Simultaneous Contradictory Belief and the Two-System Hypothesis

Joshua Mugg (joshuamugg@gmail.com)
Department of Philosophy, 4700 Keele St.
Toronto, ON M3J 1P3 Canada

Abstract

The two-system hypothesis states that there are two kinds of reasoning systems, the first of which is evolutionarily old, heuristically (or associatively) based, automatic, fast, and is a collection of independent systems. The second is evolutionarily new, perhaps peculiar to humans, is rule-based, controlled, slow, and is a single token system. Advocates of the two-system hypothesis generally support their claim by an inference to the best explanation: two systems are needed to explain experimental data from the reasoning, heuristics, and biases literature. The best evidence for this claim comes from simultaneous contradictory belief (henceforth SCB) (Sloman 1996, 2002). I argue that Sloman has not provided us with cases of SCB. In each of his examples there is no evidence that the beliefs are held simultaneously. I then offer the outline for an experimental setup that would offer compelling evidence for the existence of SCB and thereby support the two-system hypothesis.

Keywords: Dual-process; two-system hypothesis; simultaneous contradictory belief.

Introduction

The two-system hypothesis states there are two reasoning systems (or at least two kinds of reasoning systems), the first of which (System 1 or 'S1') is evolutionarily old, heuristically (or associatively) based, automatic, fast, and is a collection of independent systems. The second (System 2 or 'S2') is evolutionarily new, perhaps peculiar to humans, is rule-based, controlled, and slow.[1] The advocate of the two-system hypothesis must demonstrate that the two systems are distinct (what I call the distinctness claim), that the two systems are of different kinds (what I call the kind claim), and that S2 is a single system. Advocates of the two-system hypothesis (I have in mind Evans (2004); Evans & Over (1996); Sloman (1993, 1996); Stanovich (1999, 2004); Carruthers (2009); and Frankish (2004, 2009)) generally support their claim by an inference to the best explanation: two systems are needed to explain experimental data from the reasoning, heuristics, and biases literature. The best evidence for this claim comes from simultaneous contradictory belief (henceforth SCB) (Sloman 1996, 2002).

However, their inference to the best explanation only supports, if successful, the distinctness claim. While criticism of the two-system hypothesis has focused on the kind claim (Samuels 2009; Evans 2011), I argue that Sloman has not provided us with cases of SCB. I then offer an experimental setup that would strongly support the existence of SBC.

Why SCB?

Before examining Sloman's cases of SCB we need to understand why SCB is good evidence for the two-system hypothesis, and we need to understand what counts as evidence for SCB. Sloman seems to have a rival explanation in mind to account for human reasoning: there is just one reasoning system (call this the one-system hypothesis). The one-system hypothesis can and should allow that this system operates differently under different circumstances. It should, for example, sometimes operate deductively and other times inductively. The two-system theorist allows for a single system to operate inductively and deductive on different occasions, since S1 and S2 engage in both forms of reasoning. What, we should ask, would be the empirical difference between there being one reasoning system that operates differently under different stimuli and there being multiple systems? One reasoning system cannot have contradictory outputs for one input (Here I am in agreement with Sloman (1996, 2002)). So the one-system hypothesis is committed to the following claim: for any question demanding reasoning and for which a reasoning system will produce only one answer, subjects will only offer one answer at any given time.

Sloman understands 'belief' broadly to mean "a propensity, feeling, or conviction that a response is appropriate even if it is not strong enough to be acted on" (384). This definition is not uncontroversial, but (for the sake of argument) I will grant it for the purpose of this paper. From Sloman's definition it follows that there are at least two ways in which subjects might offer more than one response at any given time. The first is behavioral. While people might explicitly say that they believe that p, they may exhibit behavior demonstrating that they believe not-p. This would be evidence that there is more than one system involved in reasoning. They believe (explicitly) that p but believe (dispositionally, tacitly, or implicitly) not-p. Second, a subject might feel a tension between p and not-p. This is phenomenological evidence for SCB.

