

# **Decision Making Is Caused By Information Processing And Emotion: A Synthesis Of Two Approaches To Explain The Phenomenon Of Confirmation Bias**

Robert Dunne

School of Computer Science and Informatics, University College Dublin, Belfield, Dublin 4.  
robert.dunne@ucdconnect.ie

**Abstract.** In social psychology there are two dominant models of reasoning, one that is based on information processing and another based on emotion. This paper argues that there are problems with viewing decision making exclusively in these terms, which is what has been done to date in the field of social psychology. While cognitive psychologists and behavioural economists have accounted for the internal and external cognitive processes, generally they have not accounted for the role of culture in one's decision making; this is one of the reasons why participants are said to be 'irrational' if they fail to act in a specific way. This paper synthesises two perspectives one that is concerned with information processing and another which is concerned with emotional reactions in order to explain the phenomenon of confirmation bias. Areas of agreement and disagreement will be identified, before recommendations are made for future research. It is hoped that this can serve as an argument for a more pluralistic framework that also acknowledges the role of ecological factors.

**Keywords:** Information Processing, Emotion, Biases, Heuristics, Bayesianism, Social Intuitionist Model Of Reasoning.

## **1 Introduction**

In social psychology there are two dominant models of reasoning, one that is based on information processing and another based on emotion. Confirmation bias is the tendency to acquire or process new information in a way that confirms one's presuppositions, it is capable of involving both information processing and emotions. It is important to analyse the phenomenon of confirmation bias, because if it is the case that people are simply looking for ways in order to confirm their own presuppositions, this means that they are not trying to falsify their beliefs or analyse them for internal consistency, but rather they are simply confirming their own presupposition which are in part determined by one's culture and upbringing. This affects coherence in judgement. The emotional approach states that political reasoning and moral reasoning are intertwined. The way in which one reasons in a political context is likely to tell us what someone thinks is right or wrong, and also why they think their actions are moral or immoral. The information based approach discusses how confirmation bias is the result of problems with information processing. The social intuitionist model of reasoning, which has greatly influenced the emotional approach states that moral and political reasoning is effectively a process of confirmation bias.

Before one can begin to synthesise the two different approaches, it is very important that certain terminology is defined from the outset. Biased reasoning is a form of motivated reasoning caused by intuitions. An intuition is the ability to understand something without the need for conscious reasoning. Hume stated that intuitive judgements were akin to an aesthetic judgement in that they are made without inference or the use of reasoning [1]. An example of an intuitive judgement might be “I like that painting”. Heuristics should be understood as simple efficient rules which people use to form judgements. A heuristic can be considered to be a mental shortcut in decision-making, it is common for this kind of internal process to result in the creation of biases. A bias is an external observable phenomenon while heuristics and emotions are internal, unobservable and descriptions of them are theoretical [2]. It has been demonstrated that there are many different forms of bias including: judgment biases, attitudinal biases, attentional biases, response biases and biases in relation to perceptual illusions [3]. Within the field of social psychology there are two understandings of bias one as process in which information is filtered so that it can be processed more affectively, the second definition is one where evaluations are distorted by some form of motivation [3]. Motivation is being used to refer to an emotional presupposition such as an intuition, the difference between a bias and an intuition and the extent to which they are related will be discussed later [3]. When the term culture is being used it is describing factors such as the affect of upbringing, group activity and ecological factors.

It is also important to acknowledge what this theoretical critique is not trying to do. This critique is not attempting to present a unified theory of decision making this is a task that far extends the scope of this paper. Similarly a strongly positivist view is not being taken this means that I am not proclaiming that there is a definitively right or wrong answer to what causes confirmation bias, or if there are exact definitive grounds for saying that one is ‘rational’ or ‘irrational’. This paper is only surveying two approaches with a view to identifying areas of agreement and disagreement in order to provide a more pluralistic understanding of decision making. This paper will discuss cognitivist approaches to decision making, it could be the case that alternative views such as enactivist ones might be able to provide better explanations. However, if one does not discuss the problems with the existing literature, it will not be possible to provide a better explanation. Major definitional problems exist in social psychology, this paper will not be able to deal with all of these problems, rather it will advocate for an approach to research that would allow these problems to be addressed. This paper should only be seen as a theoretical critique which aims to synthesise two different approaches and identify areas of agreement and disagreement in order to provide recommendations for future research. It is also important that this is defined from the outset; for the purpose of this paper, the first approach is being referred to as the information processing based approach (which is discussed by Hahn & Harris in their paper) and the second approach is being referred to as the emotion based approach (which is described by Haidt in his paper). These papers have been chosen as the exemplar papers because each of them provide an account of the history of research in decision theory from their own individual approach. This provides a means for

analysing related work from each perspective so that the two approaches can be evaluated effectively.

