PABLO QUINTANILLA | CARLA MANTILLA | PAOLA CÉPEDA
(editores)

COGNICIÓN SOCIAL Y LENGUAJE

La intersubjetividad en la evolución de la especie y en el desarrollo del niño

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Pablo Quintanilla, Carla Mantilla y Paola Cépeda (editores)

Av. Universitaria 1801, Lima 32, Perú
Teléfono: (51 1) 626-2650
Fax: (51 1) 626-2913
feditor@pucp.edu.pe
www.pucp.edu.pe/publicaciones

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The nonlinear evolution of human cognition

H. Clark Barrett
University of California - Los Angeles (UCLA)

Humans are special. We tell ourselves this all the time, and maybe we are right. Over the last several hundred thousand years we have populated the globe, mastering both our physical environments and our social ones. It is widely held that these achievements have something to do with how smart we are, and in particular, with our *social* intelligence. Compared to other primates, humans appear to be social geniuses: we are able to live peacefully, and even cooperate, in groups both large and small. We are experts at reading each others' thoughts, feelings, intentions, and desires. We transmit information using elaborate systems of symbols, leveraging the accumulated knowledge of those who have gone before us to transform our landscapes, domesticate our food, govern ourselves, and land on the moon.

All of this cries out for explanation, and plenty of explanations have been offered. Just as scientists in the early twentieth century searched for the «missing link» that separated humans from other apes, scientists in the twenty-first century have searched for the evolutionary «it factor» —the psychological skill or capacity that separates human cognition from that of our fellow primates. Is it social learning? Symbols? Concepts? Language? Theory of mind? Prosociality? Morality? Neural plasticity? Bigger brains? Insert your favorite candidate here.

All of these, of course, are things that humans have, make, or do —that is not in question. What is hotly debated in today's evolutionary literature is the question of which of these factors —or more likely, which combination of them— explains human psychological uniqueness. And since all evolutionists are materialists who accept that our minds are made of physical stuff —neurons, neurotransmitters, genes, and other biochemical ingredients— this question obliges us to ask what changes in brains have occurred in our evolutionary lineage to give rise to the new abilities that humans have. And here is where, despite decades if not centuries of accumulating data, there still seems to be no consensus in sight.

Why not? Part of the answer, to be sure, has to do with missing pieces of the puzzle: although we've accumulated lots of data about the brains and minds of humans and other primates, we don't yet have enough for a definitive and complete answer to the question of what makes them different. But a glance around the scholarly landscape suggests that this isn't all: our problems are also, almost certainly, theoretical. In this essay I would like to briefly consider one such theoretical problem: the problem of how to theorize psychological adaptations, and how they evolve in a mind composed of multiple, interacting adaptations. First I will describe what I think the problem is. Then I will explain how I think it is standing in the way of progress in understanding the evolution of the mind. Finally, I will close with some thoughts about how this problem can be solved.

1. The problem

In 1983, philosopher Jerry Fodor published his landmark book *The Modularity of Mind,* in which he formalized the concept of a psychological «module»: a sort of cognitive «reflex», in his terms, which he contrasted with what he called «central» (flexible and domain-general) systems of thought. In some ways, Fodor's book revolutionized the field of cognitive psychology by helping to make explicit what is meant by a mental mechanism, and how we would go about studying one empirically. But in another way, the book has had a damaging consequence on the field by promulgating the widespread view that the mind is composed of two fundamentally different kinds of mechanisms: specialized mechanisms, or «modules», and unspecialized «central» systems. This is the view that I will call «psychological dualism» (Barrett, 2012). I will contrast it with what one might call a psychological *diversity* view: that the mind is composed of diverse adaptations, which in turn have diverse functions and take diverse forms, not just two. Importantly, these diverse forms can include properties that are thought to be characteristic of «central» systems —such as flexibility and interactivity— despite being specialized to carry out particular functions (Barrett & Kurzban, 2006).

