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Is our amygdala responsible for the choice of spine doctor? Pilot study

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Abstract
Behind the choice of a doctor, there is a whole world of neuroscience. The impact of the words on the conscious and unconscious level is underestimated and because of that many doctors are chosen wrongly. In order to estimate the latter impact, we asked 60 subjects who they think is responsible for the spine and to whom they will turn to for surgery. Afterwards we evaluated that not only the questions provoked the activation of different circuits through the amygdala but also a change in the response, concluding that the choice is actually emotion related process with many circuits and mechanisms of interaction. As the recent papers and books show, the operating team of the spine is playing a key role to the final outcome. To this, however, plays also a major role the fact that people do not fully understand the job of their doctor and many of them tend to make their choice based on fear. Understanding this could lead to improvement not only of the general health care but also of the final clinical outcome.

Keywords: Neuroscience, amygdala, spine surgery, emotion

Introduction
Health practitioners and nursing care exist since the beginning of time. The art of medicine is given from generation to generation to provide the humans with care. Since the XIX century, however, this general medical practice began to divide itself into so called "specialties", every one of which has adopted the name of the system that it treats. Currently, this differentiation of the specialties has reached a peak, where almost everyone could become everything. In contrast to the past, where the general practitioner used to manage every disease, nowadays there are plenty of similar specialties, or specialists with subspecialties, fellows etc. on the same subject. This cross-match, however, not only provide a wider range of choices but also an inner conflict of the patients.
Spine diseases are one of those categories that could be managed by many kinds of practitioners. And as the latest researches show [Nikova *et al*. 2018 (book); Nikova *et al*. 2018] [9, 10] the operating team appears to be one of the most important factors for the final outcome of the patients, including their quality of life. This, however, provokes a dilemma among the patients and the population, regarding their complaints. This dilemma, though, is a result of a much deeper mechanisms of consciousness that reveal themselves in such situations [Nikova *et al*. 2018 (book)] [9, 10]. Because of that, the authors decided to make a research, in order to estimate patient's opinion and somehow to evaluate to what extend the brain activity, including consciousness takes part.

Methods
The authors made a randomized cohort study, regarding the spinal cord's disease and the preferred doctor for it. Basic aim is to evaluate the opinion of the people, as it is, and their preference of a surgeon/doctor, and finally, to evaluate the neuroeconomics of the decision.
The patients were elected unsystematically in Alexandroupolis, Greece between 01 June 2018 and 1 July 2018. The participants are asked anonymously to answer a few questions. Besides age, other questions were, who they think is mainly responsible for the therapy of the spine, and to whom they will address their problem, if they have to undergo surgery.
Basic criteria for the participation were "non-doctors", over 18 years old and strictly Greeks.
We chose these criteria for the following reasons. First of all, the authors believe that the "non-doctor" sample would provide honest answers, taking under consideration the fact that they do not have medical education, which reduces the bias of the study. Second, we think that the

mentality of a nation is very serious factor, and in order to have a sample with the same criteria, we chose strictly Greeks. And finally, we chose only adults, considering that they are capable of taking responsibility for their answer.

Results

The randomized results of two months unelective research, include 98 Greek individuals. From those 90, 30 were not Greeks, so they have been excluded. From the rest 68 Greeks, 19 were males and 49 females.

43 of the individuals are in the age category from 18 to 44 and 25 are between 45 and 65 years old.

To the question who they think is mainly responsible for the spine, 29 answered "neurosurgeon", 31 answered "orthopedics" and 8 answered "the both". Because of that, we excluded those 8, and remained only the participants that answered concretely.

From those 60 participants, 17 are males and 43 females. 19 were in the category 45-65 years old and 41 in the category 18-44 years old.

