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The Unity of Higher Cognition: The Case against Dual Process Theory

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THE UNITY OF HIGHER COGNITION:
THE CASE AGAINST DUAL PROCESS THEORY

by

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ABSTRACT

Dual process theorists posit the existence of two distinct types (type-1/type-2) of cognitive processing in order to explain domains of higher cognition such as reasoning and decision-making. Such theories typically allude to co-varying clusters of properties (i.e. a dual-cluster thesis) as well as an underlying mechanism or system for each processing type (i.e. a dual systems thesis). I will argue that a host of empirical findings cast doubt upon the validity of both theses, and that simpler models of higher cognition—that do not appeal to *types* of processing—might be preferable.

INDEX WORDS: Dual process theory, The Unimodel, Evolution of cognition, Reasoning and decision-making, Cognitive science, Philosophy of psychology

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DEDICATION

I dedicate this thesis to my mother and father; Sheryll and Dave. Without them, I would not have existed. Without their support for my decision to study philosophy, I would have probably majored in something else, and hence, this thesis (too) would have never existed.

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1 INTRODUCTION

In the last few decades, psychologists and philosophers have developed *dual process theories* to give accounts of the processes involved in decision making, moral reasoning, and social cognition.[1] Dual process theorists make a distinction between two kinds of cognitive processes implicated in thought. Type-1 processes possess properties such as being unconscious, shared with non-human animals, associative, being relatively fast, and evolutionarily old. Type-2 processes are typically said to possess features that contrast with these (see Figure 1). They are often described as being conscious, unique to humans, rule-based, being relatively slow, and evolutionarily new. At the least, dual process theorists are committed to saying that there are two distinct *types* of processing (Evans 2011), and that each is identified by a cluster of co-varying properties (Samuels 2009, p. 131).[2]

The appearance of such clustering has typically been explained by a division in *cognitive architecture*.[3] The idea is that some distinct cognitive mechanism—or set of mechanisms—undergirds each of the processing types. Samuels refers to this as the Dual-Systems thesis (Samuels 2009, pg. 132). Dual process theorists are then committed to the following specific

[1] See Evans (2008) and Frankish (2010) for a review of the dual process theory literature

[2] Samuels (2009) distinguishes between the dual-cluster thesis and the dual-systems thesis. The dual-cluster thesis just states that there are two co-varying clusters of properties associated with each processing type. The dual-system thesis invokes separate systems to explain the presence of the co-varying property clusters. But a dual process theorist can remain neutral with respect to the latter thesis. Thus, they can hold the dual cluster thesis without endorsing the dual-system thesis. However, within the dual process literature, both of these theses typically hang together.

[3] Cognitive architecture can be distinguished from neural architecture. It is an abstract description of the structure and parts of the mind (e.g. working memory), rather than the concrete structure and parts of the brain (e.g. amygdala, cerebellum). Cognitive architecture is discussed often by psychologists, artificial intelligence researchers, and philosophers. Psychologists have theorized about the how mental processes involved in general intelligence, memory, and attention work in human beings. Artificial intelligence researchers have theorized about how to implement such cognitive abilities in robots and computers. Lastly, philosophers have theorized about what sorts of structure and parts the mind might have given the presence of certain cognitive abilities (e.g. productivity: the ability to entertain an infinite number of different thoughts/sentences).

claims. First, certain properties cluster together with each of the processing types and second, some difference in the architecture of the mind-brain explains why.[4] These two features—clustering properties and the postulation of differing mechanisms—would qualify type-1/type-2 processes as *natural kinds*.[5] Within the philosophy of science, natural kinds are understood as classes of objects or entities for which many scientific inductive generalizations can be made (Mill 1884, Quine 1969). Natural kinds can be also be thought of as the building blocks of scientific theories, groupings of objects that are thought to reflect the structure of the world rather than just the interests of human beings. For instance, within the science of chemistry, the elements that make up the periodic table (e.g. hydrogen, aluminum) are all instances of natural kinds. Some examples of non-natural kinds include pets, green objects, and people named Mike.[6]

Table 1 Standard menu of dual process theory

Type-1	*Type-2*
Associative	Rule-based
Heuristic	Analytic
Parallel	Serial
Automatic	Controlled
Intuitive	Reflective
Unconscious	Conscious
Low demands on cognitive capacity	High demands on cognitive capacity
Relatively fast	Relatively slow
Contextualized	Decontextualized
Evolutionarily Old	Evolutionarily New
Conserved across species	Unique to humans

[4] Stanovich and Evans (2013) are reluctant to talk of systems as it may falsely imply that there is one *token* system of each type. Since they happen to think there are multiple type-1 systems (e.g. modules, associatively learned mechanisms etc.), they now tend to only speak of type-1/type-2 *processing* to avoid this confusion.

[5] Type-1/type-2 processes would be natural kinds within the science of psychology. Other *psychological* kinds might include pain, the basic emotions (e.g. anger, happiness), perception, and cognition. If type-1/type-2 processes are natural kinds, then cognition would be subdivided into two sub-types: type-1 and type-2.

[6] For instance, pets are non-natural because the class of animals is determined by human preferences for certain features (e.g. docility). Mammals are a *natural* grouping of organisms because all mammals share certain properties (e.g. females having mammary glands for producing milk).

The philosopher Richard Samuels discusses a potential problem for a natural kinds interpretation of dual process theory, which he calls the *crossover* problem (Samuels 2009, pg. 140). Crossover occurs whenever you have processes with both type-1 and type-2 features. For example, an unconscious process that is rule-based. Crossover can be a problem because the alignment of properties is what is supposed to distinguish the two processing types. The extent to which crossover is problematic for dual process theories depends on how often or how drastic it is. For example, if psychologists were to discover that all unconscious processes are rule-based rather than associative, an auxiliary hypothesis of the theory would be falsified. But in this case, dual process theorists could just give up that one auxiliary hypothesis and just remove that particular feature from the menu of properties. While crossover between a set of processing features can be easily remedied—by just dropping a couple of properties from the menu—crossover across virtually all of the properties might falsify the view entirely. One of the major predictions of dual process theory is that certain clusters of properties are probabilistically connected, and that certain inferences can be made about a given cognitive process. For example, if a cognitive process is unconscious, then it is likely to be associative. The existence of crossover—resulting in hybrid cognitive processes—might render such inferences (e.g. unconscious→associative) invalid (Mandlebaum 2015). Unless the dual process theorists can accommodate these instances of crossover, by demonstrating that they are the exception rather than the rule, crossover across most properties would constitute a serious threat to the view.