As an example of a task where subjects give simultaneous contradictory responses which indicates the existence of distinct systems, consider the Muller-Lyer illusion. Subjects believe that the two lines are equal, but cannot help but *see* them as different lengths, even after they have measured the

[1] For a complete list of the property clusters of S1 and S2, sometimes called the 'Standard Menu', see Evans and Frankish (2009). I take the two-system hypothesis to be stronger than the existential claim that there are two systems of reasoning. The thesis is that cognition is divided into two systems and that each system has a certain set of properties associated with it—the properties on the Standard Menu.

two lines. Subjects perceive the lines as different lengths, but believe that they are the same length. So the Muller-Lyer illusion supports the claim that perception and reasoning are governed by distinct systems. Because there are two systems operating simultaneously the tension between *believing* that the lines are the same length and *seeing* them as them as different lengths persists.

While in his (1996) Sloman seems to indicate that the Muller-Lyer supports the two-system hypothesis about reasoning, in his (2002) he mere takes it to indicate that perception and knowledge are governed by distinct systems—a conclusion he (2002) recognizes is consistent with the one-system hypothesis. He explains that "the conclusion that two independent systems are at work depends critically on the fact that the *perception* and the knowledge are maintained simultaneously" (385, emphasis added). So the Muller-Lyer supports the existence of two distinct systems, but not two distinct reasoning systems.

The preceding two paragraphs help elucidate what counts as evidence for SCB. It would be too stringent to require that subjects verbally claim p and not-p at the same time. Alternatively, a subject might quickly alter her reposes (they might say 'it is valid…Wait, no it's not. Wait, yes it is…'). Call this a response toggle. A response toggle is neither necessary nor sufficient for there being SCB, though it might count in its favor. The two contradicting answers might come from an uncertainty in a step of a single system process (e.g. being asked whether an argument is sound, and the argument is valid but the subject is unsure about the truth of a premise). The uncertainty in that case reflects the uncertainty of one or more premises rather than two competing beliefs. So response toggle might count in favour of SCB, but there are cases in which a subject will response toggle without there being any SCB.[2]

While the existence of SCB would be good evidence for the existence of two reasoning systems, it is possible that there are two systems and that no SCB ever occurs. Indeed, it is possible that two systems exist and that they make (almost) no causal difference. I have two lungs, but (when both function properly) they operate in essentially the same way that one large lung would. So it is not the case that if there are two systems then those two systems will differ. That is, the existence of SCB is not necessary for the establishment of the two-system hypothesis, but if there is no SCB the case for the two-system hypothesis will be much weaker. If we can explain all the data using one system, then there is no need to posit a second system. Furthermore, if both the one-system and two-systems hypotheses offer equally plausible explanations then Ockham's Razor favours the one-system hypothesis since it posits the least kinds (and number) of entities.

One might object that SCB does is not sufficient for the establishment of the two-system hypothesis. One might reason as follows: if the two-systems hypothesis is true and the two systems can deliver different solutions to the same problem, then there may be cases in which subjects have SCB. But then the existence of SCB supports a necessary condition (rather than sufficient) for the two-system hypothesis. Actually, the argument from SCB to the two-system hypothesis is different. The reasoning is as follows:

1. There are cases of SCB.
2. If the one-system hypothesis is true, then there will be no cases of SCB.
3. So the one-system hypothesis is false.
4. If the one-system hypothesis is false, then there must be more than one reasoning system.
5. So there is more than one reasoning system.

It is true that this does not establish that there are *only* two reasoning systems, but if we need to posit more than one reasoning system a good place to start is with two reasoning systems. I now turn to the Sloman's examples of SCB.

Sloman's cases of SCB

The first example of SCB to consider is Sloman's (1998) experiment in which subjects "tended to project properties from a superordinate category to a subordinate category only to the extent that the categories were similar" (2002, 387). He supports this claim through argument strength. Subjects were asked, assuming the first statement was true, to determine the strength of the following argument:

Argument 1
Fact: Every individual piece of electronic equipment exhibits magnetic picofluctuation.
Conclusion: Every individual piece of audio equipment exhibits magnetic picofluctuation.