From the 29 with answer "neurosurgeon", 27 will go to a neurosurgeon for spine surgery, while 2 would go to a friend. From the 31 with answer "orthopedics", 20 would go to a neurosurgeon, while 11 would choose an orthopedic surgeon. (Diagram 1)

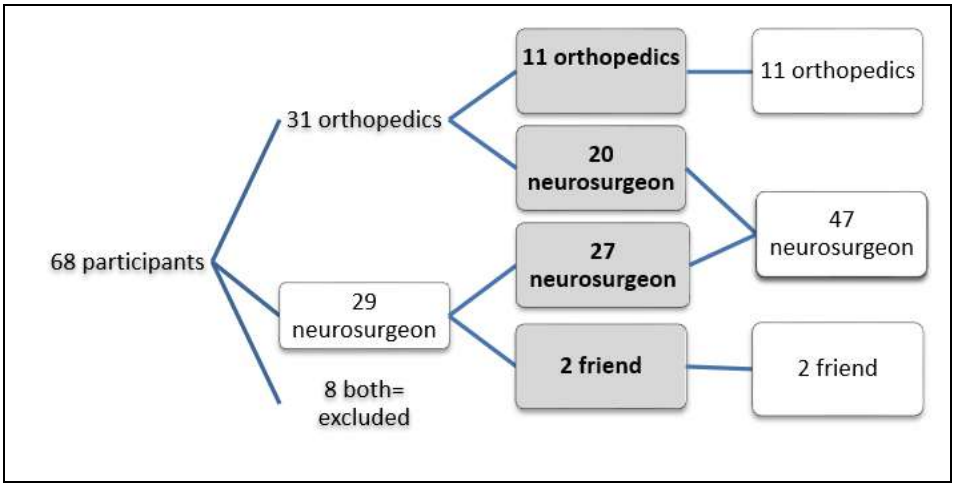

Diagram 1: Visualization of the results

Final results suggest that from the 60 participants, 47 would go to a neurosurgeon for spine surgery, while only 11 would go an orthopedic surgeon. And 2 would go to a friend. Other factors, as it could be seen, is the friendship with the doctor. (Figure 1)

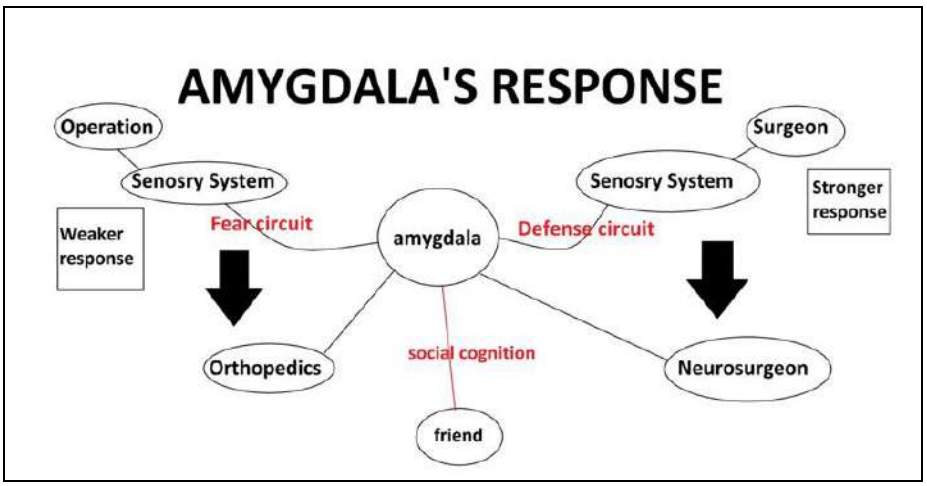

Fig 1: Amygdala's response

Revealing the consciousness, actual part took the questions. With the first question we stimulated the fear circuit and with the second – the circuit of defense. Apparently, the circuit of defense, combined with fear has very strong response and induces change in the response. Furthermore, during the research, some of the participants reveal their fear of the neurosurgeons. It stems mainly from the word "-surgeon". And most of the patients fear that the attendance of neurosurgical cabinet would lead them immediately to surgery, while the orthopedics, mainly as word, does not provoke such stress. Moreover, the participants think of the orthopedists as general practitioners and are more inclined to address firstly their problem to them, in order to avoid the "operation". When, however, surgery is required, the participants would go to a neurosurgeon, because of the security that they feel. The security is experienced mainly through the word, revealing more experience and knowledge.

