problem. As shown in Appendix 4, this mechanism is part of a broader class of phenomena in the JDM literature, in which a particular mental construction (that need not be a visual image) displaces or inhibits alternate constructions.

JDM studies typically focus on how this process leads to non-normative responses, but with stumping riddles, it can

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inhibit the production of any response.

That may be primarily a difference of approach. In other words, if known stumpers can be vehicles for discovering novel psychological effects, perhaps known effects can be vehicles for inventing novel stumpers. Below are some preliminary attempts to turn a few known effects from the JDM literature into stumpers. These are intended more as illustrations of the concept, with no pretensions to being great riddles, which (like good jingles, cartoons or logos) require more than the implementation of a feasible idea.

i In 1957, in Rhode Island, twice as many pedestrians were killed crossing on a green light as on a red light. Explain (based on Huff, 1959).

ii A notebook and pencil cost $1.10 in total. The notebook costs a dollar more than the pencil. Bonnie bought a pencil, handed the cashier a dime, and received some change. Explain (based on Frederick, 2005).

iii Four cards show a letter on one side and a digit on the other. The cards' upside faces show, respectively, A, Z, 4, 1. Check the following claim: when there's a vowel on one side of a card, there's an even number on the other. It costs 6 points to turn each of the letter cards over, 4 points to turn the 4 card over, and 1 point to turn the 1 card over. Nellie only had nine points, which was enough to turn over all and only the cards needed to check the claim. Explain (based on Wason, 1968).

iv There are three closed boxes. One has $10,000 in it, the other two are empty. Lou chose a box. The game show host promises to reveal one of the losing boxes from the others that remain. Lou is given the opportunity to switch the box he initially chose to the remaining closed box, for $100. He happily pays. Explain (based on Selvin, 1975).

Of course, since we are psychologists (rather than comedians or magicians), we care less about using known psychological effects to construct new riddles than using existing riddles to discover new psychological insights.

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Appendix 1: The stumpers (Study 1 versions)

Accountant	"That attorney is my brother", stated the accountant. Later, that attorney stated that he has no brothers. Both were telling the truth. How is that possible?
Speeding Car	A black man all dressed in black was walking alone down the middle of a black asphalt road. The man had no flashlight, and no streetlights were on. A car was travelling towards him at full speed, its headlights off, yet managed to see him in time to brake and avoid running him over. How was the driver able to see the man?
Bus Ride	Bus tickets cost one dollar each, unless you buy a card, which is good for six rides. The card costs five dollars. A passenger boards the bus, and hands the driver five dollars, without saying a word. The bus driver takes her money, and hands her a card, with one of the six holes punched out. The passenger thanks the driver and takes a seat. How did the driver know that this was what the passenger wanted?
Potato Bags	Tom broke his arm badly, and it was in a cast for weeks. When the cast was removed, he trained as follows: He extended his arm to the side, straight, and while holding a small potato bag, maintained this position for as long as he could. Once he could keep it that way for a whole minute, the small bag was replaced by a medium bag, and the exercise repeated. Once he could hold the medium bag for a full minute, it was replaced by a large bag. As soon as Tom could hold a large potato bag that way for an entire minute, one potato was added to the bag. Tom's arm collapsed almost immediately. How come?
Farmer Joe	Farmer Joe eats two fresh eggs from his own farm for breakfast every day. Yet there are no chickens on his farm. Where does Farmer Joe get his eggs?

Appendix 2: Instructions

Opening Instructions for Study 1: On some of the following pages you will find short vignettes. Read them carefully, as you will be asked one or two questions about them. On other pages you will be asked to visualize some objects in your imagination, and to report what you see in your "mind's eye". We hope you enjoy the task. Thank you for your cooperation.

Opening Instructions for Study 2: This study is comprised of several different tasks, and you will be instructed about them as you proceed. On a couple of the following screens you will find short vignettes. Read them carefully, as you will be asked a couple of questions about them. On several other pages you will be asked to visualize some things in your imagination, and to report what it is that you see in your "mind's eye". Dwell on them for a while, and try to flesh them out with some detail.

A few other little problems will follow, which you will be asked to solve. The survey will conclude with a series of moral judgments.[14] It is separate from the earlier questions, and payment does not depend on your answers to it. Throughout the study, when you wish to advance to the following screen, click on the NEXT sign at the bottom of the screen. It will not be possible to return to earlier screens. We hope you enjoy the task. Thank you for your cooperation!

Instructions for the lead stumper in Study 2. If you can think of a good answer, please enter it in the text box. If you can't come up with what seems like a satisfying answer, then please just enter the words "I am stumped." Note: We are not trying to test your ability to come up with some original, creative, atypical, exotic "solution." In other words, you don't need to struggle to say something, if you know that it couldn't be the expected answer. We are just trying to understand when people do or do not feel stumped. Your payment does not depend on whether you are stumped, nor on any answers you may provide.