The structure will be as follow: background will be provided, the definition of confirmation bias from two perspectives will be analysed in order to identify areas of agreement and disagreement, incidences in which the two perspectives could be commensurable will be examined. Before recommendations are made for future research.

## **2 Background**

### **2.1 Information Processing Approach**

Confirmation bias has a colloquial definition as a process in which one searches for and interprets information in such a way that it agrees with their predisposition. It could be considered to be a form of motivated reasoning as opposed to one in which information is filtered in a more affective manner. A common definition of what is meant by confirmation bias comes from Peter Wason who defined it as “the failure to eliminate hypotheses from a conceptual task”, this is based on a task in which participants had to correctly infer a rule governing triplets of numbers (2,4,6) he found that participants generated query triplets as opposed to the correct defined rule of increasing orders of magnitude [3]. His finding from this problem which was concerned with an information processing task was that a large proportion of participants would seek evidence that confirm their proposition. This was in complete contrast to the dominant Popperian prescription of the need to falsify in the testing of scientific hypothesis, this was taken to have failed the standard for rational inference. Popperian in this context refers to the view on science taken by Karl Popper who stated that scientific conclusions were reached through looking for information that could nullify a hypothesis [4]. This is the conventional interpretation of this experiment and many would conclude that the participants were being ‘irrational’, however, closer attention should be paid to why the participants made the decisions that they did, others such as Klayman & Ha would take issue with this approach (1987). An article by Klayman and Ha described a test with similar conditions to the Wason number task, they applied an understanding of Bayesian probability to the task. They used letters instead of numbers, so for example they used the labels "DAX" and "MED" instead of the terms “Fits the rule” or “Doesn’t fit the rule”. This avoided implying that the aim was finding a low probability. As result of the findings of Klayman and Ha, future research on confirmation bias focused on the different ways in which people reason about different topics [5]. The problem with this account is that it only seems to describe the nature of how people go about searching for information, as opposed to the reasons for their motivations.

In this way confirmation bias can be understood as a form of motivational reasoning, an attentional bias which reflects a kind of “wishful thinking” [3]. This has lead to confirmation bias becoming an umbrella term for the different ways in which beliefs

and expectations interfere with the ability to reason affectively. Below is a model for the different factors that go into bias reasoning as outlined by Nickerson.

1. Hypothesis-determined information seeking and interpretation	1.1 Restriction of attention to a favoured hypothesis	Considering only $P(D H)$ and not $p(D H)$ , for example, Doherty, Myneatt and Schivao- sometimes referred to as pseudodiagnostically bias; but see Crupi, Tentori and Lombardi [3].
	1.2 Preferential treatment of evidence supporting existing beliefs	My-side bias tendency to produce reasons for favoured side, for example, Baron [3].
	1.3 Looking only or primarily for positive cases	Tendency to ask question for which answer would “yes” if hypothesis were true: Wason [5, 6].
	1.4 Overweighting positive confirmatory instances	For example, Gilovich [3].
	1.5 Seeing what one is looking for	For example, effects of expectation on social perception Kelley; but Lenki and Leggett general tendency to respond to questions in acquiescence to interrogator hypothesis [3].
	1.6 Remembering what one expects	Eagly, Chen, Chaiken, and Shaw-Barnes [3].
	1.7 Illusory correlation	Chapman and Chapman, but see Fielder and Krueger [3, 6].
2. Wason selection task and formal reasoning	Failure to pursue falsificationist strategy in context of conditional reasoning, Wason; but see Oaksford and Chater [3, 5].	
3. The primacy effect and belief persistence	Resistance of a belief or opinion to change once formed Pitz, Downing, and Reinhold’s inertia effect; Lord, Ross, and Lepper “biased assimilation” [3].	
4. Overconfidence and the illusion of validity	For example, Lichtenstein and Fischhoff, but see also Erev, Wallsten and Budescu [3].	

