DUAL PROCESSES AND CONFLICT DURING MORAL AND LOGICAL REASONING:

A CASE FOR UTILITARIAN INTUITIONS?

Wim De Neys[1, 2, 3] & Michal Bialek[4]

1 - CNRS, Unité 8240 LaPsyDÉ, France

2 - Université Paris Descartes, Sorbonne Paris Cité, Unité 8240 LaPsyDÉ, France

3 - Université de Caen Basse-Normandie, Unité 8240 LaPsyDÉ, France

4 - Kozminski University, Warsaw, Poland

Mailing address: Wim De Neys
LaPsyDÉ (Unité CNRS 8240, Université Paris Descartes)
Sorbonne - Labo A. Binet
46, rue Saint Jacques
75005 Paris
France

wim.de-neys@parisdescartes.fr

www.wdeneys.org

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Abstract

The prominent dual process model of moral judgment suggests that an individual can intuitively detect that harming others is wrong (deontological morality), but has to deliberate to realize that harming others can be acceptable depending on the consequences (utilitarian morality). In contrast with this received view, we suggest that humans also have the ability to intuitively grasp the utilitarian dimensions of moral judgments. We review findings that indicate that individuals, despite making deontological judgments, show signs of automatic conflict detection between utilitarian and deontological aspects of moral dilemmas. We discuss the link with recent research on logical reasoning and propose a revision of the dual process model.

Introduction

Human thinking is often characterized as an interaction between intuition and deliberation. Sometimes an answer to a question will pop into our mind without conscious effort. At other times, arriving at a decision will take time and cognitive effort. These two types of thinking are often referred to as intuitive and deliberate thinking, or more recently, System 1 and System 2 thinking (Kahneman, 2011; Stanovich, 2010). The intuitive System 1 is typically characterized as fast and effortless whereas the deliberate System 2 is being characterized as slow and effortful (i.e., heavily dependent on limited cognitive working-memory resources). This two-headed, dual process view of human thinking has been very influential in the cognitive sciences (e.g., Evans & Stanovich, 2013). In the last decade the dual process framework has moved to the center stage in both logical[i] reasoning (e.g., Evans, 2003, 2008; Kahneman, 2011) and moral reasoning research (e.g., Greene, 2014; Greene & Haidt, 2002). Indeed, the adoption of this common "toolbox" in the initially somewhat isolated fields of logical and moral reasoning is believed to offer new opportunities for both fields to connect and inspire each other (Trémoliere, De Neys, & Bonnefon, 2016). In this chapter we present an illustration of such cross-field stimulation. Recent advances in the field of logical reasoning inspired us to look more closely at the interaction between the alleged System 1 and 2 processing in moral reasoning. We will review here how this endeavor forces us to revise some key assumptions of the dual process model.

We have organized the chapter in three sections. Because of the present volume's focus on moral reasoning we will first present an overview of our moral reasoning studies. Any researcher interested in moral reasoning per se should be able to read it as a stand-alone section. The second section presents an overview of the logical reasoning research that inspired our moral reasoning work. Finally, in the last section we discuss general implications for the core dual process model of human cognition.

Dual processes and moral reasoning: a case for utilitarian intuitions?

Research on moral reasoning has grown rapidly in recent years (Greene, 2014). These moral reasoning studies typically focus on the cognitive mechanisms that people use to decide between deontological and utilitarian considerations in moral dilemmas (e.g., Bialek, Terbeck, & Handley, 2014; Greene, 2014; Conway & Gawronski, 2013, Kahane, 2014; Moore, Stevens, & Conway, 2011; Nichols, 2004; Valdesole & Desteno, 2006). Imagine, for example, that by torturing a captured terrorist we can obtain critical information that allows us to prevent a planned attack that would kill dozens of innocent citizens. Would it be morally acceptable to torture in this case? Someone who takes a utilitarian point of view would say "yes". The moral principle of utilitarianism implies that the morality of an action is determined by its consequences. Consequently, although torture might be considered intrinsically wrong, it can nevertheless be judged morally acceptable because of the lives it will save (i.e., one calculates and opts for the "greater good"). Alternatively, the moral principle of deontology implies that the morality of an action depends solely on the intrinsic nature of the action. Consequently, harming others will be considered wrong regardless of its consequences and potential benefits. Hence, from a deontological point of view, the use of torture in the terrorist example would be judged inacceptable.