In this paper, I will argue that type-1/type-2 processes probably aren't natural kinds, and subsequently, that if they are not, type-1/type-2 processes would, at best, serve various heuristic purposes such as generating new hypotheses. I will then consider alternative models of higher cognition that are simpler yet possibly explanatorily equivalent. The Unimodel (Kruglanski and

Gigerenzer 2011) does not carve out a distinction between different processing types, but instead, appeals to processing features on a continuum, allowing for intermediary cases as well as hybrid processes. I will argue that if the Unimodel can explain psychological phenomena as well as dual process theory, we ought to eliminate type-1/type-2 terminology from scientific theorizing about the mind altogether.

In section 2, I elucidate and challenge a thesis which I shall call *Rigidity*. Rigidity is a natural kinds thesis, which entails that should there is no significant crossover between features of type-1 and type-2 processes. Given that our theories are understood to be picking out natural kinds, you would expect the features of each type to be fairly rigid, with the occasional exceptions. For example, type-1 processes are said to possess the feature of being unconscious, while type-2 processes are often characterized as rule-based. To challenge Rigidity, I will marshal evidence for crossover from various psychological studies (e.g. Girelli et al. 2001, Brinol et al. 2009, Sechrist and Stangor 2001). For instance, several independent studies indicate that implicit racial attitudes possess features of both type-1 and type-2 processes. Specifically, implicit attitudes seem to be both unconscious and rule-based.

In section 3, I critique how Keith Stanovich and Jonathan Evans—two prominent dual process theorists—deal with the crossover problem (Stanovich and Evans 2013). Instead of arguing that crossover rarely occurs, they propose defining features of type-1/type-2 processes. I outline several problems with Stanovich and Evan's response to crossover and argue that dual process theorists should instead try to explain away all of the instances of crossover with a divide and conquer strategy.

In section 4, I discuss why it matters whether type-1/type-2 processes are natural kinds, and what follows if they are not. I first discuss the possibility of eliminating type-1/type-2

processes altogether from our scientific discourse. If type-1/type-2 processes can be shown to be useful for scientific theorizing, then dual process theory might remain relevant to psychology. I then argue that if there are simpler models of higher cognition—such as the Unimodel—that can perform the same explanatory work as dual process theory, then such models ought to be preferred on grounds of parsimony.

2 THE PROBLEM OF CROSSOVER

2.1 Rigidity

Dual process theories have been around withiin the field of psychology for at least a hundred years. For example, take Freud's early distinction between primary and secondary processes (Freud 1915). Freud characterized primary processes as unconscious, associative and appearing early in development (e.g. childhood), whereas secondary processes are characterized as conscious, logical and appearing later in development. While splitting up processes into two types may sound trivially easy to do and scientifically uninteresting (e.g. simple vs. complex processes, fast vs. slow processes) dual process theories are also committed to the following specific claims. First, that there exist different *kinds* of cognitive processes and further, that there are just two.[7] Each cognitive kind is thought to possess a non-arbitrary cluster of features that contrast with each other. As Richard Samuels puts it, "a central and far from banal commitment of dual-process theories is that cognitive processes—either generally or within some domain, such as reasoning-can be divided in two: those that possess the S1-property cluster and those that

[7] It may be argued that there are dual process theorists, such as Keith Stanovich, who do not commit themselves to limiting processing types to two. Stanovich (2009) thinks that there may be three different types of processes. However, if there turned out to be three types of cognitive processes, *dual* process theory would not be an apt name for the view.

possess the S2-property cluster"(Samuels 2009, p 131).[8] This means that if some cognitive process C possesses stereotypic type-1 properties, then it shouldn't also possess one or many stereotypic type-2 properties. Such properties ought to *line up* with their respective type of process.

According to the influential HPC (Homeostatic property cluster) conception, a natural kind consists of a *cluster* of properties that regularly occur together, and a homeostatic *mechanism* that explains why the clustered properties co-occur (Boyd 1991).[9] If one understands dual process theory as a theory of natural kinds, then one would predict that type-1/type-2 processes to be *strongly* correlated with their respective features.[10]

Since these co-varying property clusters are supposed to be what distinguishes the two processing mechanisms from one another, *significant* overlap between their respective property clusters would blur the distinction considerably. Samuels refers to this possibility as "the crossover problem" (Samuels 2009, p 140). As Samuels notes, the mere existence of crossover (i.e. a single instance) wouldn't be enough to warrant a rejection of dual-process theory. Even if it were found that a given feature routinely resulted in hybrid processes, one could simply remove that feature from the list of co-varying properties. However, if cross-over were found to be ubiquitous (i.e. across most properties), the view would be in need of some serious re-modeling and perhaps even abandonment. While I do not think there are many dual process theorists committed to the stronger claim—i.e. no crossover whatsoever—some would be

[8] Theorists also refer to the distinction as between (s)ystem-1/(s)ystem-2 processes.
[9] A single homeostatic mechanism is typical but not required for natural kind membership. For instance, within the science of biology, species are natural kinds but are propagated by several homeostatic mechanisms.
[10] By strongly correlated, I mean correlations that obtain over 80% of the time. 80% is arbitrary, though generous to dual process theory. Clearly, correlations that obtain 51% of the time would not have much predictive value. The relevant question that follows would be, 'How often does crossover obtain?'.

committed to the weaker claim (i.e. some crossover but nothing significant), especially to those who think the distinction maps out psychological kinds. I define Rigidity as follows:

Rigidity: Type-1 processes rarely have type-2 features. Type-2 processes rarely have type-1 features (i.e. no significant crossover).