**Table 1.** Phenomena that have been brought under the header of confirmation bias, according to Nickerson [3]

The processes previously outlined in the model set by Nickerson such as: “seeing what one is looking for” and “illusory correlation”, could be informed by what one intuitively believes to be factually correct. Illusory correlation is when one perceives

that there is a relationship between variables when no relationship exists [6]. According to some social psychologists an availability heuristic is what causes the illusory correlation. Confirmation bias can occur even when people have no previous knowledge of the categories and features in question, because of this it is not always caused by an attentional bias in which one simply sees what they are looking for.

Confirmation bias could also be considered to be a form of perseverance bias, this is when one persists with a belief despite evidence to the contrary. A problem with most of these studies is that they are only concerned with information seeking, but when one is seeking to confirm their predispositions is it reasonable to suggest that they're doing this devoid of any emotional attachment or judgement to their relevant proposition?

The importance of Bayesianism also needs to be considered, it follows from the simple premise that an agent should approximate the truth, and seek to minimise inaccuracy. Bayes' rule provides normative guidance on how beliefs should be updated upon receipt of new information [3]. Klayman and Ha's alternative interpretation of the Wason number task is part of this interpretation. The qualitative properties of Bayesian belief revisionism are particularly relevant simply because most of the experimental studies show only that responses are 'different' across conditions. Only a small amount of the literature attempts to account for the context of the information that participants would be exposed to, research on coherence and risk has often produced very different results to studies on coherence in which the participants had no exposure to risk.

The information processing approach has been greatly influenced by the biases and heuristics programme of Tversky and Kahneman, which is focused on probability judgement and decision making [2, 7, 8]. They also note the contributions of Gigerenzer "simple heuristics that make us smart". The contribution of Gigerenzer are very important to the study of the biases and heuristics, largely because Gigerenzer has argued for the study of 'adaptive heuristics'. Gigerenzer has also argued that there are crucial flaws with the biases and heuristics programme of Tversky and Kahneman, particularly in the area of accuracy costs. For instance, Gigerenzer has stated that the application of heuristics may only be confined to situations in which there is little cost to getting things wrong [9]. All of these criticisms of Tversky and Kahneman's work are noted by Hahn & Harris [3].

Areas that are worthy of further investigation include analysing the differences in probabilistic reasoning among different cultures, people from different sample groups and different cultural contexts. Research by Yates et al, has analysed the difference in probabilistic judgement across different cultures. In a series of studies George Wright and Lawrence Phillips along with several collaborators posed the same question to respondents in Britain and various South East Asian countries. The experiment was a confidence study in which participants had to grade whether they believed their chosen answer was right or wrong. For example one question was: "Is Jute (Circle One): (a) A cereal crop or (b) a fiber crop. Now indicate the probability (50%-100%)" [10]. In this series of studies UK students were far more likely to believe their answers were right

as opposed to their South East Asian counterparts. There are reasons as to why one may come to different conclusions, this article stipulates many reasons for results are different across cultures such as response bias. However, depending on the sample there may be reasons why they are providing different answers, the reasons may be related to other factors that cannot be accounted for by means of quantitative analysis.

