SETSCI conference proceedings
SETSCI Conference Proceedings
4 (8), 10-21, 2019

4th International Symposium on Innovative Approaches in Social, Human and Administrative Sciences
November 22-24, 2019, Samsun, Turkey
https://doi.org/10.36287/setsci.4.8.003

ISAS SHS WINTER - 2019

P3b amplitudes differences in ultra-rapid visual categorization task of food and non-food items

Tawhida Jahan[1*+]

[1]Assistant professor, Department of Communication Disorders, University of Dhaka, Bangladesh
[1]Cognitive Science, Technical University of Kaiserslautern, Germany
[*]Corresponding Author and [+]Speaker: tawhida.jahan@du.ac.bd
Presentation/Paper Type: Oral / Full Text

Abstract- P300, especially P3b, the third positive peak with near 350ms associated with occipito-patieto-temporal region of the brain, is mainly responsible for categorization of different objects. So, this study investigates the nature of amplitude and reaction time difference in 'food' and 'no-food' objects categorization task. Object categorization processes were investigated by measuring EEG with event-related potentials (ERP) method while participants were categorizing different 'food' and 'no-food' items. The EEG study of this experiment found no P3b amplitude differences for 'food' and 'no-food' category in the ultra-rapid categorization task. On the other hand, from the behavioral study we observed no significant difference in both reaction time (RT) and error rate (ER) in the above task. The result of this study is consistent with some previous experiments. For example, regarding the reaction, the findings can be compared with VanRullen & Thrope (2001) who also found no significant longer reaction time for 'means of transport' item in comparison with 'animal'. The result of this study can also be interpreted from the perspective of 'coarse-to-fine account' hypothesis (Prass et al., 2013) which indicated that to recognize objects belong to basic level category one needs detail information with sufficient time. Since this study includes ultra-rapid visualization task participants did not get enough time to process objects of two different categories. Hence both reaction time and error rate were not significant in this regard.

Keywords: *P3b, ultra-rapid categorization task, reaction time, amplitudes, error rate, coarse-to-fine account*

1. Introduction

In the brain there appear different cognitive activities to perform livelihood of human beings. More specifically, when human beings execute numerous everyday behaviors, they have to conduct cognitive processing done in the brain. For example, to express and understand speech, to identify parents and relatives from their neighbors and thousands of unknown populations, and to categorize different objects which surround them, cognitive processing in the brain is a must. In fact, it is a difficult task to manually measure how does human brain perform such cognitive activities. So, there already developed a lot of techniques like EEG (Electroencephalography) to record such cognitive functions of the brain. At the same time, in EEG (Electroencephalography) recording, ERP (Event Related Potentials) is extensively used to process and analyze the signals elicited from human cognitive processing. This article highlights the nature of P3b in investigating amplitude differences for food and non-food item categorization.

2. Theoretical Background

2.1 Categorization and brain processing

Categorization is a cognitive processing of the brain which is a very complex mechanism and old as well. It is old because from time immemorial when human beings started to survive on the earth, they had to pragmatically recognize food from non-food, animals from non-animals, grasses from trees and plants to make their life easy and comfortable. At the same time, it is a quite complex cognitive activity in the sense that the number of objects surrounding us are diverse in color, size and quantity. So, certainly brain needs to execute multi-functional and ultra-rapid cognitive process of categorization to identify these. Now the concern is, during categorization what humans' mind exactly do. To answer to such a question, it can be briefly stated that categorization is nothing but a type of mental classification (Ungerer & Schmidt, 2006).

In fact, in the mane of mental classification, the human brain isolates different objects on the basis of similar attributes. For example, the brain possesses an innate ability to categorize a group of objects named animals from its counterparts, since objects identifying as animals contain identical features as well as attributes which non-animals cannot exhibit. Following similar process, human's cognitive process is able to differentiate food from non-food items, vehicles from house and buildings, flowers from fruits and so on. Accordingly, members of identical categories can also be classified as basic, superordinate and subordinate groups. Every healthy human being usually performs such categorization process very fast and rapidly with the help of different brain activities.

2.2 Ultra Rapid visual categorization

Human beings regularly execute such cognitive process of categorization with their visual ability form time immemorial. So, this long-lasting skill has already helped them to rapidly observe and categorize various objects and animals surrounding them. And it happens very rapidly even in a millisecond. In fact, in the visual environment rapidly identifying the objects is nothing but a strong and critical component of visual biological system (VanRullen and Thorpe, 2001). So, according to VanRullen and Thorpe (2001), it has been the system of their survival process. In the literature on brain processing and categorization task there started a number of recent research experiments to investigate how fast humans are able to categorize different visual objects. For example, Thorpe et al. (1996) reported that in a task to identify whether a flashed photograph contains an animal or not, human beings performed it under 400ms, whereas it was done in 280-290ms after stimulus onset conducted in a different study by Fabre-Thorpe et al. (1998). But a trained monkey can do this faster with the reaction time around 250ms. Accordingly, this study also depicted that a monkey was able to categorize 'food' and 'non-food' items with the same speed. And Vogels (1999) conducted a study where two trained monkeys were able to categorize 'tree' versus 'non-tree' objects with the reaction time less than 250ms.

