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THE INFLUENCE OF 5-HT, IN THE AMYGDALA, ON IMPLICIT EVALUATION AND ITS IMPACT ON JUDGMENTS MADE IN THE MAGISTRATES' COURTS

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INTRODUCTION

The human brain is one of the most complex structures found in nature. Over the years scientists have identified a vast amount of structures, receptors, and neurotransmitters, which all seem to have distinct functions, as well as integrated functions. Brain research is so important because the workings of the brain have implications for the functioning of humans, and by extension on the society that humans make for themselves. One such influence is in the courtroom, where the purpose is justice. With new discoveries of the functioning of the brain, also come discoveries raising questions about how fair the brain is actually able to function. In the courtroom judges are purported to be just, and judge based on the facts.

This paper will investigate the link between the 5-HT receptor systems in the amygdala and implicit social evaluation. This implicit social evaluation is hypothesized to influence judgments made by judges, in the Magistrates' courts in the United Kingdom more specifically. This question link is interesting because not a lot of work has been done in this specific field, but rather the main research focuses on the brains of criminals. Investigating the link between an inclination towards crime and the specific brain structure of criminals. However work done by for instance *Jacoby et al* and *Greenwald* show how past experiences and implicit memory might play a role in implicit cognitive judgments (Greenwald & Banaji 1995). Cognitive judgment could also be of influence in the judgment process, since a judge is looked upon to rule based on the evidence. This evidence can contain also emotionally loaded things, and are not necessarily clear-cut. All these things would require the brain to interpret the evidence before it, leaving room for implicit judgments of all kinds.

The processes responsible for forming judgments are known under a wide array of names, of which bias, implicit cognitive processes, implicit stereotyping, prejudice and implicit evaluation are just a few. In this research the term implicit social evaluation is taken to mean an unconscious process responsible for incorporating past memories and experiences into the present evaluation (Amodio & Devine 2006; Greenwald & Banaji 1995; Amodio et al. 2003). Implicit social evaluation was chosen to introduce the social factor. Since the brain also makes judgments about objects, that for the purpose of this research are excluded.

The 'courtroom' is limited to the cases in the magistrates' court. The cases in this court involve minor offences, are judged by a 3 magistrates or a single judge and can be sentenced to up to 12 months in jail (Slapper & Kelly 2007a). This limitation is imposed in order to keep the research within bounds, both in the chapters on the court itself, as well as in the pharmacological research. Since logically people adjudicating in the magistrates' court will be over the age of 25, roughly the age it takes to do a university course, and will not be older than 70, due to retirement. This narrows the population for the pharmacological research to males and females of ages 25 till 70.

This dissertation is divided into five chapters. The first chapter concerns the physiological role of 5-HT on implicit social evaluation, in the amygdala specifically. This chapter takes the format of a literature review, and will first explore the role of the amygdala in implicit social evaluation, which is an essential distinction to narrow the further research. It will then go on

to argue that 5-HT is the major transmitter involved in implicit social evaluation, and put forward arguments to this end.

The second chapter is a systematic review of the literature concerning the drug-induced role of 5-HT on implicit social evaluation, and emotions. Here, a systematic approach is chosen to minimize the possibility of bias. It also allows for a more thorough investigation of all the literature, thus leading to a more robust conclusion of the contemporary research. This chapter serves as a proof of concept for the first chapter, since the courtroom will probably not involve these specific drugs. It will however show that 5-HT does influence implicit social evaluation and could therefore do this in normal court circumstances.

The third chapter forms the link between pharmacology and the magistrates' court. It will first explore the workings of the magistrates' court, identifying processes in which implicit social evaluation could play a role. It will then turn to the philosophy of justice, in order to see the implications of the neuroscience on the justice system.

The fourth chapter encompasses recommendations for making the court more just, taking into account the findings from chapters I to III. It will simultaneously identify ethical limits, which might be contained in these recommendations.