Fodor originally proposed a set of nine features which he held to be characteristic of modules, and which distinguished them from central, non-modular systems: these included domain specificity, mandatory operation (automaticity), limited central access, speed, informational encapsulation, shallow outputs, fixed neural architecture, characteristic and specific breakdown patterns, and characteristic pace and sequencing of ontogeny (1983). At the time, he was clear that he didn't intend modularity to be a binary property but a «matter of degree». In the literature, however, this subtlety has been lost, and modules are now seen as uniformly possessing this

Fodorian package of traits. They are, in essence, like bits of psychological Lego that are rigid, reflex-like, automatic, innate, and independently operating. Non-modular systems, in contrast, have the opposite set of properties: they are flexible, interactive, and shaped by experience. This contrasting set of features defines a dualist taxonomy of mental mechanisms. In the «dual systems» literature, these are sometimes called *System 1* (modular) and *System 2* (non-modular), and System 1 is often explicitly associated with «specialized» psychological adaptations (Chiappe & Gardner, 2012; Kahneman, 2011; Stanovich, 2004).

There are many problems with psychological dualism, about which I have written in detail elsewhere (Barrett, 2005, 2006, 2012; Barrett & Kurzban, 2006, 2012). Here I would like to focus on one set of properties of putative «modules» which, if it were truly characteristic of psychological adaptations in general, would have extremely important implications for the study of mental evolution, and in particular, for at least some conceptualizations of the «it factor». I will refer to this set of properties as *autonomy*. Other suitable words might include *independence* and *isolability*. There are several ways in which «modules» or «adaptations» are widely held to be autonomous, independent, or isolable, all of which are probably, in a strict sense, wrong.

2. The non-autonomy of mental evolution

What I mean by autonomy is a mix of two related components —*architectural* autonomy, implying that modules can and do operate independently of other systems and can be removed while leaving the operation of other systems intact— and *evolutionary* autonomy, implying that modules are shaped by evolution independently of other systems, such that their functions are relatively isolable.

In the evolutionary developmental literature, modularity is often seen as related to the question of «evolvability»: the degree to which evolutionary forces, including mutation, drift, and natural selection, can independently shape different aspects of organismal phenotype, as a function the «decomposability» of the phenotype into relatively independent parts or subunits (Wagner & Altenberg, 1996). Modeling work, as well as empirical studies of the modularity of existing development systems, has shown that the answers are neither obvious nor entirely intuitive (Wagner and others, 2007). Importantly, it is likely that no organismic traits are *entirely* autonomous, either architecturally or evolutionarily. Degrees and aspects of autonomy must and do play a role in shaping the course of evolution —but so do degrees and aspects of interactivity and non-independence. And perhaps most importantly for thinking about the mind, this doesn't mean that everything inside the organism is one big mishmash: there is functional specialization and modularity, but the important evolutionary questions lie just as much if not more in how the specializations *interact*, as in their relative autonomy or independence.

There are several basic facts about how evolution occurs that make strict autonomy a poor diagnostic for psychological adaptations. The first is that new adaptations evolve from old ones. Therefore, «new» psychological design inherits much «old» design. This means that multiple psychological mechanisms might, indeed must, share aspects of their information-processing design because they inherited it from older mechanisms they both evolved from (Barrett, 2012). As a consequence, these mechanisms might not appear «autonomous» along dimensions of shared design, and indeed, would be empirically impossible to disentangle if investigated solely along those dimensions.

For example, it has been proposed that human minds might contain specialized subsystems for recognizing and processing different kinds of physical objects, including faces, artifacts, and places (Kanwisher, 2010). Critics of this proposal point to aspects of object processing that can be shared across object domains, such as «configural» processing, as evidence against such subspecialization (Gauthier & Nelson, 2001). But if these subsystems evolved from a shared common ancestor and are now to some degree phenotypically distinct, configural processing might be a characteristic of multiple object-processing systems that are, in fact, functionally and phenotypically distinct. Other properties widely shared across mental mechanisms might include, for example, statistical learning and Bayesian updating. These are widely regarded as diagnostic of «general purpose» systems, but there is no reason to think they could not be characteristic of specialized systems as well.

Second, there is what can be called evolutionary «feedback»: changes in one system can lead to changes in another, because of how these systems interact to impact fitness. Again, this might lead to apparent signatures of non-autonomy, even in what might be phenotypically distinct psychological specializations (Barrett, 2012). For example, the evolution of language may have involved evolutionary changes in multiple areas of the brain, including areas involved in language production, language comprehension, and the white matter pathways connecting them (Buxhoeveden and others, 2001; Friederici, 2009; Hickok & Poeppel, 2007). Clearly this speaks against autonomy in the sense that changes in these distinct areas are not evolutionarily independent, but does it does not necessarily speak against modularity, or psychological specialization, if it turns out that areas involved in language production, language comprehension, and communication between them each carry out different functions.

