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WASON, MONTY HALL, AND ADVERSE DEFAULTS

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Abstract: The paper gives an account of several well-known cognitive illusions in terms of contextual defaults which guide intuition where familiar cues are ambiguous. When the default is inappropriate, as it sometimes must be, the result is a cognitive illusion. In contrast to Kahneman & Tversky attribute substitutions, these context substitutions are *not* heuristics (cognitive shortcuts) that would often give a good approximation of a correct response. Rather, they are akin to behavior in which a person instructed to look left instead somehow is prompted to look right.

Under the label *adverse defaulting* I give an account of various cognitive illusions (the best-known being Wason and Monty Hall) in terms of contextual defaults which guide intuition where familiar cues are sparse or conflicting. When the default is inappropriate, as it sometimes must be, the result is a cognitive illusion. As in illusions due to "attribute substitution", the process is both *tacit* (subjects do not realize what is prompting their intuitions) and *illogical* (if the subjects did realize what was prompting their intuitions they would see it was inappropriate for handling the question at hand). In both *attribute substitution* and *adverse defaulting* the responses can be interpreted as giving the correct response to a question different from the one asked. But in contrast to attribute substitution, the defaults are *not* heuristics (cognitive shortcuts) that might seem to give a plausible response to the question posed, or necessarily more readily accessible, or answering an easier question (Kahneman & Frederick, 2005, p. 3). Rather, they are akin to behavior in which a person instructed to look left instead somehow is prompted to look right. Attribute substitution and adverse defaulting both are examples of tacit habits of mind, but they are different sorts of habit of mind.

This is an extension of an earlier discussion of "scenario" effects (Margolis 1987), elaborated to cover a wider range of cases. In contrast to "attribute substitution", if a cognitive illusion is due to adverse defaulting, the question that fits the answer is not necessarily (or even probably) easier or more accessible than the question actually asked, other than in the tautological sense that we can observe that for some reason responses seem to respond as if it was. Nor does *defaulting* yield responses that look plausible as an approximation of the correct response to the sort of question posed. The responses are

just unqualifiedly wrong. Further, in two of the four cases, the effect is very stubborn, resisting correction even when the correction is logically trivial. The defaulting argument suggests why that happens.

The only condition under which such effects can be cleanly seen is where intelligent subjects dealing with some simple problem somehow make very bad choices. But once identified, the potential for defaulting effects will then have consequences for understanding what may be happening in more complex situations in which people seem to be making choices which go against their own interest, but (given the richer context) there is no such naked contrast between the normal competence of subjects and their behavior in the task at hand.

As I write (December 2005), Google return more than 100,000 hits for "Monty Hall problem" and more than 20,000 for "Wason selection task". But what accounts for the anomalous results these problems reliably yield still has not been resolved after several decades of contention. They are examples of problems we are all smart enough to solve, but which somehow prompt responses that are not smart at all. The simplest explanation of why smart people so often get them wrong is the just to say that the problems are really not so simple. But in terms of the defaulting account, there is a reason that smart people commonly get them wrong which is linked to the very fact that they are so simple.¹ Hence an important element in seeing what is going on is to notice that the usual wrong answers are not only wrong but wrong even though the problems are in fact very simple. It does not help to blur that important point.²

Wason ³

Here is a version of the Wason selection task:

¹ Stanovich (1999) surveys his extensive work on correlations between measures of intelligence and vulnerability to cognitive illusions in puzzles like Wason. He is convincing in showing a positive correlation, but the gains from higher intelligence are modest. Even for subjects in Stanovich's highest intelligence category, a great majority get the problems wrong.

² A different view (mainly for Wason) is that the answers are not errors, but correct responses to an alternative reading of the question. I will take that up shortly.

³ The Wason material is taken mainly from Margolis (1987). The Monty Hall argument considerably extends the material in Margolis (1996).

Cards are labeled "A" or "D" on one side and "2" or "3" on the other. A rule says that "if A then 2". You see some of the cards. Which need to be turned over to know whether this sample of cards is consistent with the rule?⁴

If the array you are shown is [A,D,2,3] and you have not already seen the puzzle, you are very likely to respond "A & 2", or "A" alone. And this commonly occurs even with sophisticated subjects who have no trouble whatever understanding that turning the "2" is beside the point (a D on the other side *would not* violate the rule⁵), but you must turn the "3", since then an A on the other side *would* violate the rule. The usual explanation of the anomaly turns directly or indirectly on some difficulty of normal human beings to see the "modus tollens" inference that "if A then B" implies "if not-B then not-A".

But do people really have any difficulty noticing that "if he's coming, he'll be here by 3" implies that "if he isn't here by 3, he isn't coming". And an inability to handle "modus tollens" does not seem very plausible in evolutionary terms, since we can't get through a day without encountering situations in which effective behavior relies on such inferences. It would be a puzzle if our brain has not evolved in a way that made it is easy to learn to see that connection.⁶ When I first had occasion to write on Wason (Margolis 1987) I encountered an ad for an anti-dandruff shampoo using the slogan: "If you use it, no one will know. They'll only know if you don't use it." Surely the admen choosing this did not expect that 90% of the audience would have to consult a logician to grasp the point of the slogan.

But what could make it appear that people cannot easily do what you almost certainly did twice in the previous paragraph: see the point of a modus tollens inference in a subjectively immediate way, with no sense of effort?⁷ On the defaulting account the

⁴ An alternative is: "Which cards need to be turned over to know whether for this sample of cards, the rule is true" Call the first testing-the-cards, and the second testing-the-rule. Results for the basic Wason setup are very similar for either. But successful remedial variants are more likely to use testing-the-cards.

⁵ Alternatively, if you interpreted the rule as including its converse ($A \rightarrow 2$ & $\text{not-}A \rightarrow \text{not-}2$), then you should have turned all 4 cards: any one of them could violate that reading.

⁶ But the contrary view is common (e.g., Cosimedes 1989).