Lastly, the fifth chapter forms the conclusion and discussion. These will summarize the findings established in all the other chapters, as well as identify possible shortcomings of the research and introduce some ideas for further research.

CHAPTER I –THE AMYGDALA AND IMPLICIT SOCIAL EVALUATION

SOCIAL EVALUATION AND ITS EVOLUTION

The human brain has evolved to make rapid judgments about the valence of objects in order to allow the human species to survive in a world with enemies both in the open and hidden. This type of survival technique stems from a fear response, in a split second the brain will assess the situation at hand and judge it either to be negative or positive, based on this value the brain would either be put at ease or initiate a fight or flight response (Greenwald & Banaji 1995; Amodio & Devine 2006). The fight or flight response is at the extreme end of the spectrum, in the modern day world this response is not often elicited, rather we use aversive behaviours, in terms of "liking someone" or not. This type of behaviour is hypothesised to be driven by affective-evaluative processes, rather than full cognitive ones (Amodio & Devine 2006). This can be taken one step further to account for processes like discrimination. Humans are motivated by social cues, they want to be included in a social group and compete with other groups. These motivations cause the brain to make snap judgments "to discern us from them" (Amodio 2014).

Taking both these processes together leads to the term "social evaluation", this term is used to imply the processes that cause people to like someone or to identify in- and out-group members in a split second (Greenwald & Banaji 1995). Furthermore, these judgments are influenced by past experiences (Cunningham et al. 2003), albeit implicitly. The past experiences will teach the brain in one single presentation a certain pattern to follow to reach a judgment. This pattern is then very difficult to extinguish (Amodio & Devine 2006). As a result of these described social evaluative patterns and processes the stage is set for stereotyping, social categorization and prejudices (Amodio 2014).

AMYGDALA AS THE SOURCE OF IMPLICIT SOCIAL EVALUATION

The study of social evaluation goes beyond the identification of the process, to identify the specific brain region implicated in this process. The amygdala is a brain structure implicated in the fight and flight response, as well as the appetitive responses. These two types of responses are integrated by two different parts of the Amygdala, the Central nucleus (CeA) is responsible for the fear type of emotions, while the basal nucleus is in control of the appetitive response (Amodio 2014). These fear type of emotions are essential in reading and processing social cues, this is why the first brain region to be investigated in relation to social evaluation is the amygdala. Numerous studies using fMRI techniques to identify brain regions involved in social evaluation processes have been done on this topic. fMRI is a non-invasive scanning method that allows the participant to conduct cognitive tests while the brain is being mapped by the machine. In case of social evaluation the case of racial bias is often used, since it is such a prevalent situation. Early studies found a correlation between amygdala activation following a black or white face and implicit prejudice as reviewed by *Amodio* (Amodio 2014). In this type of study implicit prejudice is measured by response

time, the participant will be “primed”, by being shown either a white or a black face and then asked to categorize a word as either pleasant or unpleasant. White participant who show implicit prejudice will take longer to categorize an unpleasant word after being primed by a white face, and take shorter to categorize an unpleasant word after being shown a black face (Amodio 2014; Amodio & Devine 2006).

After this initial identification of the involvement of the amygdala in social evaluation more research was conducted to find the exact region of the amygdala, as well as the reasons for this region to be involved in implicit social evaluation over other brain regions. A study using the eye-blink reflex as a measure of fear revealed a greater eye-blink response to black faces as opposed to white or Asian faces (Amodio 2014). This eye-blink response is due to projection from the CeA to the facial motor nuclei, as was shown in a study of the rat brain (Davis & Whalen 2001). The combination of these two studies gives a strong indication for the implication of the amygdala, and more specifically the CeA in implicit social evaluation, here expressed as implicit prejudice.