Thus, even when selection has favored what from one point of view might seem to be a single ability, such as language, multiple systems can change as a consequence. This can include systems that execute «subfunctions» of the ability, such as language production and comprehension, and also systems causally related to the ability in question, such as, for example, mechanisms of social learning whose evolution might have altered, and been altered by, changes in language abilities (see below). In such causal webs, the «it factor» can't necessarily be equated with a single module —but neither is it the result solely of changes to a single «general-purpose» system. The answer is more complicated. When evolution is nonlinear, such that changes within a complex system of interacting parts cause other, non-additive changes, the search for an «it factor» may lead to just the kind of situation we see today: different parties backing their favorite candidate, and all partially right.

3. Towards a solution

Faced with the interactive complexity of the mind, some psychologists are tempted by a seemingly simple solution: let's toss out ideas like specialization and adaptation altogether and model the mind as a big dynamic system that adjusts itself in light of experience.

Of course, the mind *is* a big dynamic system that adjusts itself in light of experience (just as most biological systems are). But that doesn't mean it isn't composed of specializations shaped by the evolutionary process. Instead, it means that whatever those adaptations are, they have been shaped by how they *interact,* both with the world and with each other. This is at odds with the Fodorian view of a module as entirely dissociable. Removing a specialized component might have profound effects on the rest of the system, but that doesn't speak against specialization (imagine, for example, that you removed a component in your car engine, and the car failed to start; would you conclude that the part wasn't specialized?). It is also at odds with the dualist view of the mind as composed of two kinds of things: the rigid, inflexible, autonomous adaptations in System 1, and the flexible, interactive, undifferentiated System 2.

What if we were to stop thinking about adaptations as rigid, autonomous, reflex-like psychological Lego, and to start thinking of them as neural information-processing mechanisms that evolve through descent with modification from older systems, and that are shaped by how they interact with other systems and with the external world? On its surface this proposal would appear uncontroversial, and yet it is clearly not yet taken seriously by the psychology community because if it were, it would have several important effects on how we study psychological adaptations.

First, Fodor's list of modular properties would stop being used as a kind of diagnostic checklist for psychological adaptations. For example, techniques designed to activate System 2 mechanisms, such as placing subjects under «cognitive load», are sometimes taken to demonstrate that a particular process can't be due to a specialized adaptation, because if it were (according to dualist logic), the operation of that adaptation would be «automatic» —autonomous from other systems— and therefore not influenceable by putative System 2 processes like working memory (De Steno and others, 2002; for a critique see Barrett and others, 2006). On the view proposed here, properties like automaticity and speed are not *necessary* features of any psychological adaptation, but instead depend on the evolutionary history of the putative mechanism and what it has been selected to do. For example, we might expect many specialized adaptations in the mind, such as adaptations for learning and long-term decision-making (including partner choice), to be relatively slow in their operation, to use (potentially) lots of information in their operations, and to be influenced by the operation of other systems.

Second, a non-dualist view of adaptations would drastically change the landscape of how cross-cultural and developmental evidence is interpreted. Currently, cross-cultural variation in a skill is widely seen as evidence against the hypothesis that the skill represents an evolved adaptation, and in favor of the hypothesis that it is acquired through general-purpose learning. Conversely, uniformity in development, and in particular early development, are seen as counting for a specialization view. Rather than having either one count for or against the operation of adaptations, it makes more sense to consider each adaptation in its own terms, and ask whether features like cross-cultural uniformity or early development are likely to be an aspect of its evolved *design*. For example, some adaptations, such as adaptations causing mate competition and sexual jealousy, might be expected to evolve late in childhood; others, such as psychological adaptations against stressful circumstances, might develop at different times or rates in different individuals or environments, and perhaps sometimes not at all —despite being evolved adaptations (Frankenhuis & Panchanathan, 2011).