The mean of the subjects who affirmed the conclusion was .89, but of course if all audio equipment is electronic, then (given that the 'fact' above is true) a rational subject would give the conclusion a probability of 1. Sloman points out that when the category in the conclusion was atypical of the category in the premise, the judgments were even lower. For the following argument (Argument 2) the mean probability judgment was .76 (among those who claimed that all kitchen appliances where electronic).

Argument 2
Fact: Every individual piece of electronic equipment exhibits magnetic picofluctuation.
Conclusion: Every individual kitchen appliance exhibits magnetic picofluctuation.

During debriefing interviews, subjects agreed that there was good reason to assign this argument the maximum probability because of the category inclusion. However, subjects also thought that their lower probability assessments were also sensible, though "they inevitably failed to express why" (2002, 387). Sloman concludes that

[2] Response toggle would be behavioral evidence for SCB rather than phenomenological evidence (as in the 'belief that p', 'feels that not-p' cases).

after being shown the correct answer they had an associative S1 answer (a probability less than 1) and a rule-based S2 answer (a probability of 1).

There is a good alternative explanation to Sloman's claim that subjects had two answers in mind. There is an enthymeme in both arguments crucial to the argument going through. In Argument 1 it is "every individual piece of audio equipment is a piece of electronic equipment" and in Argument 2 it is "every individual kitchen appliance is a piece of electronic equipment." While both of these propositions seem plausible we should consider just how certain they are. Would a microphone stand count as part of the sound equipment? Does my wine opener or manual egg beater count as a kitchen appliance? Even if we answer negatively, the questions give us pause. So the enthymeme in the two arguments are not certain, and the level of each enthymeme is gauged by association. I am more inclined to exclude the microphone stand from audio equipment than I am a manual egg beater from kitchen appliances, which would explain why Argument 2 was deemed less certain than Argument 1. I propose that the subjects' responses reflect this uncertainty about the truth of the enthymeme, since subjects were not told to assume the enthymeme.

Sloman might respond that in debriefing interviews subjects admitted that there was good reason to assign each argument a probability of 1. When researchers pointed out to subjects that they ought to have assigned each argument maximal probability, I suggest that subjects then took the enthymeme to be true. They were then considering a more complete argument in the debriefing interview. However, subjects can claim that their answers were reasonable, and rightly so. Their answers simply reflected the probability that the enthymeme was true, which is identical to the probability of the conclusion given the fact. I conclude that Sloman's (1998) study does not give us a case of SCB.

Next, Sloman cites Osherson, Smith, Wilkie, Lopez, and Shafir (1990) as a case of SCB. In this study subjects were asked to compare the strength of two arguments:

Argument 3
Robins have an ulnar artery.
Therefore, birds have an ulnar artery.

Argument 4
Robins have an ulnar artery.
Therefore, ostriches have an ulnar artery.

Most subjects claimed that Argument 3 was stronger than Argument 4. Sloman thinks that subjects believe the correct answer—that Argument 4 is at least as strong as Argument 3. However they associate robins with birds more easily than robins and ostriches, and so they claim that Argument 3 is stronger. Even assuming that subjects' mistake is not due to the ambiguity in quantification (which I suspect it is), Sloman gives us no reason to think that subjects hold the beliefs *simultaneously.* All that Sloman offers in support of his claim that these beliefs are held *simultaneously* is the following: "this is a striking example in which a compelling logical argument fails to erase an even more compelling intuition: How much evidence can a fact about robins provide for an animal as dissimilar as an ostrich?" (2002, 388). So it is the intuition that is supposed to persist even after subjects realize that Argument 4 is at least as strong as Argument 3, but this is not a case of *contradictory* belief. Our intuitions (inductive reasoning) tell us that Argument 4 cannot be very strong, but deductive reasoning might then recognize that this implies that Argument 3 cannot be very strong either. The competing answers might be held at different times. First one thinks (wrongly) that Argument 3 is stronger than Argument 4. Then (after it being pointed out that ostriches are a kind of bird) Argument 4 looks at least as strong as Argument 3. There is no need for the two beliefs to be held simultaneously.