While something like Rigidity is not explicitly endorsed in the literature, it can be seen as an implicit assumption in most dual process theories, conceded by some to be the *received view* (Stanovich and Evans 2013). Dual process theorists typically provide nice tables that present the features of each of the processing types (Evans 2008). The presentation of the features in this manner suggests some sort of organized division between features.[11]

For certain groupings of processing features, strong correlations certainly obtain. For example, processes that are automatic are going to be relatively fast. However, you don't need a scientific theory to tell you that. In virtue of what it means to be automatic, it follows that the process is going to be relatively fast. Similarly, controlled processes seem to, by definition, involve some degree of conscious awareness. Control takes effort, and effort takes some degree of attention and awareness. It is thus both unsurprising and unimpressive to find strong correlations amongst such features. On the other hand, there are many processing features that allow for the possibility to mismatch. For instance, it is logically possible for there to be unconscious processes that are relatively slow. In order to properly test for claims of Rigidity, it's best to look at sets of features where misalignment is a logical possibility. In the following section, I will look at six possible counter examples to dual process theory. While even some of

[11] If dual process theorists are fine with hybrid processes, given crossover, a better way to illustrate their view would be with a Venn diagram.

the leading dual process theorists agree that crossover occurs (Stanovich and Evans 2013), it is still instructive to discuss each of the alleged counter examples in turn. Dual process theorists may want to challenge such proposed counter examples by offering alternative interpretations of the empirical findings or by demonstrating that crossover in such cases is relatively rare. I will argue that collectively, the current state of evidence casts great doubt upon the validity of dual process models, and suggests that type-1/type-2 processes are probably not natural kinds.

2.2 The empirical evidence for crossover

In this section, I will discuss six proposed instances of crossover. First, I will discuss a proposal made by Samuels (2009), which if genuine, opens the door to many more instances of crossover. I will then discuss a rather robust example of crossover put forward by Mandelbaum (2015a). Lastly, I will consider several other instances of crossover found within the reasoning and decision-making literature as well as some possible instances that arise from the animal cognition literature.

2.2.1 Evolutionarily new type-1 processes

Type-1 processes are usually characterized as evolutionary old, whereas type-2 processes are usually characterized as evolutionary recent. Samuels (2009) discusses a possible instance of crossover: i.e. an otherwise type-1 process with the feature of being evolutionary recent (Girelli et al. 2001).

> "There appear to be evolutionary recent processes that possess many S1 properties. So for example, judgments of numerical magnitude involving familiar, conventional numeral systems—such as Arabic numerals—possess many S1 properties. For instance, they are relatively fast (~200 ms); and appear to be automatic in that they exhibit Stroop-like effects" (140).

Samuels concludes that since Arabic numerals are a recent cultural invention, the processing of such a numeral system must also be an evolutionary recent one (Samuels 2009, pg. 140). Thus, it looks as if we have a case where there is a process that is fast, automatic, and *evolutionary recent*. If judgments of numerical magnitude are instantiated by newly formed cognitive processes, presumably so would judgments involving representations of other symbol systems (e.g. alphabets), various heuristics and biases (e.g. implicit racial biases) as well as the intuitive judgments of experts. For example, chess masters—whom typically over 10,000 hours of practice—quickly judge whether or not a particular move is good or not (Kahneman 2011, pg. 238). While not everyone is a chess master, virtually everyone acquires expertise with respect to some skill or area of study (e.g. reading, free throw shooting, cooking, the law). When it comes to type-1 processes, evolutionary recency may be the rule rather than the exception. This would mean that in the case of evolutionary recent type-1 processes, crossover is quite widespread.

In support of evolutionary recent type-1 processes, there are a number of well-documented instances of quite rapid evolutionary change throughout the animal kingdom (Reznick et al. 1997, McKinnon et al. 2002, Stuart et al. 2014).[12] To give one such example, stickleback fish have been found to undergo significant morphological changes (e.g. a loss of heavy armor plated scales) within ten generations (McKinnon et al. 2002). Such changes occur when marine sticklebacks are introduced into freshwater ecosystems and vice versa. There is uncertainty as to how rapidly *brains* evolve, but in general, evolutionary change does not always occur in a slow gradual fashion.

However, one might argue that the experimental findings cited by Samuels (i.e. Girelli et al. 2001) are open to another interpretation. One might think it is more plausible that most of our

[12] Some of these studies show speciation occurring within the lifetime of a single scientist.

cognitive processes carry out multiple functions and unlikely that each process was tailor-made for carrying out any one in particular. Samuels seems to reason that because the Arabic numerals are a recent cultural invention, any process which takes them onboard must be an evolutionary recent process. But isn't it possible that what we have here is an evolutionary old process has been co-opted to use new types of stimuli?[13] Put another way, perhaps these cognitive processes are exaptations.[14] One reason for preferring such an explanation would reside in the sheer number of adaptations that would have had to take place within the past 10,000 years or so in order for there to exist novel cognitive processes. Given the short time frame, considerable changes in cognitive processes may seem prima facie unlikely.

While these questions are ultimately an empirical matter, the suggestion of recent evolutionary change is by no means unreasonable. In fact, some prominent dual process theorists have already abandoned ship by admitting that evolutionary recent type-1 processes are likely (Evans 2006). At this point, crossover has only been established for one pair of the proposed dichotomous properties. Next, I will discuss another instance of crossover; type-1 processes that appear to be rule-based.

2.2.2 Rule-based type-1 processes

Type-1 processes are typically characterized as associative, whereas type-2 processes are characterized as rule-based or possessing a propositional structure. Mandelbaum (2015a) argues that implicit biases are best characterized as having many type-1 features as well as a feature prototypical of type-2 processes. Namely, implicit biases are fast, automatic and rule-based.

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[13] Dehaene (2005, 2007) argues that humans' (universal) ability to read results from co-opting evolutionary old neural structures.

[14] An exaptation is when a feature or trait selected by natural selection comes to serve a new function (Gould and Vrba 1982). For example, feathers were originally selected for thermal insulation, but later were coopted for flight.