Third, in the case of debates about human uniqueness, a more biologically realistic view of psychological adaptations would temper the search for a specific «it factor» in human psychological evolution. For reasons given above, it's highly likely that multiple mechanisms were modified in the course of human evolution. Even if it were the case that there is in some sense a «prime mover», like the evolution of culture, it is quite possible that this could exert selection on multiple aspects of human brains, and/or that it could beget an evolutionary cascade in which culture selects for other kinds of abilities, such as cooperation and morality (Boyd & Richerson, 2006).

And empirically, it might be difficult to isolate the causal contributions of multiple factors that have co-evolved in the human lineage. For example, the comparative method, perhaps the foremost technique in evolutionary biology for inferring evolutionary causation, cannot be used to make inferences about evolutionary changes that have occurred uniquely within a single taxon (that is, autapomorphies; Brooks & McLennan, 1991).

Finally, accepting that specialization and interactivity are simultaneously possible in brain evolution should lead us to reconsider what are often considered as mutually exclusive evolutionary scenarios. For example, increasing brain size is widely considered a mutually exclusive alternative to «new modules» in human evolution (Deacon, 1997; Donald, 2001). However, there are reasons to suspect that increasing brain size might be positively, not negatively, correlated with degree of modularity. At minimum, purely architectural considerations suggest that as brain volume increases, network connectivity between different regions within the volume must necessarily decrease —implying increased modularity in the sense that the term is used in network theory (Kaas, 2000; Streidter, 2005). This makes several rarely considered scenarios possible (Barrett, 2012). First, increasing brain size may have *led* to increasing modularity, with increasing functional specialization as a consequence. However, the opposite is also possible: namely, that brain size increased *because of* selection for increased modularity and specialization —one way computational systems are known to gain increased flexibility (Baldwin & Clark, 2000). These are, of course, empirical questions. But either way, changes in modularity and changes in brain size/«general-purpose» cognition no longer should be seen as necessarily exclusive alternatives for the evolution of uniquely human cognition.

4. The future of the search for human uniqueness

The view I have been advocating here is that we stop thinking about psychological adaptations in terms of properties like rigidity, autonomy, and innateness, and start thinking about them in terms of *design*. By *design*, of course, I mean evolved design: how the adaptation has been shaped by the evolutionary process to interact with the rest of the system in which it is situated, including both the brain and the world. Part of evolutionary design thinking, then, involves theorizing how changes occur within systems of interacting parts —parts that can have distinct functions, but that do not necessarily evolve autonomously. This will require the development of new theoretical tools and the abandonment of outdated positions, but it is likely get us much closer to the biological reality of what has changed in brains since the chimp-human common ancestor than the «psychological Lego» view of adaptations as purely autonomous and *sui generis*, as opposed to hierarchically evolving via descent with modification from other mechanisms (Barrett, 2012).

Let me conclude with a hypothetical example of how we might think about nonlinear evolutionary interactions within a specialized brain: in particular, *synergistic* interactions between parts that are not, themselves, entirely new, but alter each others' design through an evolutionary feedback process. The example I have in mind is the potential synergistic relationship between three abilities that have each been proposed as distinct «it factors» of human uniqueness: (1) theory of mind, or the ability to infer others' intentions, motivations, and beliefs; (2) cultural learning and transmission; and (3) cooperation. Nobody would claim that these three abilities are the *same* ability; in all likelihood, they involve at least partly distinct psychological mechanisms. And yet, it is quite plausible, if not likely, that synergistic interactions occur between each of the abilities within this triad, meaning that evolutionary alterations in one have led to, and/or have been caused by, alterations in the other.

For example, evolutionary models show that mechanisms stabilizing cooperation, such as group-level norms, can result from cultural evolution —meaning that the evolution of cultural transmission mechanisms can lead to enhanced cooperation, and can even select for psychological mechanisms stabilizing cooperation, such as conformity biases (Boyd & Richerson, 2009). Similarly, the fundamental problem in achieving cooperation is avoiding the free-rider problem, which can favor mechanisms for predicting whether or not a cooperation partner will cooperate or defect. Improved abilities to detect the intention or motivation to defect —or to cooperate— could therefore stabilize cooperation. Thus, the benefits of cooperation could have been a selective factor favoring the evolution of theory of mind (Barrett and others, 2010). This would help explain why much of human morality seems deeply intertwined with reasoning about the causes of others' actions: for example, whether the action was intentional or accidental, done knowingly or in ignorance, by commission or omission, and so on (Mikail, 2007; Young & Saxe, 2009).