Certainly, research has not been restricted to the amygdala alone. In a study conducted by *Amodio and Frith* the medial frontal cortex was extensively researched in relation to social cognitive processes (Amodio & Frith 2006). They found that parts of the medial frontal cortex were activated during tasks they called *mentalizing*, these tasks ask participants to infer a third person’s knowledge, rather than making a judgment based on their attributional information such as being white or black, mentioned in the previous studies (Amodio & Frith 2006). Additionally, this same study identifies that the anterior medial frontal cortex is activated in cases where judgments are based on attributional information. This part of the anterior medial frontal cortex is believed to be closely linked to the Amygdala, even going as far as hypothesising that the amygdala has strong inputs into this region of the medial frontal cortex (Amodio & Frith 2006). In this work it is hypothesised that for implicit social evaluation made based on the attributional information of a person, ie. the snap judgment made in first meeting a person, is caused by the amygdala, which then subsequently causes activation of other brain regions such as the anterior medial frontal cortex in the case of higher cognitive processes (Cunningham et al. 2003).

Furthermore, the claim that the amygdala is not just involved in social evaluation, but rather in *implicit* social evaluation is supported by a study conducted by *Phelps et al*, which added a self-evaluative part to the aforementioned study by *Amodio and Davis & Whalen*, here the participants could rate their own bias towards people from the other race. The results of this self-report did not correlate to the eye-blink and response time tests, thus allowing them to conclude that the participants were unconscious of this prejudice (Cunningham et al. 2003). In addition, another study replicated this response, but used not racial prejudice, but fear. The subjects were shown a fearful face, and in spite of reporting not to be afraid a higher activity in the amygdala was shown (Davis & Whalen 2001).

How does implicit evaluation influence behaviour?

The experiments described earlier were meant to show the existence of implicit social evaluation, and its origin in the brain. Another aspect of the research into implicit social evaluation is its influence on the actual behaviour of participants. This research will help determine the influence implicit evaluation has on day-to-day lives.

Firstly, a telling social experiment conducted by *Amodio and Devine* shows the influence of this evaluation on implicit race bias. White participants were firstly asked to complete an implicit association test (IAT test). This test is used to measure the automatic association of mental representations in the memory. In this task a set of words and faces are shown to the participants, who then are asked to categorize the words as either pleasant or unpleasant and the faces as black or white with the use of different keys on a normal keyboard. This test constitutes of different rounds, in some rounds the pleasant words will have to be categorized using the same key as the key for white faces, and the unpleasant words will need to be categorized with the same as black faces, while in the other rounds pleasant words will have to be categorized with the same key as black faces and unpleasant words with the same as white faces. By measuring the latency in the response it is hypothesised that the implicit social evaluation, or bias, is being measured (Amodio & Devine 2006). Later on in a seemingly unrelated task the participants were told they would have to conduct an experiment together with a partner of black ethnicity, without this partner being present they were asked to sit down in a room where their partner's belonging were put on one of the chairs. The distance the participant chose to sit from these belongings was taken as a measure of implicit race bias. In their analysis of the experiment they found that there was a correlation between higher IAT scores and the distance sat from the African American partner. Taking together the previously discussed studies and these findings, indicating that the activity of the amygdala directly influences how friendly one treats a person that has been implicitly negatively evaluated. (Amodio & Devine 2006), since the IAT shows an implicit negative evaluation of people of a different race, which is linked to the amygdala. This activity is then expressed in the distance sat from this fictional person, indicating an inclination to less friendly treatment towards this person.

Building on these findings *Amodio* in his review found that these implicit patterns are learned easily, and are resistant to extinction. (Amodio 2014) This indicates that in a society where prejudices are very normal, that everyone will have trouble ending these implicit evaluations. However, the following research will indicate a mechanism in the brain known as cognitive control, which helps moderating the expression of bias.