⁷ To explicitly process modus tollens in response to an abstract question certainly takes longer than for modus ponens, an effect large enough for a person to just notice even without a formal reaction time study.

key to this puzzle, which will also prove useful on a series of further puzzles as the argument proceeds, is that on any account of cognition that allows for Bruner's "going beyond the information given" there must be defaults in place that guides intuition when the situation looks ambiguous. Sometimes the best thing to do when you lack enough information is to look for more information. But often even a merely random choice works better than expending resources to search for a better than random choice. Caught between hesitating-too-long and jumping-too-soon there needs to be some default, and it would be surprising if evolution, or an intelligent designer for that matter, did not judge hesitating-too-long the more risky in a context where there was no good cue to warrant hesitating. We will recognize that default and several others related to it.

Since defaulting is tacit, we cannot directly see it, nor can a subject. But it can be detected. What we will look for (starting with Wason but continuing through three further examples) is some either/or pair of frequently-encountered contexts, one of which must be the default that operates when familiar cues fail to prompt one rather than the other. What comes into play in Wason is that we frequently encounter contexts in which we need to act with respect to a category (so our choice has to do with what category is appropriate) but then we almost always have to choose with respect to an instance of a category. Call this the *category/instance* pair, where as in subsequent pairs the default (what to do when you do not know what to do) is in italics.⁸ For in ordinary experience we routinely proceed through general-to-particular or strategic-to-tactical sequences. First we need to orient ourselves: what kind of task is at hand? And then, what should I do with this particular case?

But in the sparse, merely verbal, context of Wason's puzzle we don't have the richness of cues of a natural situation that almost always puts the orienting step in place without any conscious awareness and before we get to the specific question.⁹ The Wason

But as the shampoo and arrive-by-3 examples illustrate, we also can often see the modus tollens inference in a subjectively immediate way. Even working our way explicitly through it (which usually occurs only when checking a prompt response) does not seem so onerous that it would be an adequate explanation of getting Wason wrong. And as will be seen in the variants to follow, in fact subjects appear to use modus tollens with no conscious effort at all on this very problem.

⁸ Later in the paper I will come to other examples of defaults: a *hesitate/proceed* and an *interactive/passive* pair.

question is about categories. The task is to sort the cards into two categories: those which need to be checked (because they could violate the rule) and those that don't. And the question could have been framed in a way that made the target of that categorization themselves categories. The card with an "A" showing could be a card from the category, cards with an "A" on one side, and similarly for the others in the target array. In fact, though, the language plainly makes the cards to be checked instances of such categories. But without the orienting cues normally present in a real situation, in the impoverished environment of the puzzle we might be caught by the *category/instance* default and mechanically respond to the cards as categories.

Without clear evidence, this will certainly seem unlikely, as without clear evidence it would also seem very unlikely (before you see it happen) that a person like you, sensible and with reasonable vision, would see one of the Muller-Lyer lines as unmistakably longer though in fact it isn't a bit longer. And here we can point to simple tests which seem to show that this "defaulting" account of Wason in fact is what prevails.

To restate the claim: What will be likely to be entrenched (habitual) from experience would be an expectation of a 1st stage that would concern the *categories* in play and the second stage that would concern particular *instances*. That 1st step (general, strategic, category, type) mostly gets handled automatically, with no conscious awareness at all, as is usual with habitual acts. But absent sufficiently strong cues that set the 1st step in place, entrenched habit might prompt a default response to that here missing 1st step even though the language is plainly about the second step (specific, tactical, instance, token).

But if a person responds to the Wason question as if it were about categories, not instances (types, not tokens), so the cards shown represented categories (cards with an

9 This is hardly the only sort of case in which habitual expectations override what is actually said. An example due to Wason himself asks subjects to restate the remark: "No head injury is too trivial to be neglected." Unless you are a very atypical reader you understood that as if "neglected" meant "treated seriously." Similarly, in Kahneman & Tversky's Linda problem, people respond as if "probable" meant "plausible". But in ordinary usage, probable often does mean plausible, as in ordinary conversation someone who made the head injury remark probably did misspeak and really meant what the hearer understood him as saying. Such examples show habits of mind effects, but not the defaulting I want to demonstrate here. Both fall short of responses that seem to be guided by a flatly impossible reading of either the language or its gricean implications. Other Kahneman & Tversky effects might be fit smoothly into the defaulting account, for example, the ignoring of base rates in their much-contested taxi problem (1978).

"A", etc.) not the instances of such cards the questioner clearly intends, then there would be multiple correct responses. As a question in formal logic, "if A then 2" does not imply its inverse ("if not-A then not-2)", but in ordinary usage it often does, as in "if it's nice, we'll go on a picnic." So a person might (tacitly) understand the Wason rule either way. Contingent on whether the rule was understood as implying its inverse or not, if an "A" represented the category of cards with an "A" on the letter side, and similarly for the other possibilities, then facing the array [A, D, 2, 3] and interpreting the rule narrowly (as just $A \rightarrow 2$) would make checking either the category of "A" cards *or* the category of "3" cards correct. And if the rule were read broadly ($A \rightarrow 2$, but also, as in the "picnic" example, $\text{not-A} \rightarrow \text{not-2}$) then there would be four correct answers: checking A's & 2's would find all violations, but so would A's & B's, D's & 3's, and 2's & 3's.¹⁰ The unique correct response for the intended reading of the question "A&3" would *look* wrong, as indeed it would be wrong if the cards represented categories... except that the language of the task clearly refers to the particular cards shown not to categories of cards.¹¹

And however unlikely this might seem (that subjects respond to a tacit sense of context that they would not consciously accept as sensible), very simple tests provide strong evidence that indeed that is what is guiding the prevalent Wason responses. As I write there is no *theory* of cueing. The most striking experimental work is probably still Nisbett et al (1973) which mainly showed how not only are subjects not conscious of the cues that prompt responses, but how chancy foreseeing when cues will be effective is even for as experienced and shrewd an experimenter as Nisbett. Nisbett's report stresses how often he and his co-workers failed to anticipate which cues would be effective in a series of experiments which offered various subtle cues to subjects given a puzzle to solve.