Sloman offers an example from Revlin, Leirer, Yopp, and Yopp (1980) as a case of SCB in syllogistic reasoning. Subjects were asked which of the following five possible conclusions followed from the premises:

Argument 5
No members of the ad-hoc committee are women.
Some U.S. senators are members of the ad-hoc committee.
Therefore:

a. All U.S. senators are women.
b. No U.S. senators are women.
c. Some U.S. senators are women.
d. Some U.S. senators are not women.
e. None of the above is proven.

Argument 6
No U.S. governors are members of the Harem Club.
Some Arabian sheiks are members of the Harem Club.
Therefore:

a. All Arabian sheiks are U.S. governors.
b. No Arabian sheiks are U.S. governors.
c. Some Arabian sheiks are U.S. governors.
d. Some Arabian sheiks are not U.S. governors.
e. None of the above is proven.

83% responded correctly for Argument 5 (d. Some U.S. senators are not women) while only 67% of participants responded correctly to Argument 6 (d. Some Arabian sheiks are not U.S. governors). In Argument 5 the right conclusion accords with our standing beliefs while in Argument 6 our standing beliefs tell us that the stronger answer (b No Arabian sheiks are U.S. governors) is true. Sloman concludes from this example that "empirical belief obtained fairly directly through associative memory can inhibit the response generated by psycho-logic" (2002, 389). Again, Sloman has given us no reason to think that subjects *simultaneously* believe that, in Argument 6, b and d both follow and that only d follows. Do we currently have behavioral evidence that subjects *simultaneously* believe b

and only d? I think not. We only have evidence that more subjects chose wrongly in Argument 6, and perhaps they do so because when subjects lacks training in logic they fall back on their standing knowledge.

A final (well-known) example is Linda the feminist bank teller, which was devised by Tversky and Kahneman (1983). Subjects were given the following information: "Linda is 31 years old, single, outspoken and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations" (297). Subjects were then asked which of the two following is more likely: "A: Linda is a bank-teller. B: Linda is a bank-teller and is active in the feminist movement" (297). In some experimental trials more than 80% of subjects said statement B was more likely than the statement A, but of course a conjunction can never be more likely than one of its conjuncts.

Sloman claims that he "can trace through the probability argument and concede its validity, while sensing that a state of affairs that [he] can imagine much more easily has a greater chance of obtaining" (1996, 12). He offers the phenomenological experience of another psychologist as well: "I know that the [conjunction] is least probable, yet a little homunculus in my head continues to jump up and down, shouting at me—'but she can't just be a bank teller: read the description'" (Gould, 469).

Sloman pointed out the difference in temporal relation between the responses in the Muller-Lyer illusion and the Necker cube illusion to five of his department colleagues. Namely, in the Muller-Lyer case the illusion that the two lines are different lengths persists even after one knows they are the same length, while in the Necker cube illusion one is only able to recognize one square as the front face at any given time. Sloman then asked his colleagues whether their experience in the Linda case was analogous to the Muller-Lyer or Necker cube case. All five agreed that it was like the Muller-Lyer illusion. Sloman then asked his colleagues whether the 'Monty Hall' case[3] was analogous to the Muller-Lyer or Necker cube illusion. All of them (as well as Sloman) thought it was analogous to the Necker cube illusion. Sloman concludes that in the Monty Hall case the contradictory beliefs are not held simultaneously, whereas for the Linda case they are.