Within the research literature, social psychologists typically assume that implicit biases are thoroughly associative. That is to say, implicit biases are acquired by some associative process (e.g. classical conditioning) and they possess an associative *structure* as well.[15] Psychologists measure the degree of implicit bias by having subjects complete an implicit association test (IAT). Roughly speaking, an IAT measures how long a subject takes to associate a presented image with a valence (e.g. 'good' or 'bad'). For instance, subjects may be presented with photographs of people from different racial or ethnic backgrounds. The longer it takes for a subject to associate members of a given racial group with something 'good' (e.g. the words 'beautiful', 'kind'), the more engrained the implicit racial bias is towards that racial group. Mandelbaum begins by pointing out that though it's been assumed by social psychologists, an implicit bias need not be associative through and through. There is nothing contradictory about supposing that something associatively learned could have a non-associative structure. In order to infer whether the structure of an implicit bias is associative or not, we have to look at how certain kinds of stimuli alter or fail to affect behaviors associated with such cognitive processes (Mandelbaum 2015a, p 6). Mandelbaum discusses four relevant bodies of research that have measured such behavioral effects, all of which indicate that implicit biases have a non-associative structure. I will briefly summarize two of these findings.

The first kind of study found that implicit biases are sensitive to the strength of arguments (Brinol et al. 2009). Experimenters designed an IAT for race and one for vegetables. For the race IAT study, one group of subjects would read a message containing strong arguments in favor of hiring African American professors (e.g. it would increase the number and quality of professors)

[15] Two mental states X and Y (e.g. the thought of *snakes* and the emotion *fea*r) possess an associative structure if "activations of mental state X bring about mental state Y and vice versa without the mediation of any other psychological states" (Mandelbaum 2015b).

while the other group read weak arguments in favor of the proposal (e.g. it's the trendy thing to do). For the vegetable IAT study, one group of subjects read a message containing convincing reasons to eat vegetables (e.g. high in vitamin content), whereas another group read a message containing unpersuasive reasons to eat them (e.g. they look beautiful on plates). The researchers carefully controlled for associations by ensuring that both the strong and weak messages mentioned the key terms the same amount of times (i.e. 'African American professor' and 'vegetable'). They found that subjects who read the strong arguments scored more positively on race IATs than those who had read the weak arguments. The same finding was found for the vegetable group.

A second study (Sechrist and Stangor 2001) found a similar effect. This study measured seating distance—a reliable indicator of one's implicit attitudes (Macrae et al. 1994)—of participants from an African American confederate in a waiting room after the subjects had: 1) filled out a survey regarding racial bias, and 2) been informed of the survey results from their peers. After filling out the surveys, participants were placed into high and low prejudice groups. The participants were then individually told how their survey results compared with their peers (i.e. other college students from the same university). Half of each group were told that a large majority (i.e. 81%) of their peers agreed with them while the other half was told that the majority of their peers disagreed. After being informed of the survey results, the participants were then told to sit down in a waiting room containing an African American confederate. What the researchers found was that merely being informed of peer consensus or lack thereof affected how far or close the participants sat from the African American confederate.[16]

[16] If the participant held a bias and was aware of peer consensus, then participant would sit, on average, further away. If the participant did not hold a bias and was aware of peer consensus, the participant would sit, on average, closer to the African American confederate.

The take home message is that these studies indicate that implicit biases can be altered in a non-associative way. In the first study, the strength or weakness of arguments influenced performance on IAT tests. In the second study, the recognition of peer agreement/disagreement regarding racial attitudes influenced seating distance from an African American confederate. This is because determining whether an argument is good or not, or recognizing that one's peers agree/disagree with oneself plausibly requires some sort of reflection in the form of logical or rational procedures, whether it be unconscious or conscious. In other words, the process involves some rule-following, whereas the implicit bias, if merely associative, would not contain such characteristics. Mandelbaum's argument takes the form of a modus tollens. If implicit biases have an associative structure, they can only be altered one of the following two ways: *counterconditioning* (i.e. you pair some other stimulus with a positive or negative reinforcer) or via *extinction* (i.e. you no longer pair the two relata together). Some implicit biases can be modified through rational or logical procedures (e.g. see the two aforementioned studies). Therefore, at least some implicit biases have a non-associative structure.

Given the results of these studies, I am very doubtful that an explanation citing only either counterconditioning and/or extinction would be able to explain the change in the subjects' behavior. One might try and argue that the studies do not support the conclusions Mandelbaum arrives at. But this too runs short. The studies both pretty straightforwardly involve a change in implicit biases. The participants are exposed to information that they become consciously (or unconsciously) aware of and thereafter you find a change in behaviors that are highly predictive of implicit biases. What else could be changing these behaviors other than the newly acquired information?

If there are processes that are both unconscious and rule-based, what follows for dual process theory? It ultimately depends on how often the crossover obtains. At this point, we don't have any reason to think that unconscious rule-based processes are just freak occurrences. While there are many unconscious associative processes (e.g. processes involved in operant conditioning), we now have good reason to think that there is a sizeable subset of type-1 processes that are rule-based.

2.2.3 Crossover in decision-making

Reasoning and decision-making are often touted as cognitive domains where dual process theory is most applicable. However, even here we see widespread crossover. Heuristics and biases, though typically characterized as unconscious and automatic, can also be conscious and controlled (Evans 2006). For example, one familiar with the heuristics and biases literature could become more self-aware about one's own unconscious mental life. Through various training methods, those aware of their implicit biases can temporarily eliminate them, thus executing some control over their unconscious processes (Lai et al. 2016).

By using reaction time measures during various reasoning tasks, some researchers have made inferences about whether or not a process is type-1 or type-2. However, inferring process type from reaction time has not been supported by recent work (Krajbich et al. 2015, Evans et al. 2015). Evans et al. (2015) state that "researchers in experimental psychology and economics should be reluctant to interpret slow RTs as evidence of reflective thinking" (Evans et al. 2015). Even proponents of dual process theory have conceded that speed is not indicative of processing type (Carruthers 2014 pgs. 11-12, Stanovich and Evans 2013 pg. 226).

Intuitive processes are often characterized as fast whereas their contrastive reflective processes are characterized as slow. A possible counter example to these characterizations would

be “Aha! Moments” discussed widely in the insight learning literature (Kounios et. al 2003).[17] The studies within this literature suggest that having time off results in faster completions of certain puzzles and are controlled in ways so that the time off doesn’t result in periods of conscious reflection. It is plausible that there is some unconscious processing going on during the time off which aids in solving the task.