10 Outside of a class in logic, we rarely hear phrasing like "if and only if" (iff) to distinguish the broad "if/then" (including its inverse) from the narrow "if but not only if" (if). The distinction is almost always left to context. But the basic Wason problem provides so little context that if/then here could be interpreted either way.

¹¹ Once the category of cards with A's has been checked, it would be redundant to check cards with 3's. Yet another reading of if/then language implicates the converse ($A \rightarrow 2$ & $2 \rightarrow A$), as in "if you want to see the show then you need a ticket" will be understood to implicate "if you have a ticket then you will get into the show." This would also make A & 2 a correct response. See Laming's papers cited below. But this reading is hard to square with the variants coming next.

I give three examples from my 1987 book of successful cueing that yield striking responses to variants of Wason's puzzle. One variant usually cures the illusion in a particularly simple way, a second does nothing to cure the illusion but does shift the illusory response in a way that makes sense on the defaulting account and not so on accounts tied to a some difficulty with modus tollens, and a third variant looks like it cures the illusion but actually yields its mostly correct responses because the variant creates a coincidence between a correct response and the usual illusory response. This again occurs in a way that makes sense in terms of defaulting and not so in terms of more usual alternative accounts of Wason.

1. A striking "categories" effect comes by changing the question to force subjects to make 2-card choices. If the defaulting account is correct, the common "A&2" response only reflects the salience of A & 2 in the rule, since "A&D", "D&3", and "2&3" are just as pseudo-correct (on the illusory sense of the context). And if that is so, then changing the salience of the pairs might switch responses from predominantly "A&D" to some other pair rarely seen. Fox & Levav (2004) provide a parallel example of the susceptibility of responses to subtle changes in wording.¹²

This turns out to be strikingly easy. Framing the question as: "Circle two cards to turn over to check whether the rule has been violated" elicits "A&2" responses. But when the instruction is turned around to read: "Figure out which two cards could violate the rule, and circle them", the predominant response switches to the otherwise almost never seen "D&3". Checking this, Griggs (1993) very solidly confirmed the result.

2. The four cards array [A, D, 2, 3] contains two easy cards: "A", which is rarely missed, and "D", which is rarely chosen; and two hard cards: "2" and "3", which supply nearly all the errors. Overall, about 90% of subjects in fact do make errors. So what will happen if subjects are shown only the two hard cards. One might suppose, since essentially all errors are in relation to the hard cards, that subjects will continue to do badly.

¹² Subjects asked to judge the probability that "the temperature on Sunday will be higher than every other day next week" were more likely to respond with the ignorance prior probability implied by the case partition (1/2) and less likely to respond with the ignorance prior probability implied by the class partition (1/7) than participants who were asked to judge the probability that "next week, the highest temperature of the week will occur on Sunday." See the discussion of a hesitate/*proceed* default later in the paper.

But they don't. Subjects shown an array reduced to [2, 3] will return a majority of correct responses. What can possibly account for this improvement, due only to removing the two cards that are ordinarily judged correctly anyway?¹³

On the defaulting account there is a simple resolution of this odd improvement. If subjects are understanding the rule narrowly, and responding as if the cards represented categories, not particular cards, then as already noticed either "A" or "3" would catch all violations of the rule. But the salience of "A" in the rule makes "A" the usual card to be noticed, and "3" is rare. But picking "3" when "A" is no longer available requires no improvement. Even though the illusion has not been corrected, "3" is the only (pseudo-correct) choice left. We are in a situation where the illusory choice happens to coincide with the actually correct choice.¹⁴

3. And finally, performance might be helped merely by replacing Wason's generic 'cards' with 'playing cards', taking advantage of the nearly universal familiarity with the setup of playing cards on a table, where the cards seen are always particular cards, never representative of categories of cards. Griggs (1989) found this produced response improved to about 75% correct from less than 10%, for a rule just as arbitrary as Wason's original ("if the back is red, the face is at least a 7") and without invoking anything like the affect-laden conditions (suggesting obligation, alertness for cheating) sometimes described as essential.¹⁵

These simple and easily replicated tests are consistent with defaulting, but falsifying for the familiar alternative accounts. On the defaulting account the difficulty for subjects is not in their lack of fluency handling modus tollens, but in a tacit

¹³ Early on Wason & Johnson-Laird (1972) found strong remedial effects in an experiment (RAST) using repeated choices from sets of not-p and not-q cards. But they did not try the simpler manipulation here of just removing the two easy cards from the usual 4-card display.

¹⁴ A person who saw the rule as 2-way should turn both cards, which does not happen nearly as often although the A&2 response is the most common for the 4-card array. But since both readings are readily available (we rarely do any explicit processing in interpreting "if" statements in ordinary conversation though they sometimes need 1-way and sometimes 2-way interpretations), it would not take much to nudge things one way or the other. And although "all of the above" is sometimes the right answer to a puzzle, it not what we usually encounter, which apparently is enough to favor the 1-way sense of the rule. .

¹⁵ Griggs found that merely using "7" in the rule instead of "at least a 7" greatly reduced the remedial effect.. A reasonable conjecture might be that mild complications (here using "at least a 7" instead of just "7" in the rule) might in general reduce the tendency to slide into the "categories" default, which after all can only occur if you aren't paying close enough attention to what you are going. By itself it does not do much, but in conjunction with the playing cards the effect is well-marked.

misperception of what the context is. If so, then merely providing somewhat stronger cues to context (sufficient to prompt the usually effortless orienting step) should correct the anomalous choices. And over the years many such examples have been found: using familiar rules ("if you're drinking beer you must be at least 18"), or using language that invokes a sense of obligation or a concern about being cheated. But the "playing cards" variant shows that there is overkill in these variants, since the playing cards variant yields a large improvement without invoking any of these effects making the rule itself more compelling. The rule remains completely arbitrary but the remedial effect is strong, as Griggs found.