The influential dual process model of moral reasoning (Greene, 2014; Greene & Haidt, 2002) has associated utilitarian judgments with deliberate System 2 processing and deontological judgments with intuitive System 1 processing. The basic idea is that giving a utilitarian response to moral dilemmas requires that one engages in System 2 thinking and allocates cognitive resources to override an intuitively cued deontological System 1 response that primes us not to harm others. Consistent with this view it has been shown that people higher in working memory capacity tend to be more likely to make utilitarian judgments (Moore, Clark, & Kane, 2008). In addition, experimental manipulations that limit the time

(Suter & Hertwig, 2011) or cognitive resources (Conway & Gawronski, 2013; Trémolière, De Neys, & Bonnefon, 2012) that people can allocate to the decision also make it less likely that utilitarian judgments will be made. By and large, these findings present some basic support for the key dual process claim that utilitarian responders manage to recruit the deliberate System 2 to override a conflicting intuitive deontological response (but see also Baron , Scott, Fincher, & Metz, 2014; Kahane, 2014; Klein, 2011; Rai & Holyoak, 2010; Trémolière & Bonnefon, 2014).

However, the precise nature of the cognitive processing that underlies deontological responders' decision is less clear. A key but somewhat neglected question is whether or not deontological responders also detect that there are conflicting responses at play. That is, do deontological responders blindly rely on the intuitively cued deontological System 1 response without taking utilitarian considerations into account? Or, do they also realize that there is an alternative to the cued deontological response, consider the utilitarian view but simply decide against it in the end? Put differently, it is clear that deontological and utilitarian responders solve the intrinsic conflict between deontological and utilitarian considerations differently. What is not clear is whether deontological responders actually experience the same conflict.

To see if individuals who make deontological decisions detect conflict between utilitarian and deontological aspects of a problem, we designed a first study in which participants' processing of conflict and no-conflict dilemmas was contrasted (Bialek & De Neys, 2016a). To recap, in research on morality participants are typically presented with dilemmas in which they are asked whether they would be willing to sacrifice a small number of persons in order to save several more (e.g., hurt or kill one to save five). In these classic scenarios utilitarian and deontological considerations cue conflicting responses (hence, conflict dilemmas). Based on utilitarian considerations one would make the sacrifice, based on deontological considerations one would not. In the Bialek and De Neys (2016a) study we also reversed the dilemmas by asking participants whether they would be willing to sacrifice more people to save less (e.g., kill five to save one). In these no-conflict or control dilemmas both deontological and utilitarian considerations cue the exact same decision to refrain from making the sacrifice. To illustrate here is an example based on the famous Trolley problem (Foot, 1978) in a conflict and no-conflict version:

> [Conflict version]
> There is a runaway trolley barreling down the railway tracks. Ahead, on the tracks, there are five people tied up and unable to move. The trolley is headed straight for them. You are standing some

distance off in the train yard, next to a lever. If you pull this lever, the trolley will switch to a different set of tracks. Unfortunately, you notice that there is one person on the side track. This person will die if you change the tracks, but the five others will be saved. Would you choose to pull the lever?

[No-conflict version]
There is a runaway trolley barreling down the railway tracks. Ahead, on the tracks, there is one man tied up and unable to move. The trolley is headed straight for him. You are standing some distance off in the train yard, next to a lever. If you pull this lever, the trolley will switch to a different set of tracks. Unfortunately, you notice that there are five people on the side track. These five people will die if you change the tracks, but the one other person will be saved. Would you choose to pull the lever?

By contrasting processing measures such as response latencies and response confidence for both types of dilemmas we can measure participant's conflict detection sensitivity. Indeed, basic research on conflict detection in the cognitive control field and dual process studies on conflict detection during logical reasoning (see next section) have shown that detection of conflict between competing responses typically results in increased decision times and decreased response confidence (e.g., Botvinick, 2007; Botvinick, Braver, Barch, Carter, & Cohen, 2001; De Neys & Glumicic, 2008; De Neys, Rossi, & Houdé, 2013; Mevel et al., 2015; Pennycook, Trippas, Handley, & Thompson, 2014; Stupple, Ball, & Ellis, 2013). Bluntly put, when you are faced with competing responses, this will make you doubt and slow you down. Hence, if deontological responders to classic moral dilemmas take utilitarian considerations into account and detect that they conflict with the cued deontological response, response confidence should be lower and decision times should be longer when solving conflict vs control no-conflict dilemmas in which utilitarian and deontological considerations do not conflict. If deontological responders do not consider utilitarian principles, then the presence or absence of intrinsic conflict between utilitarian and deontological considerations should not have an impact on their processing. In this case, response confidence and decision latencies for conflict and no-conflict problems should not differ.

To test these predictions Bialek and De Neys (2016a) presented their participants with conflict and no-conflict dilemmas that were based on two classic problems (the Trolley and Plane problem, e.g., Royzman & Baron, 2002, and Foot, 1978). Each participant solved two different problems, one in a conflict version and the other one in a no-conflict version. Note that the key question concerned the latency and confidence data of participants who gave deontological decisions to the conflict problems (i.e., who refused to sacrifice one to save more). With respect to utilitarian responders there is little theoretical dispute that they face a conflict between deontological and utilitarian considerations.