We should not put much weight on the phenomenology of the theorists. They are not naïve subjects and their phenomenological reports are suspect. Behavioral evidence of SCB from the subjects would be better. Sloman might object citing that his definition of belief is such that it is not necessary that subject *act* upon their beliefs, and a belief might not even make a behavioral difference. Although a subject might not *act* upon his or her beliefs, if there is a propensity, feeling, or conviction that a given proposition is true then surely it will make some difference to the cognitive processes or behavior of that subject. To be is to have causal powers (Alexander's Dictum). So if there is a belief that p then that mental state has causal powers. Furthermore our mental states do not constitute a totally separate causal web from our behavior. That is, our behavior and mental states are causally connected. Therefore, if a subject believes that p then that subject's behavior will be different than if they did not believe that p, even if that belief is too weak to deliberately act upon.

Experiment to test for SCB

According to the two-system hypothesis there are two systems operating and the reason that subjects answer incorrectly in the examples above is S2 is not given a chance to make a computation or S2's response is overwhelmed by S1. Since the two systems operate in parallel[4] a subject who offers an incorrect answer and then is told what the correct (S2) answer is will keep her S1 answer at the S1 level.[5] Take the Linda case for example. If the two-system hypothesis is right then subjects continue to believe (in some sense) that it is more likely that Linda is a feminist bank-teller than a mere bank-teller even after they admit that it is at least as likely that she is merely a bank-teller. A subject must suppress her S1 systems if she is to maintain the correct answer while believing a contradictory claim at the S1 level.[6] This kind of suppression requires the use of cognitive resources, thus temporarily depleting the subject's cognitive resources. So subjects who come to believe the correct answer after the test expend more cognitive energy than those who continue to believe (wrongly) that Linda is more likely a feminist and bank-teller than just a bank-teller. Let me offer a rough sketch of an experimental setup (based on experiments performed by Richeson & Shelton (2007)) to determine if this is right. A similar test could be run for other cases that Sloman and others think are instances of SBC.

In step one subjects are given a reasoning task that might involve SCB (e.g the Linda case). Subjects who offer the correct response should be dismissed. Those who offer the incorrect response should then be divided into two groups. The individuals are interviewed concerning the test that they just underwent. The first group will be made aware of their error during this interview. The experimenters will explain the conjunction fallacy and apply it to the Linda case. The

[3] The Monty Hall case is as follows. A subject is invited to a game show at which he or she may win a new car. The car is behind one of three doors. Behind the other two is nothing. The subject is told to pick a door. Monty, the game show host, opens one of the doors which the subject did not pick. The subject is then asked if he or she would like to change his or her answer. While it might at first seem that it does not matter, in fact there is a 2/3 chance that the car is behind the door that the subject had not picked.

[4] Parallel as opposed to sequential. In the former the two systems operate at the same time, in the later S1 operates first, then may shut down while S2 performs its computations. Almost all two-system advocates endorse a form of the parallel view.

[5] On most accounts the S1 level of belief is the same as the implicit level of belief.

[6] This need not be a conscious suppression.

second group will not be made aware of their error. In the interviews with members of group two experimenters will explain some unrelated fallacy that is supposed to be similar in phenomenology to the Necker cube (say, the Monty Hall example) (this is step two). Immediately following this interaction members of both groups will be asked to complete a Stroop Test, a typical measurement of executive functioning and cognitive depletion[7] (step three). If the two-system hypothesis is right then we should expect that the first group will have slower response times or less accurate responses for the Stroop Test than the second because they will have had to use their executive functioning to suppress their S1 belief that it is more likely that Linda is a bank-teller and feminist than she is a mere bank-teller.

It is important that those in group two have a conversation that is cognitively depleting. Otherwise the cognitive depletion in group one but not group two could be attributed to subjects in group one's having a conversation concerning logic beforehand (which depleted their cognitive resources) while the subjects in group two did not. Also, it will be important that subjects in the second group do not come to realize their mistake in the Linda case on their own. Experimenters may want to check at the end of the interview that subjects' in group two have not changed their responses. Alternatively, experimenters could ask subjects if they have changed their response to the initial case after completion of the Stroop Test.