So while the remedial effects of a familiar rule and affect-invoking ("hot") variants are consistent with the defaulting account, the converse is not true. Hot cognition or familiar rules can't account for the strong effects of the three variants I've reviewed, none of which change the rule in either way. And the same point holds for two other common explanations (confirmation bias and response bias), each of which is contingent on some elaboration of the modus-tollens-is-too-hard view.

Confirmation bias is the tendency to be alert for evidence that supports a preferred view relative to evidence that goes against that view. But here it would be a puzzle if subjects felt committed to an arbitrary rule they had never before seen and never used. And no matter how much weight might plausibly be given to confirmation bias, unless modus tollens was not readily accessible, why wouldn't a person answer the question they were directly asked: whether any of the cards might violate the rule?

Response bias is the tendency for what is mentioned in the rule to be salient, hence for a bias favoring choice of cards mentioned in the rule. As with confirmation bias there is no doubt this is a real effect (indeed I have drawn on it in explaining two of the three variants just shown and an odd example will come up in connection with the "opportunity cost" puzzle later in the paper.). But it hardly is reasonable to suppose that subjects are routinely incapable of getting beyond this, as if asked what $2+2$ is, and given the choice between "2" and "4" they would respond "2". In Wason's context, unless modus tollens was hard for subjects, they would have their attention first drawn to "A" and "2" but quickly notice that it is the "3" not the "2" that needs to be checked, as usually occurs in the "playing cards" third variant here.

A second kind of account for Wason turns on an entirely different view of things. Although the details and style of their arguments are very different, Oaksford & Chater (1994) and Sperber, Cara & Girotto (1995) reach the same conclusion: namely, that subjects ignore the not-q card because they sensibly see it as irrelevant. On either line of argument, getting the problem logically wrong is pragmatically correct.

Sperber et al are emphatic that Wason is irrelevant to understanding cognition, since subjects accused of giving illusory responses in fact are giving pragmatically sensible answers. The argument here is the opposite. Absent the evidence from the three Wason variants already given and the parallel analysis to come of three more cognitive illusions, who would believe that defaulting in the stark forms found in these puzzles could be a feature of normal human cognition?

For Oaksford & Chater, “the selection task is not a logical reasoning task but a task of optimal data selection in inductive hypothesis testing.” They see the situation as properly viewed as like a philosophers’ favorite conundrum: If I claim “all ravens are black” then by modus tollens shouldn't I believe that seeing a brown cow supports the claim? It isn't black, and, by George, it isn't a raven, just as the hypothesis claims. The not-q card in Wason is treated, in their Bayesian analysis, as like the brown object which if checked would with moral certainty turn out to be a cow or some other irrelevant entity. Wouldn't a sensible person, interested in whether indeed all ravens are black, confidently ignore brown objects which are vastly unlikely to be crows even if the hypothesis is false? And if the Wason question were indeed like the raven/black conundrum, then there would be some reason to see the usual Wason choices in that way.

But consider an extreme version of Wason, tailored to fit this schema and in contrast to the more usual sort of problem statement earlier, where there are just two possibilities for each side of a card (A or D, 2 or 3). . Suppose the cards are labeled with any animal on one side and any 4-digit number on the other.¹⁶ The rule is: “If the animal is ‘skunk’ then the number is ‘4382’.” And the array of cards shows: SKUNK /

PARAKEET / 4382 / 7681. If these were randomly selected cards from a large set of such cards, it would certainly be very unlikely that turning “7681” (the not-q card here) would discover a violation even if the rule was completely invalid. But nothing in the problem implies that the “7681” card was randomly selected. It is one of just 4 cards the experimenter is using to test subjects’ acuity. Might it not be relevant?

Unlike the Wason accounts considered earlier neither Oaksford & Chater nor Sperber et al claim that seeing that the not-q card could violate the rule would take more than a moment’s thought. Rather, on either of these accounts subjects correctly treat that as pragmatically not worth a moment’s thought. Sperber et al rhetorically title one of their papers “Inept Reasoners or Pragmatic Virtuosi?” (Giroto et al 2001).¹⁷ But does it take much virtuosity to notice that if you are asked to consider four cards, it is pragmatically sensible to consider the four cards?

But if a subject is caught by the *category*/instance default, hence as proposed here, is mistakenly responding as if each card represented a category of cards, then pragmatic virtuosi, or indeed anyone of normal competence, would pseudo-correctly ignore the not-q card. That not-q *category* becomes redundant, given the defaulting.

All the interpretations of Wason discussed here, including my own, are discussed in one or another of the contributions to Newstead & Evans’ (1995) Wason festschrift and in Stanovich’s (1999) book. An earlier version of this argument (Margolis 2000) prompted a number of supporting comments from experimenters (Bucciarelli 2000, Handley & Feeney 2000, Laming 2000, Margolis 2001).

So there is evidence that the defaulting account *might* be right, and if indeed right might make this trivial puzzle a window on a striking aspect of cognition. But if defaulting is the correct explanation of these Wason effects, we should be able to find parallels in other cognitive illusions. A particularly hard test might be the famously stubborn Monty Hall puzzle.

¹⁷ Like Oaksford & Chater, Sperber et al (1995, p. 38) invoke the raven paradox. They provide an explicit “recipe” for Wason variants that subjects can more often than not handle. But it is hard to see why this explains why subjects fail to solve what after all is a very simple puzzle without the strong manipulations called for by the Sperber et al recipe.

Monty Hall

Here is a version that (with no loss in its effectiveness as a cognitive illusion) avoids ambiguities tied to what quizmaster Monty Hall might or might not have done on the TV show which gave its name to the problem.