Moreover, from a methodological point of view it is also hard to interpret the data from utilitarian responders unequivocally (e.g., Conway & Gawronski, 2013). Deontological considerations cue "no responses" on the conflict and no-conflict problems. Utilitarian considerations cue a "no" response on no-conflict problems, but a "yes" response (i.e., willingness to make a sacrifice) on conflict problems. Hence, in the case of utilitarian responses conflict and no-conflict responses not only differ in the presence or absence of conflict but also in terms of the decision made (i.e., willingness to take action or not). Consequently, when contrasting the conflict and no-conflict detection indexes, results will be confounded by the decision factor. Any potential processing difference might be attributed to the differential decision rather than to conflict sensitivity. Therefore, Bialek and De Neys (2016a) focused their analyses on participants who gave deontological responses to the conflict dilemmas.

Results were very straightforward. Deontological responders were significantly slower (i.e., about 5 s) and less confident (i.e., about 20% confidence drop) about their decision when solving moral dilemmas in which utilitarian and deontological considerations cued conflicting responses than when solving control problems in which both cued the same decision. This indicates that they are considering both deontological and utilitarian aspects of their decision. If deontological responders were not considering utilitarian principles or did not experience conflict between both viewpoints, then the presence or absence of intrinsic conflict between utilitarian and deontological considerations should not have had an impact on their decision making process.

In terms of the dual process modal of moral cognition the Bialek and De Neys (2016a) findings imply that deontological reasoners do not blindly rely on the intuitively cued deontological System 1 response. They also consider utilitarian aspects and realize that there is an alternative to the cued deontological response. This is noteworthy but a more critical question is where deontological responders' utilitarian sensitivity is coming from. That is, if deontological responders to moral dilemmas detect the utilitarian/deontological conflict, we also want to know how they manage to do this. The answer to this question has far-stretching implications for the dual process model of moral cognition. As we noted, in the dual process framework utilitarian reasoning is typically associated with deliberate, System 2 processing. Hence, one possibility is that deontological responders engage in some minimal Sytem-2 thinking. It would be this deliberate thinking that allows them to consider the utilitarian aspects of the dilemma and detect the conflict with the intuitively cued deontological response. Hence, in this case deontological reasoners would be less intuitive and more deliberate than is typically assumed in the dual process framework of moral cognition.

However, alternatively, it might be that deontological responders detect conflict between two different System 1 intuitions. In others words, under this interpretation taking utilitarian considerations into account might also be an intuitive System 1 process that does not require deliberation. Hence, rather than a System 1/System 2 conflict between an intuitive and more deliberated response, the detected conflict would reflect a System 1/System 1 clash between two different types of intuitions, one deontological in nature and the other utilitarian in nature. Interestingly, there have been a number of theoretical suggestions that alluded to the possibility of such intuitive utilitarianism (e.g., Dubljević & Racine, 2014; Kahane et al., 2011; Trémolière & Bonnefon, 2014). The point is that in case people do have such alleged utilitarian intuitions, this might allow them to detect conflict between the competing moral aspects of a dilemma without a need to engage in active deliberation.

In a second study Bialek and De Neys (2016b) decided to address this issue by burdening participants' cognitive resources with a demanding secondary task while the participants were solving conflict and no-conflict moral dilemmas. The rationale is fairly simple. A key defining characteristic of deliberate or System 2 thinking is that it draws on our limited executive working memory resources. Imposing an additional load task that burdens these resources will hamper or "knock-out" System 2. Hence, if participants' potential moral conflict sensitivity results from deliberate System 2 processing, it should become less likely under load. Consequently, response confidence and latencies should no longer differ for conflict and no-conflict dilemmas under load. Alternatively, intuitive System 1 processes are assumed to operate automatically in the dual process model. Hence, if participants' conflict sensitivity results from the competing output of two intuitive System 1 processes, it should not be affected by load.

Bialek and De Neys (2016b) adopted the complex load task that was previously introduced by Trémolière et al. (2012) to test these predictions. Before the moral dilemma was presented participants in a high load group were briefly shown a 4x4 matrix in which 5 random quadrants were filled with a dot. Participants had to memorize the position of the dots while they solved the moral dilemma. This memorization task has been shown to put a heavy burden on people's executive resources (e.g., De Neys, 2006; Miyake, Friedman, Rettinger, Shah, & Hegarty, 2001; Trémoliere et al., 2012). Once participants had entered their response to the moral dilemma they were asked to indicate their confidence, and finally they had to recall the dot pattern (by indicating which one of four possible matrixes was the one that was originally presented). Each participant solved four different moral dilemmas based on popular problems (i.e., the trolley, plane, cave, and hospital scenario, see De Neys & Bialek, 2016b). Two randomly selected

problems were presented in a conflict version; the other two were presented in a no-conflict version. Participants in a low load control group solved the same problems following the same procedure except that they were presented with a simple dot pattern (i.e., four dots on a straight line) for which the memorization puts only a minimal burden on executive resources (De Neys, 2006).