Cognitive control is believed to be situated in two areas of the brain; the Anterior Cingulate Cortex (ACC) and the prefrontal cortex. More specifically, the ACC is believed to be the detection centre, and the prefrontal cortex the implementing centre. (Amodio et al. 2004; Greene et al. 2004) Measuring the activity in these areas following IAT tasks shows a significantly higher activity in the ACC after an error in categorizing a tool as a gun after a black face, as compared to after a white face, this is indicative of the cognitive control process at play in the brain, making sure that our bias does not overly influence our behaviour. However, *Amodio et al* also indicate that this process is not fail proof, especially if there is a lack of time, or cognitive resources, ie. a lot of information processing at the same

time, can cause errors in the cognitive control system, allowing the implicit bias to be incorporated in the final judgment (Amodio et al. 2004).

5-HT CONNECTION

So far the Amygdala has been implicated in implicit social evaluation, however the brain is a highly complex organ with one region having multiple functions and neurotransmitters. In the face of this complex organ specificity is of the highest importance. In face of this specificity from here on further focus will be laid on the neurotransmitter 5-HT, also referred to as serotonin. 5-HT has long been indicated in emotional aggression and social behaviour (Crockett 2009). Furthermore, 5-HT is linked to the amygdala, affecting the activity seen in this area. By indication, this means that 5-HT could have an important role to play in implicit social evaluation, since it both influences the Amygdala, which has been shown to be a key area for this process, and plays a role in social behaviour itself.

Moreover, 5-HT plays a role in the startle reflex, or eye-blink reflex as mentioned in the experiments before this is a measure of implicit prejudice, indicating a link between 5-HT and spontaneous implicit social evaluation (Davis & Whalen 2001). Spontaneous is important here, since it lays the foundation for a potential role of 5-HT in the courtroom. In chapter II the concept will be examined by a systematic review of the published scientific papers examining the relationship between pharmacological techniques of 5-HT depletion and enhancement and social evaluation.

CHAPTER II – 5-HT AND IMPLICIT SOCIAL EVALUATION, A SYSTEMATIC REVIEW

INTRODUCTION

Chapter I has tried to identify the link between implicit social evaluation and the amygdala, pointing out that the amygdala is essential in emotional responses, involved in implicit bias. This chapter will evaluate the more specific pharmacological role of 5-HT in these processes in the amygdala. A systematic review of the literature was chosen here in order to maximize the input of relevant scientific information, to minimize selection bias on my part and to structure data acquisition. In addition, there have not been any studies that specifically target 5-HT and implicit social evaluation; the systematic review will allow me to see patterns in the data.

AIM

The aim of this review is to identify the pharmacological role of 5-HT in implicit social evaluation, however there is no data to be found on this, since a pharmacological intervention will lead to more than implicit social evaluation. Since the drugs interventions commonly used are for instance Selective Serotonin Reuptake Inhibitors (SSRI). These drugs are currently used in the treatment of depression and anxiety. The research done on these show that 5-HT can be found in a lot of different places in the brain, involved in different processes. This makes it difficult to discern the observed reaction after application of the intervention between implicit social evaluation in the amygdala and influences from other brain regions. With the background of chapter I, it was therefore decided to not use implicit social evaluation as the outcome, but rather an emotional response. Emotional response is chosen, since it is likely that the introduction of drugs will make the response more radical, implicit evaluations have a basis in emotions, thus making a logical outcome. This is hypothesised to be shown in an emotional response, since emotions are closely linked to social judgments, and would thus provide proof of the concept.

METHODS

Although the main method used here follows the pattern of the systematic review, due to the time constraint a full systematic review was not possible. Instead it will be a 'mini systematic review', which only includes a single database, no follow up with authors, and only English articles (Griffiths 2002). The question in a systematic review needs to be sufficiently precise, for this purpose the PICOS – Patient population, Intervention, Control, Outcome, Study type – system was utilized (Offringa 1999). Furthermore, the search criteria, inclusion and exclusion criteria were established before the search was performed, leading to the following protocol.

What is the emotional effect, as opposed to a placebo, of drugs interfering with the 5-HT pathways in the Amygdala in 25-70 year old males and females, assessed in randomized controlled trials or clinically controlled trials?