[MH] An Ace and two 5's from a deck of playing cards lay face-down. You must point to one. *I then will check the two remaining cards and turn one over to reveal a 5.* You win \$10 if you end up with the Ace. You can keep your original card, or switch it for the remaining unchosen card. Is there an advantage to switching?

The usual response is a very confident intuition that there is no advantage to switching, though in fact switching doubles your chance (from $1/3$ to $2/3$). A reader not already familiar with the problem is pretty likely to find this claim incredible. And as anyone who has tried the puzzle on colleagues will know, it can be hard to persuade even extremely sophisticated victims of this illusion that the immediately and powerfully intuitive response is wrong. Yet the only reasoning required is:

[MH*] Checking the two not-chosen cards to find a 5 doesn't change the location of the Ace. So once you eliminate that 5 (by revealing it as a loser), unless you picked the Ace initially (a $1/3$ chance) switching wins.

This reasoning is short, simple, and correct. But until a person is thoroughly familiar with Monty Hall, it is likely to seem like a trick proof that $2 = 3$. Even if you can't see what is wrong with it, you can feel sure it must be wrong... except that here there is nothing wrong.

As with Wason, we look for an either/or pair of frequently-encountered contexts, one of which must be the default that operates when familiar cues fail to prompt one rather than the other. But the *category/instance* adverse default in Wason is unlikely here, since the situation so clearly involves manipulating particular cards (picking one, turning over another). We can observe that in Wason subjects overwhelmingly respond as if the targets represented categories, overriding (but not consciously) the actual question, as we override the literal question in Wason's "head-injury" example (note 8). And since that *category/instance* pair does not seem relevant here, we should look again for some either/or pair of frequently-encountered contexts, one of which must be the default that operates when familiar cues fail to prompt one rather than the other.

Here the default (if the defaulting conjecture is correct) will be such that the illusory "equal chances" intuition is prompted. And we can pick out *two* such pairs, which immediately suggests why this illusory intuition is notoriously hard to correct though Wason is easy to correct. For habits of mind, like habits in general, operate outside of conscious attention. If there are *two* adverse defaults available in this problem, we can correct one by focusing attention on it, but that leaves the other still available to prompt the illusory "equal chances" intuition. Since our brains can consciously attend to only one thing at a time, whichever faulty default we point to leaves another adverse default available to prompt the illusion. That is why even a reader thoroughly cured of the Monty Hall illusion (she has no remaining doubt that it pays to switch) is likely to still find the false intuition popping up, except that now you realize it is an illusion.

Here are the candidates for defaults in play here.

(1) (*hesitate/proceed*) We constantly encounter new information, which needs to be sorted between items which warrant our attention, since we might reach a better choice if we stopped to consider it vs. information that does not seem to warrant stopping. Wherever our attention is focused, there is something to be noticed. Sometimes that new information makes us hesitate and reconsider our choice. But if we had to adopt a general rule (a default rule about whether to stop and reconsider our choice when we have no good indication one way or the other), we would be crippled unless that rule made us reluctant to rethink our choices in response to a new bit of information that does not set off alarm signals. If I am walking across a minefield, it will not take much to get my attention, but in an ordinary field I will not stop to consider how to maneuver around every bush I encounter: just random choices will be good enough. For this pair it is pretty obvious which must be the default, since if I easily stopped to reconsider my choices for any new item of information I could scarcely get through the day.

(2) (*interactive/passive*) And even when we stop to consider (or reconsider) a choice, it might be "interactive" in the sense that things relevant to my choice might change due to my choice. *Or* the situation might be treated as "passive": what I do, or might do, does not look like it warrants stopping to think about possible interactions. Clearly, it takes more time and effort to go through the assessment required for an interactive choice, which may or may not turn out to be worthwhile. If I go on the picnic, that does not make it more likely to rain (a passive case). But if I bet the limit in a poker game that does make it more likely other players will fold (an interactive case). In an impoverished context, one or the other (interactive or passive) will be the default. And on reasoning akin to conjecturing the default for (1), we might expect that the default here is the passive case. And this would extend to "your choice" or even "nature's choice", since the interactive/passive argument would continue to apply.

Both defaults would prompt a "makes no difference" response to the Monty Hall question. At the start of the process, if the *hesitate/proceed* default is active we are prompted to just pick one, not try to make some assessment of which card would be best. Here the default is not adverse. But at the next step the same default *is* adverse. A default *hesitate/proceed* response to the new information that a particular card other than my own is a 5 is then the illusory "makes no difference". And should I escape that adverse default, so I give some thought to what to make of the information, the *interactive/passive* default is that my initial choice wouldn't change equally-likely winners into a likely winner and an unlikely winner. Offered a choice between the two remaining cards the intuition prompted by the *interactive/passive* default is then again "makes no difference".

So we have a two-fold adverse defaulting, which can account for the vastly greater difficulty undoing the Monty Hall illusion relative to the usually easily-corrected Wason illusion.

Consider this variant on Monty Hall:

[XMH] An Ace and two 5's from a deck of playing cards lay face-down. You must point to one. *Without looking, I then will turn over one of the two remaining cards. Suppose the card I turn reveals a 5. You win \$10 if you end up with the Ace. You can keep your original card, or switch it for the remaining unchosen card. Is there an advantage to switching?*

The reasoning to the correct response is, if anything, rather more complicated than given a moment ago for Monty Hall:

[XMH*] If one of the three cards is randomly turned That can't make one of the remaining cards more likely than the other to be the Ace. If the turned card is the Ace, the other two cards each now have 0 probability of winning. If it is a 5 both now have .5 chance. Either way, there is nothing to be gained by switching. But one of the three cards is protected (the card picked can't be turned). However, that makes no difference because... So there is still no advantage to switching.