Results showed that - as previously observed by Trémolière et al. (2012) - high load decreased the number of utilitarian responses to conflict problems. Participants in the high load condition whose executive resources were heavily burdened were significantly less likely to give utilitarian responses than participants in the low load control group. In and by itself this finding supports the dual process claim that giving a utilitarian response to standard moral dilemmas requires executive resource demanding System 2 thinking. When System 2 processing is hampered under load, utilitarian responding consequently decreases. However, the key result here concerns the conflict detection measures. Bialek and De Neys (2016b) found that deontological responders still showed sensitivity to the presence of conflict between deontological and utilitarian principles under load. Although procedural complications made the response latencies uninformative, the confidence ratings established that deontological reasoners showed a significant confidence decrease when solving the conflict vs no-conflict problems. Indeed, the observed confidence decrease did not differ in the high load and low load control group. Hence, deontological responders showed the exact same sensitivity to utilitarian/deontological conflict when executive resources were burdened or not. This implies that the detection of this conflict and the generation of the utilitarian considerations is effortless and happens automatically. Hence, this supports the hypothesis that the whole operation is achieved by mere System 1 processing.

It is important to stress that the Bialek and De Neys (2016b) load study - just as the Trémolière et al. (2012) study before - established that people gave fewer utilitarian responses under load. This implies that although people might be intuitively detecting conflict between utilitarian and deontological dimensions of a moral dilemma, resolving the conflict in favour of a utilitarian decision does require executive resources. Hence, there is definitely evidence for some type of utilitarian thinking that is driven by System 2, as suggested by the classic dual process model of moral reasoning. However, the key point here is that simply taking utilitarian consideration into account per se does not necessarily require deliberation or System 2 thinking. Mere System 1 thinking suffices to have people grasp the utilitarian dimensions of a dilemma and detect the conflict with competing deontological considerations. It is this observation that

forces us to revise the classic dual process model of moral reasoning and postulate that System 1 is also generating a utilitarian intuition.

To be clear, we readily acknowledge that our claims here are based on only two empirical studies and will need to be interpreted with some caution. Obviously, it will be important to validate and fine-tune the findings in future moral reasoning studies (Bialek, & Terbeck, 2016). However, we would like to underline that our studies did not come out of the blue. As we noted, they were inspired by related dual process findings in the logical reasoning field. As we will clarify below, the standard dual process model of logical reasoning considers logical thinking as a paradigmatic System 2 process. However, a growing number of studies on conflict detection during logical reasoning indicate that reasoners also take logical considerations intuitively into account on the basis of System 1 processing. In other words, there seems to be some general evidence across different fields that points to the need to revise some core assumptions of the dual process framework. We review the logical reasoning studies in the following section and discuss general conclusions for the dual process framework in the final section.

Dual processes and logical reasoning: a case for logical intuitions?

One of the striking findings of psychological studies on logical reasoning since the field emerged in the 1960s is that people's inferences are often biased. In a wide range of tasks and situations it has been observed that even educated adults often fail to respect some of the most basic logical principles (e.g., Kahneman, 2011). To illustrate, consider the following problem:

> You are faced with two trays each filled with white and red jelly beans. You can draw one jelly bean without looking from one of the trays. The small tray contains a total of 10 jelly beans of which 1 is red. The large tray contains a total of 100 jelly beans of which 9 are red.
>
> From which tray should you draw to maximize your chance of drawing a red jelly bean?
> 1. The small tray
> 2. The large tray

When presented with this problem many participants have a strong preference for the large tray. From a logical point of view, this is not correct of course. Although the large tray contains more red beans than the small tray (9 vs 1), there are also a lot more white beans in the large tray. If you take the ratio of red

and white beans in both trays into account it is clear that the small tray is giving you a 10% chance of picking a red bean (i.e., 1/10) while the large tray only offers a 9% chance (i.e., 9/100). However, many educated reasoners are tricked by the absolute difference and fail to solve this basic "ratio" problem (e.g., Epstein, 1994). The fact that the absolute number of red beans is higher in the large tray has such a strong pull on people's thinking that they seem to neglect the ratio principle and end up being biased.