Type-2 processes have also been characterized as de-contextualized, whereas type-1 processes have been characterized as contextualized. However, several dual process theorists have conceded that *both* type-1 and type-2 processes operate over contextualized representations (De Neys et al. 2005; Evans 2007). Evans puts it like this: “A little reflection will reveal why it must be fallacious to equate type-2 processing with abstract, decontextualized thought. Bearing in mind that type-2 processing involves putting a load on working memory—and is not a mental logic—it is evident that much (indeed most) of the contents that pass through our working memories are forms of explicit belief and knowledge that are semantically rich” (Evans 2012). Thus, according to Evans, those who think of type-2 as decontextualized or involving purely abstract thinking are simply mistaken. This is because type-2 thinking, like all thinking, is inherently entangled with several sources of semantically rich, and thus contextualized content.

While there may be many counter examples to dual process theory when it comes to reasoning and decision making, one might think that the view captures something unique about the human mind. As humans, we can regularly engage in conscious, reflective decision making. Other creatures might not. In the following section, I will present research findings suggesting that non-human animals engage in conscious decision making, and that the minds of humans may be a difference of degree rather than a difference in kind.

[17] Suggested by Carruthers (2014).

2.2.4 Crossover in non-human animals

Initially, claims regarding human minds as unique in the animal kingdom could easily be seen as trivial or uninteresting. For example, few would doubt that the possession of complex language is very likely to be unique to humans. The same goes for contemplation about the workings of the universe or the meaning of life and so on. But the claim being made by certain dual process theorists is that type-2 processes are unique to humans (see figure 1). There are at least two ways of initially understanding this claim. Whatever is on the list of type-2 features will not be found in non-human animals or that there are no non-human animals that instantiate **all** of the type-2 features. The former reading would, for example, deny the possibility of a non-human animal having conscious cognitive processes. The latter reading denies that there are any non-human animals with processes that are fast, conscious, rule-based, etc. While it is expected that some of the type-2 processes should co-occur, it is not necessary for all of them to, even in humans.

While one could characterize type-2 processes in a way to exclude animals, say by adding a "language-dependent" feature, there is reason to think that many if not all of properties listed on the Standard menu are instantiated in animal minds. Conscious processes are likely seen in various primates, dolphins and perhaps even in some birds. There is evidence that non-human primates such as gorillas, undergo mental time travel, the ability to be aware of one's future or past (Osvath et al. 2014). Other evidence highly suggestive of conscious processing in non-human animals include insight learning (Kohler 1925) and self-recognition (i.e. mirror test) studies (Gallup 1970). Recently, some scientists have made a distinction between *automatic* processes and higher-order *control* even in rats (Toates 2006). Lastly, there is a wealth of studies indicating that bees along with other invertebrates use rule-based, computational processes to

navigate their environments (Gallistel 1995). Without going through every feature on the list, it should be clear that there are currently multiple strands of evidence from the animal cognition literature that go against the idea that the type-1/type-2 distinction only holds true for humans. Let's say that one is not convinced by the current state of evidence. It is important to bear in mind that the empirical details are far from being worked out. At this moment, it would be too hasty to restrict these processing types to our own species.

3 RESPONSES TO THE CROSSOVER PROBLEM

It's an open question as to what properties a given cognitive process will have. Unless we have principled reasons for thinking that certain properties would cluster together, we should hold off on adopting Rigidity for a particular set of properties. For example, if we were to discover good evidence that indicated that type-2 processes were instantiated by working memory and that working memory could only give rise to these particular properties, it might make sense to adopt a Rigidity-like thesis since we would have principled reasons for supporting that prediction. However, the empirical evidence for crossover makes it hard to adopt such a view. Those who want to maintain Rigidity will have to say either that the crossover is not significant or eliminate some of the crossover features from the Standard menu.

Two very prominent dual process theorists—Keith Stanovich and Jonathan Evans—accept that the crossover is significant and effectively reject the idea that an adoption of Rigidity is necessary. They demonstrate this by virtually removing all of the properties from the Standard menu (Evans and Stanovich 2013). In a following section (§4.3), I will argue that this results in a very uninteresting dual process thesis and that the more promising move to make would be to deny that the crossover is significant.

3.1 Objections and replies

Objection 1: Even if one thinks that the instances of crossover outlined in (§2-3) are genuine, these do not collectively result in *significant* crossover. Significant crossover would consist of a misalignment between every property on the Standard menu. The empirical findings have just indicated that some (if not most) of the properties crossover.

Reply: Pointing out that most properties crossover is not enough to warrant the claim that there are some properties that do not crossover. Instead, one could reasonably infer that this misalignment might be true for the other remaining processes. There is also the issue of defining the properties in such a way that disallows for certain hybrid processes. One might think that is just incoherent to suppose that there could be certain combinations of properties (e.g. conscious and parallel). Rather than interpreting the correlation of certain features as a successful prediction of dual process theory, it may just be that certain features have to correlate by definition. For example, processes that are automatic are also going to be relatively fast. Likewise, controlled processes seem to require some degree of conscious awareness. If the only processing features exempt from crossover effects are those features that correlate by definition, dual process theory has little predictive power. Dual process theorists must account for the existence of hybrid processes and explain why they occur, and hope that such occurrences are rare.

O**bjection 2:** Significant crossover would consist of properties that were misaligned (e.g. type-1 process+type-2 feature) most of the time. At best, the instances of crossover discussed are just times in which there is some temporary misalignment. This does not mean that the misalignment is frequent or the rule rather than the exception. In fact, these cases may just result from cherry-picking.

Reply: I do think that this sort of move is in the right ballpark. In fact, this may be the most promising sort of objection a dual process theorist could offer. However, the dual process theorist will have to demonstrate that crossover across each of the features is rare. It may be argued that the literature on dual process theory is full of instances where no crossover is observed. The best explanation for the absence of crossover in most studies is that crossover is relatively rare, occurring in only a handful of conditions. The problem with this line of reasoning is that many of the studies within the literature on dual process theory are carried out using similar experimental methods and designs (e.g. syllogism tasks, Wason-selection task). Additionally, dual process theorists do not routinely test for crossover. It may be that even crossover obtains within the standard experiments. We know that there are conditions in which crossover obtains, and we know that there are conditions in which crossover does not obtain. At this point, it is not unreasonable to think that crossover may obtain regularly, but it is largely an unsettled empirical matter.