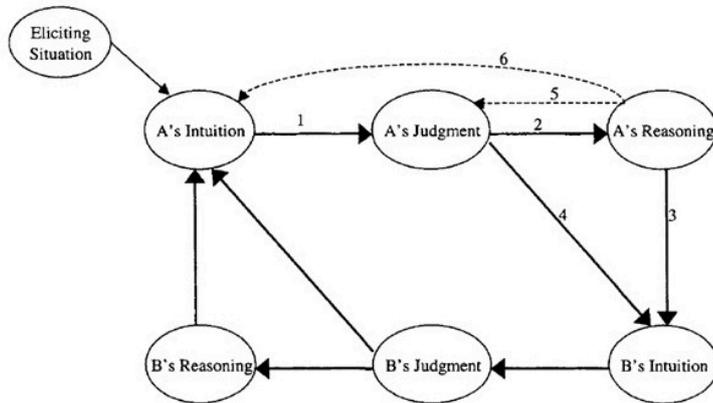
## 2.2 The Emotional Approach

“The Reasoning process is more like a lawyer defending a client than a Judge or Scientist seeking truth” [1]. This section will describe the social intuitionist model of reasoning, which has been highly influential in the field of political psychology. According to Haidt, there are two separate cognitive processes at work intuition and reason, and often times the reasoning component is overemphasised. The Haidt paper states that reasoning is often motivated and consists of posthoc justifications [1]. Like Hahn & Harris, Haidt provides a history of the understanding of reason that can serve as an affective way to understand the emotional approach. However, according to Haidt we experience the illusion of objective reasoning. In his paper Haidt provides a detailed history of decision theory from the emotional perspective. Haidt also discusses Kohlberg and the cognitive revolution. Kohlberg argued that reasoning was ‘rational’ but it was subject to affective forces [1]. According to the social-intuitionist model, people are said to think about the consequences of an action before determining whether the action is a moral violation. Before going any further it is important to note that Haidt embraces Damasio’s definition of emotion, which is that somatic markers are bodily reactions which are the result of environmental stimuli. According to Damasio, negative emotion is the result of negatives experiences while positive emotions are associated with positive experiences [1].

When this is the case it is important to define what Haidt means by moral judgement, moral reasoning and moral intuition. According to Haidt, moral judgement is defined as evaluations (good versus bad) of the actions or character of a person that are made with respect to a set of virtues held by a culture or subculture to be obligatory. Moral reasoning can now be defined as: conscious mental activity that consists of transforming given information about people in order to reach a moral judgment. Moral intuition can be defined as: the sudden appearance in consciousness of a moral judgment, including an affective valence (good-bad, like-dislike), without any conscious awareness of having gone through steps of search, weighing evidence, or inferring a conclusion [1]. The social intuitionist model of reasoning has helped to inform a lot of work in political psychology that focuses on the role of emotional reactions. This line of reasoning is held together by four links: (i) The intuitive judgment link, which states that moral judgments appear in the consciousness automatically and effortlessly as the result of moral intuitions. (ii) The post-hoc reasoning link, this model proposes that moral reasoning is an effortful process, engaged in after a moral judgment is made, in which a person searches for arguments that will support an already-made judgment. Nisbett and Wilson demonstrated such post-hoc reasoning for causal explanations. (iii) The reasoned persuasion link, which proposes that moral reasoning is produced and sent forth

verbally in order to justify one's already-made moral judgment to others. (iv) The social persuasion link, because people are highly attuned to the emergence of group norms, the model proposes that the mere fact that friends, allies, and acquaintances have made a moral judgment exerts a direct influence on others, even if no reasoned persuasion is used. (v) The reasoned judgment link, because people may at times reason their way to a judgment by sheer force of logic, which can override their initial intuition. In these cases reasoning truly is causal [1]. However, Haidt believes that this kind of reasoning is rare [1]. It is this approach to reasoning that has informed a series of studies on political and moral reasoning.

Dual process approaches are often dismissed by those who are coming from the emotional approach, this appears to be the case in a lot of literature which focuses on reasoning as being the result of emotion, a point made by Zajonc in her papers [11]. However, Haidt does note that affective evaluations occur regularly. It is acknowledged by some who embrace the emotional approach that moral judgements require more than just social stimuli. It is stated in some literature on the topic of social attitudes that it needs to be analysed. In relation to heuristics, Haidt says that the principle of least effort in decision making generally prevails. Although Haidt admits that there is plausibility in a dual process model for social judgements. He states that it's possible for relatedness motives and coherence motives to exist [11]. Research on the topic of cognitive dissonance can help to provide some insight on this issue. More recently, some research has shown that defense motivation can reveal information about how bias is culturally determined. Some studies showed that when people are asked to think about their own deaths they appear to suppress a generalised fear of mortality by clinging more tightly to their cultural world view [1]. This work seems to demonstrate that from a terror management perspective, moral judgement is a special kind of management, since moral judgemental ways implicate the cultural world view. It is plausible to say "I don't like asparagus, but I don't care if you eat it." It is not plausible to say "I think human life is sacred, but I don't care if you kill him". Some research shows that people do not always seek to confirm their initial hypothesis; sometimes they ask questions to get to the truth [12]. It should be mentioned as a side note, that the study of cognitive dissonance as described by Haidt earlier is an area worthy of further investigation. Research in this area which attempts to explain the way participants process information and the emotional reaction it solicits (if any), could help to create a theoretical framework which could unite the two accounts. A problem with a lot of these studies is that they don't involve moral questions and often contain propositions; which there is no need to defend [1]. This may therefore create an unusual and non-representative kind of moral judgment. But in real judgment situations, e.g. when people are gossiping or arguing, relatedness motives are always at work. If more shocking or threatening issues are being judged (e.g. abortion, euthanasia, or consensual incest) then coherence motives will be at work too [1].