The popular dual process model of logical reasoning as it has been put forward in the seminal work of such authors as Daniel Kahneman (2011), Jonathan Evans (2008), or Keith Stanovich (2010) presents a straightforward account of the widespread logical reasoning bias. In general, the theory posits that sound logical reasoning requires slow and demanding System 2 processing. Incorrect or biased responding is typically attributed to System 1 processing. Hence, in the above ratio bias task, for example, the preference for the incorrect large tray is believed to result from System 1 processing whereas the realization that this tray provides worse winning changes is achieved by System 2. More specifically, the idea is that when we are faced with a reasoning problem, System 1 will immediately cue an intuitive response based on stored semantic and visuospatial associations. This System 1 response can be conceived as a simple rule of thumb or "heuristic" answer that suffices to answer most problems. However, the problem is that sometimes this heuristic System 1 answer can conflict with more logical considerations. In these circumstances System 2 will be needed to arrive at a correct response. But because System 2 thinking is cognitively demanding, many reasoners will lack the motivation (or cognitive resources) to engage in it. Consequently, these *cognitive misers* will not notice that their heuristic System 1 response conflicts with logical considerations and end up being biased.

The above clarifies that a core prediction of the standard dual process model of logical reasoning is that biased reasoners will typically not detect that their heuristic answer is logically questionable. In the last couple of years a range of studies has started to test this central "lax" conflict detection hypothesis empirically (e.g., see De Neys, 2012, 2015 for review). The studies typically contrast people's processing of classic reasoning problems such as the ratio bias task with newly constructed control versions. In the control or no-conflict versions the conflict is removed and the cued heuristic System 1 response is made consistent with the correct logical response. For example, a no-conflict control version of the ratio bias task could simply state that the large tray contains 11 (instead of 9) red beans. Everything else stays the same. In this case both the absolute number of red beans (i.e., 1 vs 11) and the ratio of red beans (i.e.,

1/10 vs 11/100) would be higher in the large tray. Hence, both heuristic System 1 considerations based on the absolute number and logical ratio considerations cue the exact same response.

The conflict detection studies have introduced a wide variety of measures to examine whether people process the conflict and no-conflict versions differently. The rationale is simple. Since the only difference between the two versions is the presence of conflict between a cued heuristic and some basic logical or probabilistic principle, a differential cognitive treatment of both versions (e.g., longer response latencies for conflict vs no-conflict versions) can help us to determine whether people are sensitive to this conflict or not. If biased reasoners do not consider logical implications, the two versions of the problem should be isomorphic and processed in the same manner.

Results of the studies typically suggest that reasoners (biased and unbiased alike) are sensitive to conflict. For example, it has been shown that even for biased reasoners, solving conflict problems as compared to their control versions results in increased response times (Bonner & Newell, 2010; De Neys & Glumicic, 2008; Stupple et al., 2013; Villejoubert, 2009; Pennycook, Fugelsang, & Koehler, 2015; but see also Pennycook, Fugelsang, & Koehler, 2012), increased skin conductance (De Neys, Moyens, & Vansteenwegen, 2010), increased activation of brain regions supposed to be mediating conflict detection (i.e., the Anterior Cingulate Cortex, e.g., De Neys, Vartanian, & Goel, 2008; Simon, Lubin, Houdé, & De Neys, 2015), increased inspection and recall of logically critical problem parts (Ball, Philips, Wade, & Qualyle, 2006; De Neys & Glumicic, 2008; Morsanyi & Handley, 2012), and a decreased accessibility of semantic knowledge related to the intuitive heuristic response (De Neys & Franssens, 2009; Svedholm-Häkkinen, 2015). In addition, biased reasoners also show a decreased response confidence after solving the classic conflict version of a problem (e.g., De Neys, Cromheeke, & Osman, 2011; De Neys, Rossi, & Houdé, 2013; Gangemi, Bourgeois-Gironde, & Mancini, 2014; Thompson & Johnson, 2014).

In sum, the conflict detection studies on logical reasoning indicate that reasoners who give an incorrect, heuristic response are detecting that their answer conflicts with more logical considerations. This directly argues against the lax conflict detection hypothesis in the standard dual process framework of logical reasoning (Bonner & Newell, 2010; De Neys & Glumicic, 2008; De Neys, 2012; Handley & Trippas, 2015; Morsanyi & Handley, 2012b; Pennycook et al., 2015; Thompson & Johnson, 2014; Villejoubert, 2009; but see for discussion also Singmann, Klauer, Kellen, 2014; Aczel, Szollosi, Bago, 2015; Mata,

Schubert, & Ferreira, 2014). However, although establishing that biased reasoners show some logical sensitivity is important, it is equally crucial to determine where this logical sensitivity comes from. Does it imply that biased reasoners are engaging in demanding System 2 thinking or does it imply that taking logical considerations can be achieved by System 1? Following the same rationale as the moral reasoning studies we reviewed in the previous section, De Neys and colleagues therefore ran a series of secondary task studies in which reasoners were asked to reason under load (e.g., Franssens & De Neys, 2009; Johnson, Tubau, & De Neys, 2016). Johnson et al., for example, used Tremolière et al.'s (2012) dot memorization task (see previous section) and observed that reasoners in a high load condition showed the same confidence decrease and latency increase for conflict vs no-conflict problems as reasoners in a no load condition. Franssens and De Neys (2009) also observed that biased reasoners' logical sensitivity was unaffected under load. Related findings have also been reported by Pennycook et al. (2014) using a time pressure manipulation.