Considering the group that chose finally a friend, the neuroscientific data (Frith, 2007) [3] reveals that the amygdala is a center of social cognition that has parallel connections to other important brain centers. And probably these individuals had an activation of more centers included in the social cognition during the questionnaire that helped making a final decision.

Discussion

Human mind has the ability to make categories. Moreover, everything that happens is detected on a first place from the senses, analyzed by common features and placed in the memory in groups. Our experiences shape categories and when we experience something new, for example watch a movie or listen to a story, this brand new information is categorized based on our previous experience or already established stereotype. This could be explained detailed, if we image how the events are stored in our working memory. As working memory region we think of the prefrontal cortex and part of the limbic system (Carter, 1998) [2]. The information, as it is determined, is stored in the working memory, but it could constantly correlate with the short- and long-term memories, which, on the other hand, correlate constantly with other domains, such as the amygdala.

During the years, the profession and people's work is categorized, for example: an accountant is associated with boring personality, a scientist on the other hand is associated with strange behavior and introversion as a personality trait. The surgeon as a profession is connected in the people's conscious with operations, scalpels, pain and sometimes death. That's the reason why the emotional conscious sends us warning signals when we hear this suffix. Sigmund Freud argued that human's conscious experience and action is shaped by emotional and motivational states, of which we are unaware of (Kihlstrom, 1998; Stepansky, 2003) [4].

According to a study made by (LeDoux, 2003) [5] the sense of fear is triggered in the limbic system of the brain, and more concrete in the amygdala. Furthermore, this sense is triggered involuntarily, given the thought that it could not be learned. Amygdala is also considered as a modulator of fear memory (Packard, 1994). Regarding the response to fear as emotion, amygdala has replaced the hypothalamus and could determine the reaction to threats. And because of its connections with nuclei of the working memory, it could modulate also the awareness of fear (LeDoux, 2003) [5]. In this concept, Pessoa *et al*. (2002) [12] suggested that the activation of the amygdala is concealed when the attention is occupied by something else, while the response to fear is undependable to the attention (Vuilleumier, 2001) [15], which could be concluded in one thing- fear could be provoked unconsciously. Moreover, Pessoa *et al*. (2002) [12] linked this activation of the amygdala to routines rather than single occurences. As we mentioned above, habits and stereotypes are learned, so the activation of fear after hearing "surgeon" could be provoked without the awareness of the individual.

Furthermore, the amygdala is linked to the defensive circuit that could be activated without the sense of actual fear (LeDoux, 2003; LeDoux, 2012; LeDoux, 2014) [5, 7, 14]. The circuit of defense, additionally, is thought to be a separate form of cirucuit but when it is activated, the response is believed to be stronger (Mobbs, 2015, Rachman, 1974) [8, 13]. Like this, hearing "operation" the participants not only activated the circuit of defense but also the circuit of fear. They chose in the beginning "the least harmful", but if operation is needed they chose 'the most experienced", in order to provide themselves the best possible care.

Another capability of the amygdala is believed to be its role in the social cognition (Frith, 2007; Bickart, 2014) [3, 1]. As we see in the aforementioned results, two individuals would go to a friend for surgery. Explanation of the process, could be the fact that the amygdala, as a center of emotion, is stimulated by different sensory stimuli and as a nucleus that has many connection with the whole brain, could have activated other regions, responsible for the cognition.

Concluding from this, we believe that choosing doctor for the spine triggers so many circuits, mainly in the amygdala that provoke response of defense and fear, and the final choice is based not on the doctor, but to the belief of every participant, who would be better to "save" him (Figure 1).

Conclusion

The amygdala responses every day to different stimuli in ways, which are far beyond our consciousness. Choosing a doctor for the spinal diseases stimulates actually the circuit of fear, but choosing who is going to operate stimulates the circuit of defense, which appears to be stronger, and because of that, the majority that responded "orthopedics" changed to "neurosurgeon". So concluding to this, the choice of doctor has actually deeper mechanisms than expected, and more complex responses, as it could be seen.

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