**Figure 1.** Haidt's Social Intuitionist Model of Reasoning [1]. (1) The Intuitive judgement link. (2) The post hoc reasoning link, (3) the reasoned persuasion link, (4) the social persuasion link. (5) the reasoned judgement link and (6) the private reflection link. This is a visual representation of the model that was discussed previously.

### 3 Discussion and Analysis

What is being argued is that a more pluralistic framework is possible. This section will attempt to provide a more pluralistic understanding of confirmation bias by identifying areas of agreement and disagreement. Areas of commensurability will be highlighted before recommendations are made for future research.

#### 3.1 The definition of confirmation bias: areas of agreement and disagreement. Common ground: what the two approaches can agree on

While the two approaches are very distinct in their methodological approaches they argue a similar point. The most significant problems with both approaches are as follows. The information processing approach does not account for the role of emotions or culture in their account of intuitive judgements. The emotional approach fails to account for the literature in behavioural economics on the topic of information processing. This is a such a large area of research it can't be ignored.

Confirmation bias is understood to be the result of information processing and emotional processing, one may be wondering whether the two approaches are mutually exclusive but in fact the distinction between the two which has developed in social psychology may be completely arbitrary in certain ways. An account of confirmation bias that would be consistent with both papers is that it is a form of motivated reasoning in which one attempts to justify their own viewpoint by means of post-hoc justifications. But the two approaches disagree with what the cause of confirmation bias

is. The emotional approach seems to understand confirmation bias to be something that occurs as a result of one's cultural context, childhood development and one's innate sense of right or wrong, this forms their intuitions which leads to them providing post-hoc justifications for their beliefs. The information processing approach seems to understand it as the result of behaviours in which one: looks at instances in which they expect to verify, rather than falsify, and chooses the currently preferred hypothesis by examining incidences which only seems to confirm the existing hypothesis. When this is the case, one will be overly confident that their view is true, and this will affect their judgement. In this way confirmation bias could be said to be affecting coherence.

Both approaches seem to be in agreement that confirmation bias should be understood as a combination of myside bias or "wishful thinking"; in which one believes that there is a high likelihood that they are right and goes about trying to justify their intuitive judgement with a post hoc explanation.

### **3.2 Both approaches agree that confirmation bias interferes with coherence and that this is a problem**

Both approaches can be in agreement that confirmation bias is an issue, largely because it interferes with coherence motives. The information processing approach has been concerned with incoherence in judgement and overconfidence. Let's refer to the papers by Yates et al in relation to the information processing approach. There are factors which can be said to be influencing these results. While the information processing approach has provided a good explanation for how the mechanics of intuitive judgement work, it has a problem with describing how the intuitions that guide one's judgement are formed. The emotional approach which is concerned with how cultural factors can shape one's intuitions could help to explain how affective factors could help to shape the nature of intuitive judgements. This is a way in which the two models could be said to interact, however, more research is required.

### **3.3 Constraint Ground areas of disagreement:**

Although there doesn't appear to be much disagreement on the definition of confirmation bias, there are different explanations provided for how it may occur. In order to understand why there is disagreement let us look at the history of this area of research, this may provide an explanation which can help to bring about a more pluralistic understanding. While there are distinct methodological differences both exemplar papers cite Nessbit (1980), this text provides a valuable connection which could unite the two accounts. The text describes reasoning as being a process in which people develop posthoc justifications for their intuitive judgements, it also tries to account for how external stimuli is processed in a way in which emotional judgement is used.