And however a reader chooses to fill out the gap I have left in XMH*, the XMH reasoning will be rather more complicated than the reasoning for MH. Nevertheless subjects find it as easy to get XMH right as it is hard to get MH right. This would be puzzling, except that the pair of *adverse* defaults for MH, each prompting the illusory intuition, are no longer adverse in XMH. Rather they efficiently prompt a person to the

correct intuition, even though the explicit reasoning in XMH is more complicated. The same habit-governed response here happen to be correct, so there is no cognitive illusion to be seen.

That XMH is as easy for subjects as MH is hard is not at all a small point, since analyses of Monty Hall typically treat the problem as intrinsically difficult, requiring reasoning far more complicated than the simple but entirely adequate remarks in MH* to justify switching.¹⁸ But the XMH variant is logically at least as challenging but subjects usually have no difficulty at all getting it right. So something apparently is in play (on the account here, defaulting) that is not contingent on statistical, logical or any other sort of sophistication.

A different bit of support for the defaulting account comes from considering a variant that is less likely to elicit the usual stubbornly wrong intuitions about Monty Hall. Suppose that instead of the three cards, the objects on offer are three golf balls. The variant is then:

Three identical-appearing golf balls have been altered so that no two weigh the same. You must point to one. I then will put the two unchosen balls on a balance, so you can see which of the two is lighter. You win \$10 if you end up with the heaviest ball, and you can exchange your pick for the heavier ball on the balance. Should you switch?

So in this variant, Player wins if she ends up with the heaviest ball, as she wins in MH if she ends up with the Ace. But this yields a substantial improvement in responses, to about 1/2 correct, similar to the results reported by Burns & Wieth (2004) and also by Fox & Levav (2004) for parallel variants.¹⁹ But a more striking difference is that it is usually easy to correct response a faulty intuition for the 3-balls version while for the 3-

¹⁸ Three recent Monty Hall discussions are Krauss, & Wang (2003) and Burns & Wieth (2004), and Fox & Levav (2004), all in the *Journal of Experimental Psychology (General)*. Krauss & Wang report a substantial correction of the illusion, but using a "guided intuition" manipulation which is very elaborate compared to the MH* argument here. Burns & Wieth point to a "collider effect" as the key to the difficulty, and indeed this effect is interesting, but it seems to apply as much to XMH as to MH, without causing any difficulty for XMH. Fox & Levav treat a wider range of problems, to be commented on in a later note.

¹⁹ Michael Stein of the Chicago statistics department (for a different reason than proposed here) suggested a version of this "three balls" Monty Hall variant to me, which I used in a 2002 conference paper. Burns & Wieth (previous note) independently use a version framed in terms of three boxers, where the chooser wins if she picks the best boxer; Fox & Levav, again independently, use versions which again provide some sort of explicit contest between the not-chosen candidates.

cards version that is notoriously hard. Somehow the stubbornness characteristic of MH is usually cured even though illusory responses remain common.

Both games can be described in identical language. In each, Player chooses one of three objects (two losing, the other winning but identical in appearance). A procedure then demonstrates that one of the two unchosen objects cannot be the winner. Then Player must decide whether it is better to switch her initial choice for the remaining possible winner. But after the procedure the $2/3$ probability that one of the two unchosen items is the winner is now concentrated on the sole remaining possibility. Switching therefore will raise the chance of winning from $1/3$ to $2/3$.

Since this applies exactly to both games, apparently it is something about the difference in procedure (checking both cards and turning one to reveal a 5, putting both balls on a balance so that the lighter one is revealed) that makes identical reasoning hard to follow in one context, easy in the other.

In terms of the defaulting conjecture, the essential difference between the "3-balls" and MH variants seems to be that even if the *hesitate/proceed* default may be as likely to be prompted for 3-balls as for MH, the *interactive/passive* default might be (from what we see, indeed is) less likely, and also likely to be easily displaced if it does take hold. In 3-balls here, or the versions mentioned in note 18, there is a contest of some kind from which one of the two not-chosen cards emerges as the preliminary winner. This seems (and apparently, for subjects, in fact is) considerably more vivid than envisioning which of two cards might be arbitrarily turned and keeping in mind the crucial point that the cards are first checked to be sure the card turned in a 5.

This conjecture is supported by another sort of variant. If subjects actually play the MH game a few times (*handling the cards themselves: watching someone else is not very effective*), that physical sense of the situation easily switches the intuition. After a few plays where you handle the cards yourself, it will become obvious that it pays to switch. But mere verbal instructions or even merely watching someone else handle the cards will easily fail. So a person in doubt about whether it really pays to switch ought to take a couple of minutes and deal the game a few times. And on the defaulting conjecture, it makes sense that defaults inappropriate to the physical situation, which can

take hold for a person merely given a verbal description, do not stay in place for a person actually put in the physical situation.

But invoking (even though only verbally) a more vivid physical procedure might help move a person past what is logically an inappropriate default, as indeed we already saw in the playing cards variant of Wason. And this would account both for the immediate improvement in responses (much more often, an adverse default never takes hold) and also to the loss of stubbornness among those still subject to the illusion (the default can be fully dispelled).

Restating this twofold default argument in another way: Absent effective cues to offset the default, uncertainty about whether an incoming bit of information is correlated with the choice (so it can affect the value of the choice) or uncorrelated (so it won't) would tend to favor uncorrelated. Otherwise we would have time to do very little but reconsider our choices. And, if this tendency (how to react when it's unclear how to react) was entrenched as the default early enough in our evolutionary history, this mostly helpful but occasionally perverse default would far precede literacy, and indeed probably precede language. This yields the *hesitate/proceed* default, leaving the "makes no difference" intuition of the original pick in place. .

But there is also the distinguishable second (*interactive/passive*) default propensity to treat the world as passive with respect to your choice (so the chance that it will rain is not affected by whether you go on your picnic). That would prompt the intuition, even if the *hesitate/proceed* default were not active, that picking one card wouldn't make some other card more likely to be the Ace.