The fact that people's logical sensitivity is observed when System 2 is "knocked out" under load directly suggests that it is achieved by System 1 processing. Hence, in contrast with the standard dual process model it is not the case that taking logical considerations into account requires System 2 thinking. Therefore, it has been suggested that System 1 cues not only a heuristic intuition based on semantic and visuospatial associations but also a logical one based on activation of stored logical principles (De Neys, 2012, 2014). In other words, the logical intuition concept refers to the idea that people have implicit knowledge of the basic logical principles that are evoked in classic reasoning problems (e.g., the role of ratios in the introductory ratio bias task), and automatically activate this knowledge when faced with the problem (De Neys, 2015).

It is important to underline that positing a logical System 1 intuition does not argue against the idea that there also exists a type of demanding, "proper" logical reasoning as suggested by the classic dual process model of logical reasoning. Note for example, that both the load studies of Johnson et al. (2016) and Franssens and De Neys (2009) typically observed that reasoners gave fewer correct responses on the conflict problems under load. Hence, although people might be intuitively detecting conflict between heuristic and logical dimensions of a reasoning problem, resolving the conflict in favour of a logical decision does seem to require executive resources. However, the point is that simply taking logical consideration into account per se does not necessarily require deliberation or System 2 thinking. Mere System 1 thinking suffices to have people grasp the logical dimensions of a problem and detect the

conflict with competing heuristic considerations. Paralleling our claim in the moral reasoning domain, it this observation that forces us to revise the classic dual process model and postulate that system 1 is also generating a logical utilitarian intuition.

Conclusion: towards a dual process theory 2.0?

In this chapter we reviewed evidence from moral reasoning studies that indicates - contrary to the standard dual process model of moral reasoning - that people intuitively grasp the utilitarian dimension of moral dilemmas. We illustrated how this research was inspired by logical reasoning studies that indicate - contrary to the standard dual process model of logical reasoning - that people intuitively grasp the logical dimension of classic reasoning problems. Both these findings argue against the standard dual process model in each of the individual fields in which utilitarian and logical reasoning are characterized as System 2 processes. We believe that this work presents a nice illustration of cross-field research interaction potential that the common underlying dual process framework holds for the moral and logical reasoning fields (Bialek & Terbeck, 2016; Trémolière et al., 2016). At the same time the findings also presents converging evidence for a fundamental problem of the core underlying dual process model of human cognition. Bluntly put, the evidence reviewed here indicates that System 1 is less oblivious and more informed than traditionally assumed. Reasoning processes that have been traditionally attributed to System 2 can also be achieved by System 1 both in the case of moral and logical reasoning. Future work will have to pinpoint how exactly these System 1 and 2 forms of utilitarianism or logicism differ but evidence is amassing for a revision of the standard dual process framework in which the potential of System 1 will need to be upgraded. We believe that a continuation of the cross-stimulation and interaction between moral and logical reasoning research will be particularly helpful in the development of such a dual process theory 2.0.

References

Aczel, B., Szollosi, A., & Bago, B. (2015). Lax monitoring versus logical intuition: The determinants of confidence in conjunction fallacy. *Thinking & Reasoning*, 1-19.

Ball, L. J., Philips, P., Wade, C. N., & Quayle, J. D. (2006). Effects of belief and logic on syllogistic reasoning: Eye-movement evidence for selective processing models. *Experimental Psychology, 53*, 77-86.

Baron, J., Scott, S., Fincher, K., & Emlen Metz, S. (2014). Why does the Cognitive Reflection Test (sometimes) predict utilitarian moral judgment (and other things)? *Journal of Applied Research in Memory and Cognition, 4,* Advance online publication.

Bialek, M., & De Neys, W. (2016a). Conflict detection during moral decision making : Evidence for deontic reasoners' utilitarian sensitivity. *Journal of Cognitive Psychology*.

Bialek, M., & De Neys, W. (2016b). Intuitive utilitarianism?: Evidence for automatic conflict detection in moral judgments. *Manuscript submitted for publication.*

Bialek, M., & Terbeck, S. (2016) Can cognitive psychological research on reasoning enhance the discussion on moral judgements? *Cognitive Processing,* 1-7.

Bialek, M., Terbeck, S., & Handley, S. J. (2014). Cognitive psychological support for the ADC Model of Moral Judgment. *AJOB Neuroscience, 5,* 21-23.

Bonner, C., & Newell, B. R. (2010). In conflict with ourselves? An investigation of heuristic and analytic processes in decision making. *Memory & Cognition, 38,* 186-196.

Botvinick, M. M. (2007). Conflict monitoring and decision making: reconciling two perspectives on anterior cingulate function. *Cognitive, Affective, & Behavioral Neuroscience, 7,* 356-366.