The 1980 text by Nessbit is particularly concerned with the affect heuristic, the availability heuristic and it's affects on behaviour. Certain aspects of the social

intuitionist model of reasoning could be described using the terms affect heuristic and availability heuristic [13]. There was a rather pluralistic understanding of what was meant by confirmation bias and how it occurred until the 1990s, at that time disagreements arose with new theories about the nature of emotions, Damasio's somatic marker hypothesis caused certain researchers to focus on emotional reaction as opposed to how people might be trying to think logically about the information that was being presented to them. Likewise, the work of Tversky and Kahneman has been embraced in behavioural economics, but problems with information processing tasks seem to have been focused on to the detriment of analysing emotional reactions. The popularity of these theories seems to have caused diversions and a series of different explanations to arise. When this is the case it's important to identify areas of agreement and disagreement so that a more pluralistic account can be developed.

### **3.4 Which aspects of the information processing approach are compatible with the emotional approach: a synthesis towards a more pluralistic framework**

It appears as if both approaches can be in agreement that lack of coherence in judgement is a problem that requires an explanation. In order to explain why these problems occur a more pluralistic account of decision making needs to be created.

Based on the analysis in this paper, researchers should consider what aspects of the information processing could be commensurable with the emotional approach. In his book *Descartes Error*, Damasio acknowledges that the work of Tversky and Kahneman helps to point out errors in human judgement. However, Damasio's views do stand in contrast to many in the field of behavioural economics who wish to say that decision making consists of people conducting cost and benefit analysis. However, there are accounts of reasoning in the study of heuristics that may be commensurable with the accounts provided by Damasio whose work has greatly influenced Haidt and researchers from the emotional approach.

An approach to heuristics that may be commensurable with the emotional approach is the fast and frugal approach to heuristics, this refers to the idea that when individuals are presented with less information as opposed to more information they will make better decisions. The book which discusses this approach to heuristics *Simple Heuristics That Makes Us Smarter* was referenced in the paper by Hahn & Harris, it describes deep thought as "an unaffordable luxury" [9]. This approach to heuristics was noted earlier. A type of heuristic which would account for the role of emotional judgements is the affect heuristic in which one uses emotions to carry out a risk and benefit analysis in order to process information and solve problems in a more efficient manner [14, 15].

Although these two accounts come from two different methodological approaches they are rather similar, but there are two main problems. Firstly, they are couched in separate vocabularies. Secondly, the role of external factors needs to be accounted for and current findings need to be interpreted in line with this information. This account would be consistent with studies by Damasio which showed that neurological

abnormalities which blocked somatic markers impaired the ability to make risky decisions [1]. Other research by Wilson et al, demonstrates that decision making suffers when affective inputs are negatively affected and participants are forced to make a decision systematically weighing up the pros and cons. Some in social psychology have embraced Damasio's somatic marker hypothesis. Gigerenzer and Damasio would both be in agreement that it isn't possible for people to be thinking deeply about their every single move. If the two accounts are to be commensurable there needs to be some acknowledgement that individuals aren't thinking in a systematic manner.

It needs to be acknowledged that reasoning is not going to be the same in every circumstance; the context of the information can vary and a person's reaction could be caused by environmental factors (e.g. culture, upbringing, values, etc). Therefore, reactions shouldn't just be dismissed as being 'rational' or 'irrational'. The emotional approach which is concerned with the nature of intuitions and affective factors could help to account for behaviours that quantitative methods can't easily account for.

#### **4 Recommendations For Future Research and Conclusion**

What should be derived from studying the two approaches is, it's important to analyse the reasons why people make decisions. In many contexts it makes sense to have experiments with a normatively defined rule or a rational standard, but this is not always the best method to tell us about the different ways in which people are capable of reasoning. Focusing too much on whether participants are being 'rational' or 'irrational', could mean that researchers will overlook the different ways in which participants are capable of reasoning and why they reach the conclusions that they do.