Finally, there appears to be a synergistic relationship between theory of mind and cultural transmission. While social learning is certainly possible in the absence of theory of mind, increasing evidence suggests that human cultural learning is greatly boosted by our capacity to go past the surface features of others' actions to infer the goals and intentions underlying what they are doing (Csibra & Gergely, 2009; Lyons and others, 2007; Meltzoff, 1995; Whiten and others, 2009). In contrast with other apes, humans, even infants, view pedagogical demonstrations as demonstrations not of arbitrary sets of actions, but of ways to achieve a particular goal (Csibra & Gergely, 2009). And in linguistic communication —arguably, one of the most important means of cultural transmission of humans— transfer of meaning is greatly aided by our ability to use the surface content of speech acts to infer the speaker's intended meaning (Sperber & Wilson, 1995). Thus, theory of mind and cultural transmission could have coevolved synergistically, at least in part, in the human lineage.

Clearly, humans differ from other apes in each of these ways: we cooperate more, have better theory of mind, engage in much more cultural transmission, and use language to do so. None of these, then, is the «it factor» in the sense of being *the* ability that sets us apart from other apes. But is one of them the «prime mover?». Did one of them serve as the main selective factor that drove the evolution of the others? It's possible, but difficult to tell just from the fact that all three differ in humans. To find out the answer, we need to develop more sophisticated models that allow for the kinds of synergies described above. Some such models exist, but more will be needed —perhaps with greater detail, and exploring more parameters in the space of possible brain variation, including ones we haven't yet considered— before the question of human uniqueness can be settled.

Importantly, when interactions become nonlinear, as the interactions between theory of mind, cultural transmission, and cooperation probably are, then verbal arguments rapidly lose force, suggesting the need for formal models using the tools of evolutionary, developmental and cognitive modeling (McElreath & Boyd, 2007). Arguably, one of the reasons for the impasse that confronts us in debates about human cognition is that our dualist models of the mind are many orders of magnitude simpler than the phenomena we are invoking them to explain. Unlike the recipe for french fries, the recipe for brain evolution is likely to require far more than two ingredients. Hopefully our theories will become more complex, rather than less so, in order to rise to the challenge.

References

Baldwin, Carliss Young & Kim Clark (2000). *Design Rules: The Power of Modularity*. Volume I. Cambridge: The MIT Press.

Barrett, Clark (2005). Enzymatic Computation and Cognitive Modularity. *Mind and Language*, *20*(3), 259-287.

Barrett, Clark (2006). Modularity and Design Reincarnation. In Peter Carruthers, Stephen Laurence and Stephen Stich (eds.), *The Innate Mind: Culture and Cognition* (pp. 199-271). New York: Oxford University Press.

Barrett, Clark (2012). A Hierarchical Model of the Evolution of Human Brain Specializations. *Proceedings of the National Academy of Sciences, 109*(1), 10733-10740.

Barrett, Clark, Leda Cosmides & John Tooby (2010). Coevolution of Cooperation, Causal Cognition and Mindreading. *Communicative* & *Integrative Biology*, *3*(6), 522-524.

Barrett, Clark, David A. Fredrick, Martie Haselton & Robert Kurzban (2006). Can Manipulations of Cognitive Load Be Used to Test Evolutionary Hypotheses? *Journal of Personality and Social Psychology, 91*(3), 513-518.

Barrett, Clark & Robert Kurzban (2006). Modularity in Cognition: Framing the Debate. *Psychological Review*, *113*(3), 628-647.

Barrett, Clark & Robert Kurzban (2012). What Are the Functions of System 2 Modules? A Reply to Chiappe and Gardner. *Theory and Psychology, 22*(5), 683-688.

Boyd, Robert & Peter Richerson (2006). Culture and the Evolution of the Human Social Instincts. In Stephen Levinson and Nicholas J. Enfield (eds.), *Roots of Human Sociality. Culture Cognition and Interaction* (pp. 453-477). Oxford: Berg.

Boyd, Robert & Peter Richerson (2009). Culture and the Evolution of Human Cooperation. *Philosophical Transactions of the Royal Society Biological Sciences, 364*, 3281-3288.