Appendix 3: Examples of respondents' answers.

Some respondents who failed to solve the stumper nonetheless gave answers that were consistent with the stumper's premises, and we deemed them acceptable. Popular examples follow.

Accountant: In Study 1, 28%[15] of the respondents pointed out that the salutation "brother" has more than one meaning – e.g., friend, fellowman, etc. In Study 2, we explicitly stated that the two protagonists shared parents, leaving no room for acceptable non-canonical answers.

Speeding Car: In Study 1, 22% of the respondents enlisted the moon as the source of light by which the driver saw the man on the road. So in Study 2's version, the moon's presence was explicitly ruled out. However, some respondents sought to explain how the driver brakes in time, and assumed the road had 2 lanes, with cow and truck occupying different sides of the road.

Bus Ride: In Study 1, 26% of the respondents surmised, in one form or other, that the passenger was a repeat passenger, recognized by the driver, who therefore knew just what transaction was desired. So in Study 2 it was explicitly stated that the passenger was a first time rider.

Potato Bags: In Study 1, 53% of the respondents pointed out, in one way or another, the truism that everyone has their physical limits, so the added potato was the proverbial straw that broke the camel's back. In Study 2 the training story was replaced by a market story; 25% assumed that the "expensive" potato was a very special one – very big, or of superior quality.

Some "solutions" called for more creativity, and were rarer. Examples:

Accountant: Five Study 1 respondents answered that the accountant must have died between the two utterances.

Speeding Car: One respondent conjured a firefly as the source of light.

Bus Ride: A few subjects suggested that the silent passenger used some form of non-verbal communication (e.g., a written note requesting a card, or holding up 5 fingers).

Potato Bags: One respondent suggested that "There is one potato left in the market and the price has been raised very high."

We deemed many answers "unacceptable". Examples: Some were inane (e.g., the 30% of all Bus Rides who denied, directly or indirectly, that there could be any reason for handing the driver $5 except for wanting a card, when of course a reason could be that the passenger had nothing smaller than a fiver). Some were clutching at straws (e.g., the 12% of all Speeding Car respondents who thought that even in the absence of any light, the whites of one's eye or of one's toothy grin, or mere movement, would suffice to make the man visible). Some were in outright defiance of the vignette's premises (e.g., in Study 2, those who guessed that the attorney is adopted, although told explicitly that the protagonists have the same parents). And some were just plain fantastical (e.g., the respondent who wrote: "He (Tom) was hypnotized, and the "magic" phrase or action to make him drop his arms was executed").

[14] These data do not pertain to the present study.

[15] These percents are smaller than those shown in the "acceptable" column, because they are examples of such answers, but not a comprehensive list of them.

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Appendix 4: Examples of robust JDM effects where having one thing in mind can block or hinder other considerations which are normatively relevant. (Table courtesy of Jon Baron.)

JDM Effect	Sample Reference
Base-Rate Fallacy Individuating information blocks the judged relevance of background base-rates.	Bar-Hillel (1980)
Non-regressive prediction (along with *representativeness* and *availability*, the major judgment heuristics) WYSIATI (What You See Is All There Is).	Kahneman (2011)
The Volvo Effect A single vivid concrete anecdote overrides plentiful statistical evidence.	Fagerlin, Wang & Ubel (2005)
Hindsight Bias Outcome knowledge hinders access to pre-knowledge prediction uncertainty.	Fischhoff (1975)
Curse of Knowledge A known fact prevents full imagination of a state of belief without that knowledge.	Camerer, Loewenstein & Weber (1989)
Isolation Effect People focusing on immediate consequences of an option fail to think of side effects or indirect effects.	McCaffery and Baron (2006)
Focusing Illusion	
1. A salient attribute relevant to a comparison blocks consideration of other attributes relevant to the same comparison.	Schkade & Kahneman (1998)
2. An initial mental model blocks consideration of alternative models.	Legrenzi, Girotto & Johnson-Laird (1993)
Choice Bracketing Choice considered in isolation prevents seeing the broader picture determined by the entire choice set. Similar to other dichotomies:	Read, Loewenstein & Rabin (1999)
Sequential vs. simultaneous choice	Simonson (1990)
Narrow vs. broad decision frames	Kahneman & Lovallo (1993)
Isolated vs. distributed choice	Herrnstein & Prelec (1992a,b)
Local vs. overall value functions	Heyman (1996)
Myopic loss aversion	Benartzi & Thaler (1995)
Neglect Defaulting	
People who neglect to continue reasoning after the first step may fail to see that further steps can overturn the default.	Margolis (2008)

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