- = Patient population

- = Intervention

- = Control

- = Outcome

- = Study types to be included

SEARCH CRITERIA

Biological Psychiatry AND,

Amygdala AND,

Serotonin OR 5-HT

INCLUSION CRITERIA

- 5-HT or serotonin
- patients with neuropsychiatric disorders
- Healthy volunteers given SSRIs or other drugs acting on 5-HT
- Disorders of the 5-HT transmission system
- Outcome: influence on emotions and mood
- Randomized and clinically controlled trials

EXCLUSION CRITERIA

- No intervention with drugs interfering with the 5-HT pathways in the Amygdala
- Other neurotransmitters such as Dopamine or Noradrenaline
- Non-journal articles
- Articles not written in English
- Patient groups not between 25-70 years old

- Drugs that influence other transmitter systems, not the 5-HT transmitter system
- Outcome other than on social evaluation or emotional responses
- Non-randomized or clinically controlled trials

DATA EXTRACTION

The data was extracted from the respective studies using the Cochrane checklist for data extraction, since this has been a trusted source for systematic reviews in the past. [1] This data was then accumulated in a table, making it easy to find the common pattern.

RESULTS

Firstly, the literature search yielded the following results, represented in the following flowchart, modeled after *Liberati et al*(Liberati et al. 2009):