Conclusion

Sloman has put forth the most explicit reasons for the two-system hypothesis: at least some of the experiments in the reasoning literature involve SCB, the explanation of which requires at least two reasoning systems. I have argued that the evidence thus far presented does not demonstrate that the beliefs are held simultaneously. However this does not imply a stalemate for advocates and skeptics of the two-system hypothesis. I have offered the outline for an experiment that would demonstrate the existence of SCB and so give good evidence that humans have two distinct reasoning systems.

References

Evans, Jonathan St. B. T.(Ed); Frankish, Keith(Ed) (2009a). *In Two Minds and Beyond*. New York, NY, US: Oxford University Press.

Evans, Jonathan St. B. T. and Frankish, Keith (2009b). "The duality of mind: an historical perspective." In *In Two Minds and Beyond*. Evans, Jonathan St. B. T.(Ed); Frankish, Keith(Ed). New York, NY, US: Oxford University Press.

Evans, Jonathan St. B. T (2003). In two minds: dual-process accounts of reasoning. *Trends in Cognitive Science* 7:10, 454-459.

Evans, Jonathan St. B. T. (2011). *Thinking twice: two minds in one brain*. Oxford and New York: Oxford University Press.

Frankish, K. (2004). *Mind and Supermind*. Cambridge University Press.

Kahneman, D. (2011). *Thinking, Fast and Slow*. New York: Farrar, Straus and Giroux.

Reber, A.S. (1993) Implicit Learning and Tacit Knowledge, Oxford University Press.

Revlin, R., Leirer, V., Yopp, H., & Yopp, R. (1980). The belief-bias effect in formal reasoning: The influence of knowledge on logic. *Memory & Cognition*, 8, 584-592.

Richeson, J. A., & Shelton, J. N. (2007). Negotiating interracial interactions: Costs, consequences, and possibilities. *Current Directions in Psychological Science*, 16(6), 316–320.

Osherson, D. Smith, E.E., Wilkie, O., Lopez, A., and E. Shafir. (1990) Category-based induction. *Psychological Review*, 97: 185-200.

Samuels, Richard. The magical number two, plus or minus: Dual-process theory as a theory of cognitive kinds. In *In Two Minds and Beyond*. Evans, Jonathan St. B. T.(Ed); Frankish, Keith(Ed). New York, NY, US: Oxford University Press.

Sloman, S. A. (1993). Feature-based induction. Cognitive Psychology, 25,231-280.

Sloman, S.A. (1996) "The Empirical Case for Two Systems of Reasoning." Psychological Bulletin 119, 3-22.

Sloman, S.A. (1998) "Categorical inference is not a tree: The myth of inheritance hierarchies. *Cognitive Psychology*, 35, 1-33.

Sloman, S.A. (2002) "Two Systems Reasoning." In T Gilovich, D. Griffin and D. Kahneman (Eds.) "Heuristics and Biases: The Psychology of Intuitive Judgment." Cambridge University Press, New York.

Stanovich, K. (1999). Who is Rational? Studies of individual differences in reasoning. Lawrence Erlbaum.

Stanovich, K. (2004). *The Robot's Rebellion: Finding Meaning in the Age of Darwin*. University of Chicago Press: London.

Tversky, A., & Kahneman, D. (1983). Extensional versus intuitive reasoning: The conjunction fallacy in probability judgment. Psychological Review, 90, 293-315.

Tverky, A. & Kahneman, D . (1986). Rational choice and the framing of decisions. *Journal of Business, 59* s251-s278.

[7] This well-known test involves the subject being shown the names of colors written in various colored prints. The subject is asked to give the name of the print-color. The faster and more accurately the participant gives the color of the print (rather than the word), the higher executive functioning and less cognitively depleted that participant, while the slower and less accurately the participant gives the name of the color of print, the lower the participant's executive functioning and more cognitively depleted the participant.