Objection 3: Neuroimaging evidence validates dual process theory

Stanovich and Evans often discuss neuroimaging evidence as support for a real distinction (2013). Neuroimaging evidence would strengthen the case for dual process theory considerably, though the crossover evidence against Rigidity would still be problematic. Why wouldn't we see distinct neural processing features given that there are two separate systems at play? Providing a complete review of the literature would be outside the scope of this thesis, but there are a number of problems with the data worth pointing out. Generally speaking, there is good reason to be skeptical of the assumption that brain regions map neatly 1-to-1 onto some function or behavior (Anderson 2010, 2014). A lack of 1-1 mapping for particular regions casts doubt upon findings specifying *whole networks* of brain regions associated with say, emotional

processing or higher cognitive processing. This may be why studies that have tried to identify distinct regions for emotion and cognition have been largely inconsistent. For example, Lieberman (Lieberman 2007) has proposed that neuroimaging evidence supports the existence of an X-system (i.e. reflexive) and C-system (i.e. cognitive), each said to possess many of the same features as the dual process standard menu. The X-system is said to involve brain regions typically characterized as "emotional" such as the amygdala, basal ganglia and the ventromedial prefrontal cortex (VMPFC) whereas the C-system is said to be associated regions typically associated with cognition (e.g. the lateral prefrontal cortex (LPFC), medial prefrontal cortex (MPFC) and the lateral parietal cortex (LPAC)). The problem is that more recent brain imaging studies suggest that the relation between cognition and emotion is much more complex and interconnected (Pessoa 2015, Okon-Singer et al. 2015). According to Okon-Singer et al.,"there is compelling evidence that brain territories and psychological processes commonly associated with cognition, such as the dorsolateral prefrontal cortex and working memory, play a central role in emotion" (Okon-Singer et al. 2015). Likewise, the same has been found true with respect to processes associated with emotion playing a role in cognition (Okon-Singer et al. 2015). Even if one discounts these more recent studies, there are several cognitive scientists who argue that the inconclusive evidence for neural localization (Lieberman 2007) is perfectly compatible models of higher cognition other than dual process theory (Osman 2004, Krugalanski and Gigenrezer 2011). At the present, the neuroimaging evidence is, at best a wash, and at worst, suggesting a much more integrated network than dual process theory can allow for. Either way, the neuroimaging evidence does not seem to offer much support for the theory.

Objection 4: Why should psychologists or cognitive scientists care whether dual process theories meet the criteria for (HPC) natural kinds? Isn't this just of interest to philosophers?

Reply: While cognitive scientists might not be familiar with the terminology—thus unfazed by such claims—the claims they make commit them to philosophical positions. If one interprets the dual systems thesis as essentially a natural kinds claim, then those committed to the dual systems thesis also (implicitly) commit themselves to the more philosophical claim. To answer the objection: psychologists and cognitive scientists should care whether their theories commit them to falsehoods. If one takes seriously what a theory predicts, failed predictions ought to cause worry. I will now turn to Stanovich and Evans' revisions to dual process theory in light of crossover, and argue that they are wanting.

3.2 Revisions to dual process theory

In response to criticisms of dual process theories, Stanovich and Evans (henceforth S&E) essentially concede that there exists significant crossover with respect to the properties of the Standard menu. Specifically, they state that both types of processes can be rule-based, many of the proposed distinctions are too vague (e.g. automatic vs. controlled), and contrary to the title of Kahneman's popularization of dual process theory[18], they reject the idea that the speed of a cognitive process is indicative of its type (Stanovich and Evans 2013).

While S&E concede that many of the standard processing features misalign or are underspecified, they argue that each processing type has necessary and sufficient conditions, and these are what distinguish the two types of processes. In their words, "all of these dichotomies were never necessary to establish the two types of processing. The only thing needed is at least one dichotomous property that is necessary and sufficient" (Evans, Stanovich 2013). While there are some natural kinds that possess necessary and sufficient conditions (e.g. chemical kinds[19]), it

[18] Thinking, fast and slow (2011)

[19] For example, each atomic element has its own signature properties. Each element has its own atomic number, a measure of the number of protons within the atom. For instance, having two protons is both necessary and sufficient for being a helium atom.

is not required that they do so. On the HPC conception, natural kinds can also be identified with a cluster of properties that are strongly correlated. To further assess the viability of S&E's new proposal, one must also look carefully at the alleged defining features of each processing type.

Table 2 Defining features of processing types (S&E)

Type-1	**Type-2**
Does not require working memory	Requires working memory
Autonomous	Cognitive decoupling; mental simulation[20]

The first defining feature of the type-1/type-2 distinction is said to be related to working memory. One issue is that the nature and function of working memory as a theoretical construct is far from settled (see Baddeley, 2012). For example, contrary to the idea that working memory is associated solely with higher-order thinking, there is evidence for an implicit working memory system (Hassin et al. 2009). If such alternative models of working memory are right, there could very well be crossover (e.g. autonomous processes that require working memory). Putting issues of theoretical constructs aside, I take that S&E predict that there won't be any autonomous processes that require the activation of working memory, or mental simulation that can be carried out without working memory. I take both of these assumptions to be questionable, as working memory activation seems to be associated with cognition in general, rather than just higher cognitive (e.g. conscious) processes (Gilchrist and Cowan 2010). But given the difficulties (e.g. crossover, vagueness) facing the properties S&E want to reject, why should we expect these two "defining features" to fare any better? As Keren rightfully points out, the kinds of evidence they use to support the validity of these distinctions are rather similar to the limited evidence

[20] This table is adopted from Evans and Stanovich (2013).

marshaled for the "typical features" (Keren 2013). They seem to be in a position no better than earlier dual process theorists who put forward the distinctions featured in the Standard menu.