[1] See appendix 1 for the full cochrane checklist for data extraction

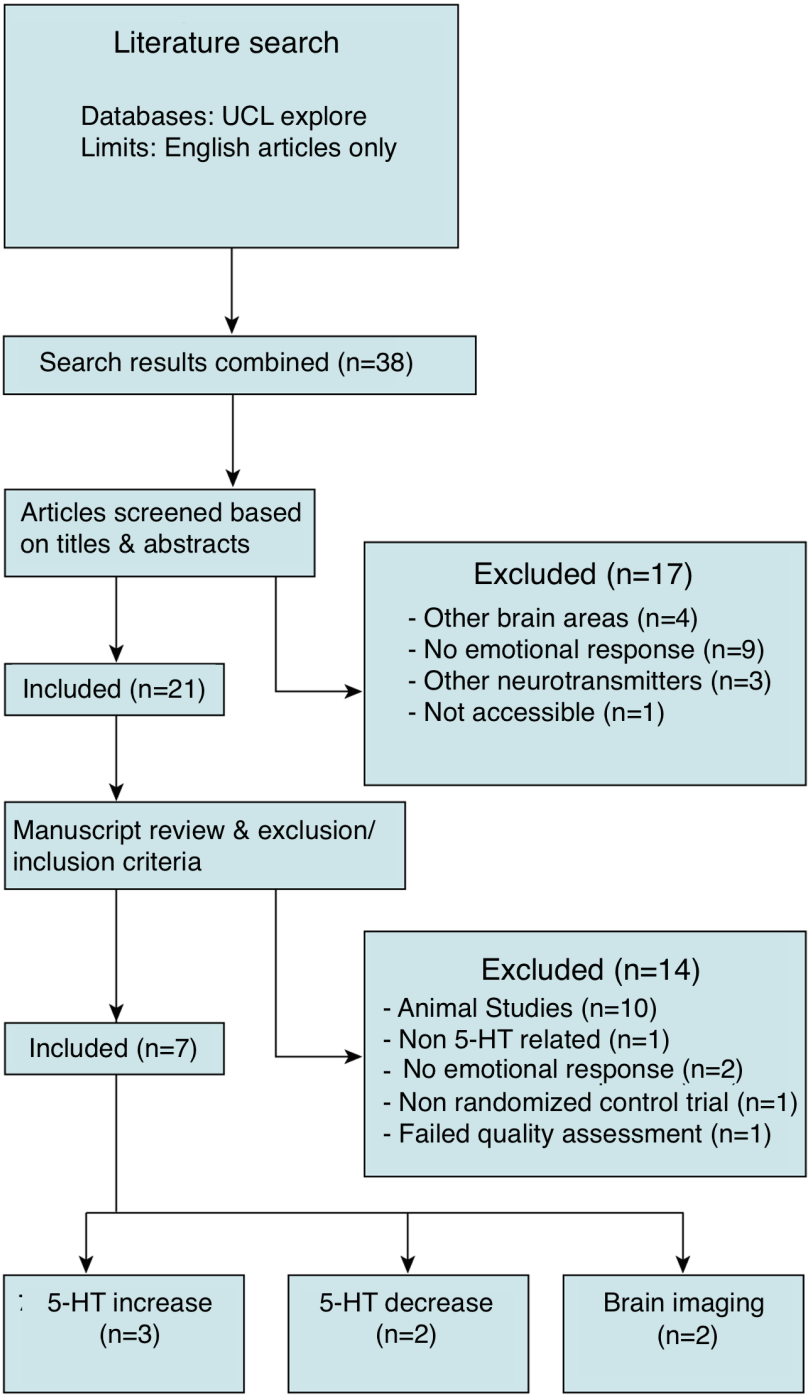

Figure 1 Flow chart depicting the literature search. The final data extraction and analysis was performed on 7 articles.

The search of the UCL explore database gave 38 results, subsequently in the first round only the titles and abstracts were scanned for obvious difference from the question. 17 articles were excluded in this round, on the bases mentioned in the flow chart. In the next round the full text of every article was read, and the exclusion criteria applied to the text, this excluded another 15 articles, most articles were excluded because they involved animals instead of human subjects. This left 7 articles, of which 2 studied an increase in 5-HT in the amygdala, 2 a decrease of 5-HT and 2 studies performed brain imaging. One more article was added based on application of inclusion criteria to the sources of the articles selected. This article fell in the decrease of 5-HT category.

QUALITY ASSESSMENT

It is paramount in a systematic review to include only those studies that meet a certain standard of quality. However, it should also be a consideration that making these standards too high will exclude good data that is also valid (Jüni et al. 2001). In order to find a middle way between this *Verhagen et al* utilized the Delphi method to ask scientists to get a consensus on essential criteria for quality assessment (Verhagen et al. 1998). In this systematic review this list was utilized to assess the quality of studies used, if the answer to more than three questions was no, or if the question "was the patient blinded", was answered in the negative, the study was excluded from this systematic review. [2]Quality assessment was performed on these 7 articles leading to the following results:

The Delphi List	Carhart-Harris et al. 2015	Crockett et al. 2010	Terburg et al. 2013	Passamonti et al. 2012	Yasuno et al. 2004	Lanzenberger et al. 2007	Selvaraj et al. 2015
1.Treatment allocation							
a. randomization	Yes	Yes	Yes	Yes	No	No	Yes
b. treatment allocation concealed	Yes	Yes	Yes	Yes	N/A	N/A	Yes
2. groups similar at baseline?	Yes	Don't know	Yes	Don't know	Yes	Yes	Yes
3. eligibility criteria specified?	Yes	Yes	No	Yes	Yes	Yes	Yes
4. outcome assessor blinded?	Don't know	Yes	Yes	Yes	No	No	Don't know
5. care provider blinded?	Don't know	Yes	Don't know	Don't know	No	No	Don't know
6. patient blinded?	Yes	Yes	Yes	Yes	Yes	N/A	Yes
7. point estimates and measures of variability presented?	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[2] See appendix 2 for the full Delphi List for quality assessment.

The indication N/A was used when the study was for instance a brain imaging trial of patients with and without a psychiatric disorder, since this quality assessment didn't encompass this type of study. This is why the indication N/A was not counted towards exclusion of the article based on its quality, in order not to exclude essential data.

DATA EXTRACTION

Using the Cochrane checklist data was extracted from the 8 final articles and summarised in the following table.