Botvinick, M. M., Braver, T. S., Barch, D. M., Carter, C. S., & Cohen, J. D. (2001). Conflict monitoring and cognitive control. *Psychological review, 108,* 624-652.

Conway, P., & Gawronski, B. (2013). Deontological and utilitarian inclinations in moral decision making: A process dissociation approach. *Journal of Personality and Social Psychology, 104,* 216-235.

De Neys, W. (2006). Dual processing in reasoning two systems but one reasoner. Psychological science, 17, 428-433.

De Neys, W. (2012). Bias and conflict: A case for logical intuitions. *Perspectives on Psychological Science, 7,* 28-38.

De Neys, W. (2014). Conflict detection, dual processes, and logical intuitions: Some clarifications. *Thinking & Reasoning, 20,* 169-187.

De Neys, W. (2015). Heuristic bias and conflict detection during thinking. In B. Ross (Ed.*), Psychology of Learning and Motivation* (Vol. 62, pp. 1-32): Academic Press

De Neys, W., Cromheeke, S., & Osman, M. (2011). Biased but in doubt: Conflict and decision confidence. *PLoS ONE, 6,* e15954.

De Neys, W., & Franssens, S. (2009). Belief inhibition during thinking: Not always winning but at least taking part. *Cognition, 113,* 45-61.

De Neys, W., & Glumicic, T. (2008). Conflict monitoring in dual process theories of thinking. *Cognition, 106,* 1248-1299

De Neys, W., Moyens, E., & Vansteenwegen, D. (2010). Feeling we're biased: Autonomic arousal and reasoning conflict. *Cognitive, Affective, & Behavioral Neuroscience, 10*, 208-216.

De Neys, W., Rossi, S., & Houdé, O. (2013). Bats, balls, and substitution sensitivity: Cognitive misers are no happy fools. *Psychonomic Bulletin & Review, 20*, 269-273.

De Neys, W., Vartanian, O., & Goel, V. (2008). Smarter than we think: When our brains detect that we are biased. *Psychological Science, 19*, 483-489.

Dubljević, V., & Racine, E. (2014). The ADC of moral judgment: Opening the black box of moral intuitions with heuristics about agents, deeds, and consequences. *AJOB Neuroscience, 5*, 3-20.

Epstein, S. (1994). Integration of the cognitive and psychodynamic unconscious. *American Psychologists, 49*, 709-724.

Evans, J. St. B. T. (2003). In two minds: Dual process accounts of reasoning. *Trends in Cognitive Sciences, 7*, 454-459.

Evans, J. S. B. (2008). Dual-Processing Accounts of Reasoning, Judgment, and Social Cognition. *Annual Review of Psychology, 59*, 255-278.

Evans, J. S. B., & Stanovich, K. E. (2013). Dual-process theories of higher cognition advancing the debate. *Perspectives on Psychological Science, 8*, 223-241.

Foot, P. (1978). The Problem of Abortion and Negative and Positive Duty: A Reply to James LeRoy Smith. *Journal of Medicine and Philosophy, 3*, 253-255.

Franssens, S., & De Neys, W. (2009). The effortless nature of conflict detection during thinking. *Thinking & Reasoning, 15*, 105-128.

Gangemi, A., Bourgeois-Gironde, S., & Mancini, F. (2014). Feelings of error in reasoning—in search of a phenomenon. Thinking & Reasoning, (ahead-of-print), 1-14.

Greene, J. D. (2014). Moral tribes: emotion, reason and the gap between us and them. Atlantic Books Ltd.

Greene, J. D., & Haidt, J. (2002). How (and where) does moral judgment work? *Trends in Cognitive Sciences, 6*, 517-523.

Handley, S. J., & Trippas, D. (2015). Dual Processes and the Interplay between Knowledge and Structure: A New Parallel Processing Model. In B. Ross (Ed.), Psychology of Learning and Motivation (Vol. 62, pp. 33-58): Academic Press.

Johnson, E. D., Tubau, E., & De Neys, W. (2016). The Doubting System 1: Evidence for automatic substitution sensitivity. *Acta Psychologica, 164*, 56-64

Kahane, G. (2014). Intuition and Deliberation in Moral Psychology. In J. D'Arms, D. Jacobson (Eds.) *Moral Psychology and Human Agency: Philosophical Essays on the Science of Ethics*, (pp 9-40). London: Oxford University Press

Kahane, G., Wiech, K., Shackel, N., Farias, M., Savulescu, J., & Tracey, I. (2012). The neural basis of intuitive and counterintuitive moral judgment. *Social Cognitive and Affective Neuroscience, 7(4)*, 393-402.

Kahneman, D. (2011). *Thinking, fast and slow*. New York: Farrar, Strauss and Giroux.