Future research, should be concerned with understanding what Thaler & Sunstein referred to as choice architecture, and the different kinds of conclusions that individuals may reach depending on the factors which form their intuitions and guide their judgement [16]. No theoretical perspective succeeds in uniting the two approaches and there isn't always going to be a clear demarcation criteria for whether data that one receives is an entirely information based or if it is more emotionally charged. There is no exact way to quantify how emotional a piece of data is. Any devised measurement could not possibly account for how data can be interpreted differently by people. This means that future research shouldn't be attempting to obtain findings which can be generalised out to the entire population, rather they should be looking at the way in which different individuals can reach different conclusions and what is leading them to make those conclusions. Likewise, studies which presume that people aren't trying to think logically can be problematic. It's not inconceivable that many different forms of cognitive architecture could exist. Observational studies, free from problems such as forced choice should be considered, they could give participants the opportunity to describe their mental processes. Experiments which are qualitative should be considered. It's important to analyse why people reach the conclusions that they do. This way we can learn more about why people make the choices that they do. It is

possible that many factors are affecting participants abilities to make decisions. The work of Haidt which attempts to interpret data by analysing information from a variety of different disciplines, is an approach that could provide a greater understanding of choice architecture and the different kinds of architecture that can exist. This could help to create a more pluralistic account of decision making, an overarching theoretical perspective which succeeds in uniting the two approaches.

## References

1. Haidt, J.: The Emotional Dog and It's Rational Tail: A Social Intuitionist Approach to Moral Judgement. *Psychological Review*. 108, 814–834 (2001)
2. Kahneman, D., Tversky, A.: On The Reality of Cognitive Illusions. *Psychological Review*. 103 (3), 582–591 (1996)
3. Hahn, U., Harris, A.: What Does It Mean To Be Biased: Motivated Reasoning and Rationality. *Psychology of Learning And Motivation*, 61, 41–102 (2014)
4. Popper, K.: *Conjectures and Refutations: The growth of scientific knowledge*. Routledge, Abingdon (2014)
5. Klayman, J., Ha, Y,W.: Confirmation, Disconfirmation, and Information in Hypothesis testing. *Psychological review*, 94(2), 211–228 (1987)
6. Chapman, L.J., Chapman, J.P: Genesis of Popular but Erroneous Psychodiagnostic observations. *Journal of Abnormal Psychology*, 72(3), 193–204 (1967)
7. Kahneman, D., Tversky, A.: Extension versus Intuitive Reasoning: The conjunction fallacy in probability judgment. *Psychological review* 90 (4): 293–315 (1983)
8. Kahneman, D., Tversky, A.: Judgment Under Uncertainty: Heuristics and Biases. *Science*, 185 (4157), 1124–1131 (1974)
9. Gigerenzer, G., Czerlinski, J., Martignon, L.: How Good Are Fast and Frugal Heuristics. In Gilovich, T. Griffin, D and Kahneman, D (Ed), *Heuristics and Biases The Psychology of Intuitive Judgments*. pp. 559–582. Cambridge University Press, Cambridge (2007)
10. Yates, F., Lee, J.W., Sieck, W., Choi, I., Price, P,C.: Probability Judgement Across Cultures. In Gilovich, T, Griffin, D and Kahneman, D (Ed), *Heuristics And Biases The Psychology Of Intuitive Judgments*. pp. 271–292. Cambridge University Press, Cambridge (2007)
11. Zajonc, R. B.: Feeling and Thinking: Preferences Need No Inferences. *American Psychologist*, 35(2), 151–175 (1980)
12. Snyder, M., and Swann, W. B.: Hypothesis Testing Processes In Social Interaction. *Journal of Personality and Social Psychology*, 36, 1202–1212 (1978)
13. Nisbett, R., Ross, L.: *Human Inference: Strategies and Shortcomings of Social Judgment*. Englewood Cliffs, Prentice-Hall, New Jersey (1980)
14. Finucane, M.L., Alhakami, A., Slovic, P., Johnson, S.M.: The Affect Heuristic in Judgment of Risks and Benefits. *Journal of Behavioral Decision Making*, 13 (1) (2000)
15. Loewenstein, G. F., Weber, E. U., Hsee, C. K., and Welch, N.: Risk as feelings. *Psychological Bulletin*, 127(2), 267–285 (2001)
16. Sunstein, C and Thaler, R.,: *Nudge: The Politics of Libertarian Paternalism*. Yale University Press, New Haven (2008)