Brooks, Daniel & Deborah McLennan (1991). *Phylogeny, Ecology, and Behavior: A Research Program in Comparative Biology.* Chicago: University of Chicago Press.

Buxhoeveden, Daniel, Andrew E. Switala, Mark Litaker, Emil Roy & Manuel F. Cassanova (2001). Lateralization of Minicolumns in Human Planum Temporale is Absent in Nonhuman Primate Cortex. *Brain, Behavior and Evolution, 57*(6), 349-358.

Chiappe, Dan & Ricca Gardner (2012). The Modularity Debate in Evolutionary Psychology. *Theory* & *Psychology, 22*(5), 669-682.

Csibra, Gergerly & György Gergely (2009). Natural Pedagogy. *Trends in Cognitive Sciences, 13*(4), 148-153.

De Steno, David, Monica Y. Barlett, Julia Braveman & Peter Salovey (2002). Sex Differences in Jealousy: Evolutionary Mechanism or Artifact of Measurement? *Journal of Personality and Social Psychology, 83*(5), 1103-1116.

Deacon, Terrence (1997). *The Symbolic Species: The Co-Evolution of Language and the Brain.* New York: Norton & Company.

Donald, Merlin (2001). *A Mind so Rare: The Evolution of Human Consciousness.* New York: Norton & Company.

Fodor, Jerry (1983). *The Modularity of Mind.* Cambridge: The MIT Press.

Frankenhuis, Willem & Karthik Panchanathan (2011). Balancing Sampling and Specialization: An Adaptationist Model of Incremental Development. *Proceedings of the Royal Society B*, *278*(1724), 3558-3565.

Friederici, Angela (2009). Pathways to Language: Fiber Tracts in the Human Brain. *Trends in Cognitive Sciences, 13*(3), 175-181.

Gauthier, Isabel & Charles Nelson (2001). The Development of Face Expertise. *Current Opinion in Neurobiology, 11*(2), 219-224.

Hickok, Gregory & David Poeppel (2007). The Cortical Organization of Speech Processing. *Nature Reviews Neuroscience, 8*(5), 93-402.

Kaas, Jon (2000). Why is Brain Size so Important: Design Problems and Solutions as Neocortex Gets Bigger or Smaller. *Brain and Mind, 1*(1), 7-23.

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

Kanwisher, Nancy (2010). Functional Specificity in the Human Brain: A Window into the Functional Architecture of the Mind. *Proceedings of the National Academy of Sciences, 107*(25), 11163-11170.

Lyons, Derek, Andrew Young & Frank Keil (2007). The Hidden Structure of Overimitation. *Proceedings of the National Academy of Sciences, 104*(25), 19751-19756.

McElreath, Richard & Robert Boyd (2007). *Mathematical Models of Social Evolution: A Guide for the Perplexed.* Chicago: University of Chicago Press.

Meltzoff, Andrew (1995). Understanding the Intentions of Others: Re-Enactment of Intended Acts by 18-Month-old Children. *Developmental Psychology, 31*(5), 838-850.

Mikhail, John (2007). Universal Moral Grammar: Theory, Evidence and the Future. *Trends in Cognitive Sciences, 11*(4), 143-152.

Sperber, Dan & Deirdre Wilson (1995). *Relevance: Communication and Cognition*. Oxford: Blackwell.

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

Striedter, Georg (2005). *Principles of Brain Evolution.* Sunderland: Sinauer Associates.

Wagner, Gunter & Lee Altenberg (1996). Complex Adaptations and the Evolution of Evolvability. *Evolution*, *50*(3), 967-976.

Wagner, Gunter, Mihaela Pavlicev & James Cheverud (2007). The Road to Modularity. *Nature Reviews Genetics, 8*(12), 921-931.

Whiten, Andrew, Nicola McGuigan, Sarah Marshall-Pescini & Lydia Hopper (2009). Emulation, Imitation, Over-Imitation and the Scope of Culture for Child and Chimpanzee. *Philosophical Transactions of the Royal Society B, 364*(7), 2417-2428.

Young, Lianne & Rebecca Saxe (2009). An FMRI Investigation of Spontaneous Mental State Inference for Moral Judgment. *Journal of Cognitive Neuroscience, 21*(364), 1396-1405.