At this point, why even make the distinction between two types of processing when there is already an available construct to use instead (i.e. the activation of working memory)? Instead of redirecting the discussion towards necessary and sufficient conditions, I think it would be best for dual process theorists to focus on their efforts on explaining away the empirical findings discussed in 2.2. If they can show that crossover is relatively rare or only occur within a handful of conditions, then there would be no crossover problem. Alternatively, dual process theorists could just remove several of the features from the Standard menu. Some combination of the two strategies may be the most effective way to deal with the apparent crossover problem. On the other hand, one might take the findings discussed in 2.2 to justify not just skepticism towards dual process models, but an adoption of eliminativism regarding type-1/type-2 processes.

4 ABANDONING DUAL PROCESS THEORY

4.1 Type-1/Type-2 Eliminativism

It is not clear that the theory left behind−after the abandonment of Rigidity−is something that we will need to figure into a final psychological theory. Put another way, if one understands the end goal of science to give us an account of natural kinds and laws, dual process theory may be explanatorily unnecessary for scientific psychology. Type-1/type-2 processes may be useful for heuristic purposes, such as generating new hypotheses, but ultimately, the distinction might able to be discarded.

Due to recent empirical discoveries, eliminativist strategies regarding various alleged psychological kinds (e.g. emotion, concepts) have been on the rise (Machery 2009, Griffiths

1997). Instead of pursuing more old-fashioned eliminativist strategies (Stich and Ravenscroft 1990, Churchland 1981)—which would render type-1/type-2 processes mythical—I will propose a more recent strain of eliminativism which states that type-1/type-2 processes might still exist but that the distinction does not map onto natural kinds (Griffiths 1997, Machery 2005). In a nutshell, proponents of this more recent strain of eliminativism argue that scientific terms that fail to refer to natural kinds are probably useless and might even be a hurdle for scientific research programs (Machery 2009, pg. 241). Thus, such scientific terms ought to be eliminated from our scientific vocabulary. What follows will be a more or less a generalized version of Machery's eliminativist argument for concepts (Machery 2005, 2009).[21]

In previous sections, I discussed findings that suggest that there probably aren't any stable clusters of properties for type-1/type-2 processes. This is because there are many instances where type-1 processes can have type-2 features and vice versa. If crossover is widespread, few scientific generalizations could be made about type-1/type-2 processes. If one assumes that natural kinds require a cluster of numerous co-varying properties as well a large number of scientific generalizations, then type-1/type-2 processes wouldn't be natural kinds, and such a grouping may very well be entirely arbitrary. Similar to the sublunary/superlunary distinction proposed by Aristotle in his astronomical theory, the type-1/type-2 distinction might just be a reflection of human interests during a particular historical period. Since scientific terms that do not refer to natural kinds carry great risks (e.g. wasted time, money and energy) with little to no benefits, it may seem appropriate to say that type-1/type-2 processes ought to be eliminated from our scientific vocabulary. But one may object to this line of reasoning by pointing out that elimination carries risks as well. After all, in eliminating dual process language, one might

[21] Machery refers to his version of eliminativism as "scientific eliminativism" (Machery 2009).

prematurely cancel what may be a fruitful research program. While I think the objection has some force, I think there is a strong rejoinder. It may be true that the current state of dual process theory makes use of scientific terms that don't refer to natural kinds, but future dual process theories—that are more refined and strongly supported by empirical evidence—might. While this may look like backpedaling, I contend that if such future theories include wholly different clusters of properties—which is what I would expect given the failings of contemporary theories—then future scientists would be talking about different cognitive entities.

Despite the apparent implausibility of type-1/type-2 natural kinds, it may be argued that the distinction still may be useful in science. Holding that type-1/type-2 processes are useful but not psychological kinds is a coherent and available position to hold. But whether or not certain theoretical terms can be useful is not the deciding factor for adopting them. For example, there may be other simpler models that are equally useful for scientific theorizing about the mind (5.2).

I have argued that the theoretical terms of standard conceptions of dual process theory—which consist of a dual-systems and dual-cluster thesis—probably fail to refer to natural kinds. However, one might hold onto a much more modest version of dual process theory, namely, a theory that is just committed to a *dual types thesis*. On this limited view, all that is said is that there are two types of cognitive processes. But absent differing homeostatic mechanisms or clusters of properties, what would be the motivation for such a distinction?

4.2 The dual types thesis and the Unimodel

In this section, I will assess the alleged explanatory benefits of appealing to types in accounts of higher cognition. Dual process theorists allege that appealing to two types of processes help explain various features of human minds. For example, type-1/type-2 processes

are invoked to explain the phenomena of *belief bias* and to account for individual differences in cognitive abilities. I will show how *unimodel* approach to higher cognition can account for both without appealing to any types (Krugalanski 2001, 2013). If I am right, this would take away yet another reason to hold onto dual process theory.

The Unimodel theory of cognition has been alleged to explain the very same data dual process theorists take as evidence for duality (Krugalanski 2011, 2013). In light of the evidence for crossover, the Unimodel may be fit to fill the shoes of dual process theories, especially if one takes up an eliminativist position regarding type 1/type 2 kinds.

Simpler theories are in general preferable to more complicated theories. If one can reduce the number of processing types from two to one without losing any explanatory force, then one ought to. But in order for the Unimodel to be preferable, it has to be able to perform the same explanatory work are their competitor. Specifically, they need to capture the central phenomenon alleged to be explained by dual process theories. Later, I will briefly show how the Unimodel can account for two closely related phenomena: i.e. individual differences in performance and belief bias.[22] First, I will flesh out how the Unimodel is supposed to work.

One can borrow dual process terminology to illustrate how the Unimodel differs. Dual process theorists such as S&E argue that the deployment of type-2 processes requires working memory activation and mental simulation. Unimodel theorists argue that the speed or ease at which a cognitive process becomes active depends on additional factors, including one's motivation, availability of *cognitive resources* and familiarity with the domain at hand, and that focusing on these factors better explains higher cognition (Kruglanski et al. 2012). To illustrate, an expert chess player will possess a much larger set of cognitive resources (i.e. moves and

[22] See (Evans et al. 2005) for a dual process theorist's interpretation of the belief bias literature.

strategies to draw) than a novice. Given the abundance of resources, a chess expert will typically outperform a novice competitor, provided that the expert is not intoxicated, distracted or unmotivated. This contrasts with dual process theory, whose proponents think that it is the *functional architecture* of working memory that best accounts for belief bias and individual differences (Pylyshn 1984). The functional architecture of working memory would include the its limitations on retrieving and storing cognitive resources, the kinds of operations it can perform as well as its buffering capacities (Pylyshn 1984, p. 92). Since cognitive resources are typically drawn from long term memory systems (e.g. semantic long term memory), Unimodel theorists appeal to factors beyond the functional architecture of WMC to explain performance. Both theories essentially agree about the experimental data, though their interpretations diverge by focusing on different aspects of working memory; its inherent structure and limitations versus the pool of resources it has to work with.