For both defaults, the sort of merely verbal cues that are adequate to fluently displace this double default might need to be more vivid or more affect-laden than is invoked in a standard version of Monty Hall. But a shift to explicit competition between two of the three candidates (in 3-balls and its analogs in note 18) might make it much easier to displace the *interactive/passive* default relative to the standard form. It is easier to see that the two candidates who have to compete are more likely to hold the best candidate than the untested candidate, so that (contrary to the default) the initial choice does interact with the chance that the initial pick is the winner.

The physical experiment described supports that. But we can also test it with another well-known cognitive illusion.

*Chips*²⁰

Three poker chips are in a cup. One is marked with a BLUE dot on each side, and another with a RED dot on each side. The third chip has a BLUE dot on one side and a RED dot on the other. So there is one blue/blue chip, one red/red chip, and one blue/red chip. Without looking, you take out one chip, and lay it on the table.

1. Suppose the up-side turns out to be BLUE? What is the chance that the down-side will also be BLUE?
2. What if the up-side is RED? What is the chance that the down-side will also be RED?
3. Before you see how the chip has fallen, what is the chance that it has the same color dot on both sides?
4. Suppose you answered 1/2 in response to Questions 1 & 2. That would mean that whichever the up color of the chip, the chance is 50/50 that the color on the down side is the same. But if at Question 3 you said that chance is 2/3, aren't you contradicting yourself?

As implied by (3) the usual response to (1) and (2) is 1/2. As implied by (4), the universal response to (3) is 2/3. And the response to (4) from the large majority who report 1/2 for (1) and (2) but 2/3 for (3) is almost always that there must be some mistake in the reasoning which claims to show a contradiction. Indeed this is very often a most emphatic response, which is hard to overcome: all the more so for people (like economists and engineers) whose experience in the world gives them confidence that they could not have a *mistaken* clear intuition about such a simple probability question. But the reasoning required to see the "1/2" intuition *is* mistaken could hardly be simpler. If the color on the up-side is blue, then:

Of three equally-likely blue dots, two are on the Blue/Blue chip, and only one on the Blue/Red chip. So the chance is 2/3 that you are looking at the Blue/Blue chip.

²⁰ The problem has been a favorite among statisticians for a long time, known as Bertrand's Box paradox. Bertrand's original version, from 1889, postulated three boxes, each with two drawers, one containing a gold coin in each drawer, a second with silver coins, and the last one gold and one silver. The discussion here elaborates on Margolis (1996, Ch. 3). The problem was brought to the attention of cognitive psychologists by Falk & Bar Hillel (1982).

Or, even simpler though it takes a few more words:

With two same color chips and only one mixed color chip no one doubts that indeed (Q3) the chance is $2/3$ that the chip you picked is a same color chip. And from there no further *logic* is required, merely some fluency in English. If the chance is $2/3$ you picked a same color chip, what that *means* is that the chance is $2/3$ that whatever the color on the top (say, blue), the color on the bottom is the same (in this case, blue).

But the intuition of even sophisticated subjects usually defies the simple logic. As with Monty Hall, the easiest way to correct the illusion is to do the experiment. Set up the situation and try it a few times. You will find that it is not at all necessary to run enough iterations to make it statistically apparent that the correct response to Q1 or Q2 is $2/3$, not $1/2$. Rather, once in the physical situation you will find your intuition switches and it now becomes intuitively immediate that the correct probability is $2/3$. But without that physical experience, what logically seems too trivial to miss, in fact is missed by nearly everyone.

That Chips, like Monty Hall, is remarkably stubborn suggests that as in Monty Hall there are multiple defaults. Indeed all three discussed so far might play a role.

For Chips, the *category/instance* default, if in place, would not be adverse. A subject seeing the choices in terms of categories would distinguish between the category of chips with a blue dot (blue/blue & blue/red) and the chip with no blue dot (red/red). A person missing this default might only see the chip picked as one of three chips. The *hesitate/proceed* default would prompt a person to ignore the new information (the color on the up-side), leaving in place the intuition that any chip is as likely as any other. This would yield a response of $1/2$ if the default had taken hold only after the subject had noticed that the signal eliminated the red/red chip (which is by a wide measure the predominant response) but yields a response of $1/3$ if it had taken hold immediately, so again any chip is as likely as any other but now with all three chips left in play. This is also fairly common. And the *interactive/passive* default would ignore considering that my random choice of a particular side on a particular chip could change the probability that I picked one chip rather than another (the blue/blue rather than the blue/red). That would (again) yield a response of $1/2$ if the *category/instance* default was in place but a response of $1/3$ in the less likely case that it was not. So as with Monty Hall we could account for both the common errors and (from the availability of two adverse defaults) for the stubbornness of the errors.

Some support for this reading comes from the responses Fox & Levav (2004) report for a variant using three cards in a hat with red or white sides. They get a typical result with the basic problem ($1/2 = 59\%$, $1/3 = 13\%$, $2/3 = 2.6\%$, others = 26%). But a remedial variant tells subjects the sides were numbered red1–red2, white1-white2, and red3-white3. The FL question then was: “Given that the side showing is red, what is the probability that it is side Red1 or Red2?”

This manipulation emphatically draws attention from the cards to the sides of the cards, increasing the fraction who treated sides rather than cards as equally likely. And if a subject did that, then a person would reach the correct “ $2/3$ ” response by just counting, with no need to think about probabilities at all. But though correct responses were increased 10-fold (certainly providing some support for the FL account), the great majority of responses were still wrong. Responses of “ $2/3$ ” improved from 2.7% to 27%, but that left almost 3 of 4 (73%) still getting the problem wrong.

But in absolute terms the biggest effect of the manipulation was in decreasing the fraction who have the usually modal “ $1/2$ ” response from 59% to 24%, with most of that shift transferring to “ $1/3$ ”, which increased its share from 13% to 35%.²¹ So for many subjects focusing attention on particular sides corrected an illusion, but for even more it made things worse. For a person who reported “ $1/2$ ” as least responded as if realizing that one of the three possibilities was eliminated absolutely (the white1/white2 card) The new modal response ($1/3$) did not even get that far.