Klein, C. (2011). The dual track theory of moral decision-making: a critique of the neuroimaging evidence. *Neuroethics, 4*, 143-162.

Mata, A., Schubert, A. L., & Ferreira, M. B. (2014). The role of language comprehension in reasoning: How "good-enough" representations induce biases. *Cognition, 133*, 457-463.

Mevel, K., Poirel, N., Rossi, S., Cassotti, M., Simon, G., Houdé, O., & De Neys, W. (2015). Bias detection: Response confidence evidence for conflict sensitivity in the ratio bias task. *Journal of Cognitive Psychology, 27*, 227-237.

Miyake, A., Friedman, N. P., Rettinger, D. A., Shah, P., & Hegarty, M. (2001). How are visuospatial working memory, executive functioning, and spatial abilities related? A latent-variable analysis. *Journal of Experimental Psychology: General, 130*, 621–640.

Moore, A. B., Clark, B. A., & Kane, M. J. (2008). Who shalt not kill? Individual differences in working memory capacity, executive control, and moral judgment. *Psychological science, 19*, 549-557.

Moore, A. B., Stevens, J., & Conway, A. R. (2011). Individual differences in sensitivity to reward and punishment predict moral judgment. *Personality and Individual Differences, 50*, 621-625.

Morsanyi, K., & Handley, S. (2012). Does thinking make you biased? The case of the engineers and lawyer problem. *Proceedings of the Annual Meeting of the Cognitive Science society, 34*, 2049-2054.

Nichols, S. (2004). Folk concepts and intuitions: From philosophy to cognitive science. *Trends in Cognitive Sciences, 8*, 514-518.

Pennycook, G., Fugelsang, J. A., & Koehler, D. J. (2012). Are we good at detecting conflict during reasoning? *Cognition, 124*, 101-106.

Pennycook, G., Fugelsang, J. A., & Koehler, D. J. (2015). What makes us think? A three-stage dual-process model of analytic engagement. *Cognitive Psychology, 80*, 34-72.

Pennycook, G., Trippas, D., Handley, S., & Thompson, V. (2014). Base rates: Both neglected and intuitive. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 40*, 544-554.

Rai, T. S., & Holyoak, K. J. (2010). Moral principles or consumer preferences? Alternative framings of the trolley problem. *Cognitive Science, 34(2)*, 311-321.

Royzman, E. B., & Baron, J. (2002). The preference for indirect harm. *Social Justice Research, 15*, 165-184.

Simon, G. Lubin, A., Houdé, O. & De Neys, W. (2015). Anterior cingulate cortex and intuitive bias detection during number conservation. *Cognitive Neuroscience,* 6, 158-168.

Singmann, H., Klauer, K. C. & Kellen, D. (2014). Intuitive Logic Revisited: New Data and a Bayesian Mixed Model Meta-Analysis. *PLoS ONE, 9(4),* e94223.

Stanovich, K. E. (2010). *Rationality and the reflective mind*. New York: Oxford University Press.

Stupple, E. J., Ball, L. J., & Ellis, D. (2013). Matching bias in syllogistic reasoning: Evidence for a dual-process account from response times and confidence ratings. *Thinking & Reasoning, 19,* 54-77.

Suter, R. S., & Hertwig, R. (2011). Time and moral judgment. *Cognition, 119*, 454-458.

Svedholm-Häkkinen, A. M. (2015). Highly reflective reasoners show no signs of belief inhibition. *Acta psychologica, 154*, 69-76.

Thompson, V. A., & Johnson, S. C. (2014). Conflict, metacognition, and analytic thinking. *Thinking & Reasoning, 20*, 215-244.

Trémolière, B., & Bonnefon, J.-F. (2014). Efficient Kill–Save Ratios Ease Up the Cognitive Demands on Counterintuitive Moral Utilitarianism. *Personality and Social Psychology Bulletin, 40*, 923-930.

Trémolière, B., De Neys, W., & Bonnefon, J.-F. (2012). Mortality salience and morality: Thinking about death makes people less utilitarian. *Cognition, 124*, 379-384.

Trémolière, B., De Neys, W., & Bonnefon, J. F. (2016). Reasoning and moral judgment: A common experimental toolbox. In L. J. Ball & V. A. Thompson (Eds.), *International Handbook of Thinking and Reasoning*. Hove, UK: Psychology Press

Valdesolo, P., & DeSteno, D. (2006). Manipulations of emotional context shape moral judgment. *Psychological science, 17*, 476-477.

Villejoubert, G. (2009). Are representativeness judgments automatic and rapid? The effect of time pressure on the conjunction fallacy. *Proceedings of the Annual Meeting of the Cognitive Science society, 30*, 2980-2985.

[i] We use the label logical reasoning here as a general header to refer to both deductive and probabilistic inferencing as it has been studied in the Heuristics and Biases work (e.g., Kahneman, 2011), for example.