While everyone would concede that there are individual differences in the functional architecture of working memory, there is disagreement about the extent to which this affects performance. Unimodel theorists argue that it's the pool of resources that better explain the differences whereas the dual process theorists think you need to look at the machine (WM) itself. The advantage goes towards the theory with that does not commit itself to any extra, seemingly unnecessary theses.

Table 3 Differences between the two views

The Unimodel	Dual process theory (S&E)
Not committed to types thesis	Committed to dual types thesis
Properties fall on a continuum	Dichotomous properties
WM: Focus on cognitive resources	WM: Focus on functional architecture

It is not the case that there are processes with special properties that come into play during conscious reflection (i.e. type-2 thinking). Rather, the processes involved during "type-2" deliberations share many of the same features as the "type-1" processes. As Kruglanski puts it, "As one keeps thinking about a problem, new ideas might be activated 'automatically' by a stream of stimuli encountered on the way, much in the same way as the initial default response"(Kruglanski 2013, pg. 245). On this view, most processes are rule-based and automatic, once triggered. The appearance of type-2 processes comes from an enhanced ability or capacity to utilize more processes during some cognitively demanding task. Contrary to the dichotomous nature of type-1/type-2 features, Unimodel theorists understand the features of processes as varying along a continuum. Though it may be tempting to retain use of the type-1/type-2 language, this view lacks such commitments. One might want to say that there is only one kind of cognitive process, on this view which does not correspond to either type-1 or type-2 but rather a combination of the two. However, a perhaps better way to characterize the view is to say it is simply agnostic on how many types of cognitive processes there are. Instead of appealing to types, one can just refer to the features involved in the cognitive process at hand. To just pick out the far ends of the spectrum seems arbitrary, and seemingly doesn't provide any additional explanatory work.

Now that the view has been described, I will follow up by demonstrating specifically how the unimodel can account for belief bias and individual differences; two phenomena alleged to be exclusively captured by dual process theories.

Figure 1 Processes on a continuum

Belief bias

Belief bias is the tendency to consider an argument valid based on the believability of the argument's conclusion rather than assessing its logical structure. This tendency has been shown to increase when simultaneously performing working memory tasks and while under time pressure (De Neys 2006). Dual process theorists argue that this tendency results from overloading working memory. Since type-2 processes require working memory activation, their activation will be inhibited, resulting in the activation of (back-up) type-1 processes. Unimodel theorists welcome such findings but offer an alternative interpretation. They would concede that there is a connection between working memory activation and changes in decision-making strategies. However, this is due to a subject's inability to access the entirety of one's cognitive resources. If an individual is distracted or subject to time constraints, there will be a tendency to go with the first options that come to mind (i.e. the backup options). To be clear, working memory would still active to some degree, and perhaps there would be disagreement between theorists about the extent of activation. The question remains as to why there should be consistent individual differences regarding these changes in decision-making. Why are some individuals much better at certain tasks, if not for some difference in working memory (e.g. faster processing)?

Individual differences

Dual process theorists have pointed out that the extent to which one utilizes type-2 processes correlates with measures of intelligence such as IQ and working memory capacity. Furthermore, it is argued there are little to no individual differences when it comes to type-1 processing (Stanovich and Evans 2013). The Unimodel can easily account for such correlations. When there is more time for reflection, individuals with higher working memory and IQ—whom

tend to have more cognitive resources to draw from—will tend to perform better (Kruglanski 2012). The reason why individuals with low working memory and IQ are unable to perform better when given more time or fewer distractions is because they simply don't have many other strategies or options to draw from. Their store of cognitive resources (e.g. facts, knowledge, mental shortcuts) is comparably scarce. Unlike dual process theories, Unimodel theorists do not need to appeal to different types of processing to account for individual differences. The Unimodel invokes differences in what working memory has access to rather than available cognitive resources to account for the differences in performance. To test these competing interpretations, one could devise an experiment that holds working memory capacities constant while manipulating the store of available cognitive resources. If the manipulations showed drastic changes in performance on working memory tasks, the Unimodel would be supported. If the manipulations showed no significant difference across individuals, dual process theory would be supported.

5 CONCLUSION

In this paper, I have argued that the type-1/type-2 distinction is threatened by the evidence for crossover outlined in §2, assuming that dual process theory is a theory of natural kinds. If one grants that the crossover is significant, the natural kinds thesis (i.e. type-1/type-2 processes are natural kinds)—as well as the dual-cluster thesis—becomes untenable. However, dual process theorists can still hold onto a dual types thesis. I have argued that one would still have to be some motivation for the *types* distinction, and suggested that they may play a useful

role in explanation. Nonetheless, however useful these terms may be, they may be undercut by a simpler theory which commits itself to one less thesis, the Unimodel.

While the scope of the paper was meant to focus on one variety of psychological theories, its application may be far reaching. For example, dual process theories are not just put forward to explain higher cognition; they have also cropped up within discussions of memory (Brainerd 2002). Similarly, a largely forgotten debate over the validity of memory *systems* has recently resurfaced (Cabeza and Moscovitch 2013). Eerily paralleling the discussion here, the memory systems view, which understands memory in terms of distinct systems (e.g. semantic memory, episodic memory), is now once again being called into question. Alternative models, such as the component process framework, understand memory without appeal to systems, and in terms of a dozen or so interconnected components (Witherspoon and Moscovitch 1989). There still remains much to learn about the mind-brain and its architecture and we are far from settling which kinds or scientific terms will be included in a final psychological theory. Pronouncements to the contrary should be met with ample skepticism, as they are probably premature.

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