But this odd 2-way shift in responses makes sense in terms of the defaulting account. The manipulation emphatically pushed attention to the sides of cards (from the cards), which indeed made it easier to reach the correct “ $2/3$ ” response. For escaping the *interactive/passive* default is no longer need to reach the “ $2/3$ ” response. You only need to be able to count to three. But presumably because the problem statement becomes a little more complicated, hence increasing the cognitive work needed to escape the *hesitate/proceed* default, the variant yielded the large shift in the modal response from 59% “ $1/2$ ” to 36% “ $1/3$ ”, with only 24% still at “ $1/2$ ”.

²¹ The full results are: $1/2 = 24\%$, $1/3 = 35\%$, $2/3 = 27\%$, others = 14%.

Note that the *category/instance* default is not adverse here. A subject oriented toward categories correctly sees that only items within the category "cards with a red side" (in my version "chips with a red dot" are relevant.

An opportunity cost puzzle

Here is a final example, which like Wason is once again not at all stubborn, but also like Wason seems to involve only a single default.

Ferraro and Taylor (2005) asked economists encountered in the hotel lobby at the 2005 annual meeting to answer a question adapted from Chapter 1 of an introductory text. So the circumstances were not favorable to extended thought. Nevertheless the result was remarkable. Almost four out of five (in a sample of 199) got it wrong. FT argued that what that showed was a need for more attention to fundamental concepts in training economists. In a reply I argued that on the contrary what it showed was that economists are human, hence that economists, like all other human beings, are vulnerable to cognitive illusions when presented with a question outside of the sort of context in which they are familiar with that sort of question.

Here is FT's survey question:

You won a free ticket to see an Eric Clapton concert (which has no resale value). Bob Dylan is performing on the same night and is your next-best alternative activity. Tickets to see Dylan cost \$40. On any given day, you would be willing to pay up to \$50 to see Dylan. Assume there are no other costs of seeing either performer. Based on this information, what is the opportunity cost of seeing Eric?

And offered a multiple choice of [\$0, \$10, \$40, \$50], only 43 of a sample of 199 (21.6%) saw that \$10 is the correct response. The number of correct responses from PhD's in economics, consequently, was somewhat less than the expected number if the respondents had been chickens pecking randomly.

The 80+% who missed the correct response scattered their answers about equally among the three incorrect responses, in contrast to 'chips' and Monty Hall where the usual response is a firm though unsound intuition. But on the argument as developed so far this merely suggests that in this casual context of a quick question in a hotel lobby, subjects were especially vulnerable to an adverse *hesitate/proceed* default, relying on their "blink"

intuition to get what obviously was a very simple question right. But what we see are essentially random responses, but slightly biased against the correct (\$10) response because it is the only choice not mentioned in the question, hence the least salient to a random guesser. This does not really show that professors of economics have a grossly inadequate grasp of "opportunity cost", but rather that FT's question happens to trigger the sort of cognitive mechanism that accounts for illusory responses elsewhere.

In FT's simple problem, you can't go to both the Clapton concert and its alternative because you can't be in two places at the same time, not because (the usual context for thinking about opportunity cost) money to pay for Dylan isn't available for Clapton. What is needed is the opportunity cost of using time in one leisure activity rather than another. This is not the value of time issue ordinarily encountered in an economic analysis, which usually trades off value of work vs. value of leisure. And since the out-of-pocket cost for the Dylan concert is zero, nothing prompts a subject to think about the price of the concert, though of course \$0 is indeed a price. This combination of odd features makes the problem just a bit "translucent" relative to a question where a person doesn't have to switch dimensions to get to the opportunity cost. The value of the time used to attend the free Dylan concert here is the consumer surplus foregone by not going to the Clapton concert for which you have a WTP of \$50 but need to pay only \$40. And although consumer surplus is another perfectly familiar notion to any economist, no one ordinarily thinks of consumer surplus you could have gotten from the next-best thing you did not choose as the opportunity cost of whatever you did choose, though indeed that is true.

So the textbook question is a really good one for students. It provokes them to see what at first sight is a weird connection and see why, though odd, it is correct. But as a question outside that tutorial context, it is only weird. The cognitive connection needed to make the correct response readily intuitive is not difficult but it is certainly unusual, so that even though the concepts engaged (opportunity cost, value of time, consumer surplus) are familiar to any economist, the connections among them do not just "click" into place.

Indeed, if you were easily prompted to thinking about the opportunity cost of the use of time implications of everyday choices, you could scarcely get through the day. You

are almost constantly making choices of what to do next. At each choice, there is something else you might have chosen (or it wouldn't be a choice). Even if a next-best alternative is salient, all you need to know is that you prefer A to B, though every time you choose A there is an opportunity cost from not choosing B. It makes sense that our brains are organized in a way that inhibits being distracted by contemplation of such questions. It is only under special conditions (here indeed is where training comes in) that focusing on such things as opportunity cost is fruitful.

On FT's problem the ordinarily useful *hesitate/proceed* default which appeared in both the Monty Hall and 'Chips' accounts overrides really simple logic that any economist would know very well. It is logic that most respondents would have had occasion many times to explain to students. But they do not notice what they know very well. FT's startling result ought to sharpen alertness to the possibility that more serious situations must arise where cognitive effects yield bad choices by people who certainly know better.

Is a cognitive illusion affecting experts in their domain of expertise unprecedented? Not at all. As I've shown elsewhere (Margolis 1998), for 400 years the very best experts in early astronomy (from Kepler through Thomas Kuhn and beyond) uniformly misjudged a very simple technical issue due to a stubborn but (as a matter of logic) trivial cognitive illusion. But it is in the realm of social policy that the most serious consequences are likely to arise, but there nothing so simple as to allow a flat, no qualifications, verdict of "error" can be expected.

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