But at the same time, we have to remember that visual cognitive process which is executed during categorizing involves a pattern of brain signals that can be measured by neuroimaging techniques like EEG. We need to remember that visual cognitive process is associated with visual perception of human beings which affects cognitive process of perception, learning, memory etc.

2.3 EEG in a nutshell

The acronym EEG stands for Electro encephalography which was invented by Hans Berger in 1929. EEG exhibits signals which carry information getting from the stimuli that stimulate the brain during cognitive processing (Daliri et al., 2013). Although there have already developed different neuroimaging techniques of brain such as Magnetic Resonance Imaging (MRI), Functional Magnetic Resonance Imaging (fMRI) and Myelin Oligodendrocyte Glycoprotein (MOG); EEG exhibits some advantages. For example, unlike other neuroimaging procedures EEG has excellent time resolution. So, if someone needs to take cognitive activity of the brain of 'very short periods (about hundreds of ms)', EEG is the suitable one (El-Lone et al., 2015: 115). In brain the data collection procedure EEG is more appropriate since it takes low cost in designing experiment (Daliri et al., 2013: 37). Since EEG ignores the restriction of hemodynamic delay appeared in fMRI, it is potential enough to immediately read the brain states (Daliri et al., 2013: 37).

2.4 ERP: A technique to analyze signals of EEG

We need to analyze the EEG signals collected from brain activity with the help of ERP technique. Hence Event Related Potentials (ERP) which was introduced in 1964 is such a method to properly analyze the signals of EEG (Walter et al., 1964).

ERP is a time-locked measure of electrical responses of EEG techniques generated by cognitive functions of brain (Patel and Azzam, 2005). These responses could be created by visual or auditory external stimuli that cause voltage fluctuations in EEG brain signals. In addition, Hruby & Marsalek (2003: 56) have provided three essential technical features of ERP. For example, 1) ERP is used to distinguish the respective cognitive aspect from the evoked potentials (EP); 2) The assumed goal of ERP is to evaluate some of the high-level characteristics of information processing in the central nervous system; and 3) During doing

ERP there is a hypothesis that psychological processes leading to completion of given task are reflected in a measurable change of electric potentials generated by the appropriate neural system.

After all, ERP is an associated method with EEG technique which investigates the nature of brain activity in a given task. It is used to measure the changes of EEG signals during observing stimuli. At the same time, it also investigates time duration of a correct response o the stimuli. So, since ERP provides the researcher a whole picture of the different states of living human brain, it is genuinely called 'an alphabet of brain language' (Daliri et al., 2013: 38).

2.5 P300 of ERP: The late positive component

In the EEG signals ERP technique is frequently used to measure the pattern of human cognitive processes extracted from the activities of perception and selective attention to specific stimuli of human beings. In this regard, the most authentic constituents of ERP are N200 and P300 respectively (Patel and Azzam, 2005). So, we can state that P300 is exclusively associated with cognitive processing of selective attention (Patel and Azzam, 2005).

P300 was first described in the 1960s by Sutton et al. (1965). Sometimes it is also called P3 because it is the third positive wave, or the wave with a 300ms latency. Sutton et al. (1965) also called it as the 'late positive component'. Picton (1992) depicted that P300 wave only occurs if the subject is actively engaged in the task of detecting the target.

From the long-lasting literature of ERP conducted in the 1970s and onwards, we have noticed that there require multiple conditions and features to elicit P300 wave, especially amplitude and latency. For example, Fabiani et al. (1987) reported that the best P300 wave is measured in the peak amplitude relative to a prestimuli baseline and a peak latency relative to the stimulus onset. Concerning localization of electrode in the scalp the P300 is usually done at one electrode location which is typically Cz or Pz. In addition, if the activity of a stimulus occurs earlier at the more frontal location, then P300 wave varies from one electrode to the next. It is worth mentioning that the latency of P300 usually varies according to the nature of electrode localization. For instance, Rodin (1991) stated that, in the measurement, when the information from multiple electrode locations are gathered, it is called "global field power". But regarding P300, such approaches to identifying and measuring cannot be taken into account because multiple process can occur at the time of P300 wave. So, according to Polich (1999), in the task which is done irrespective of the modality, the maximum amplitude of P3 wave can be seen at the parieto-occipital and fronto-central areas of human scalp.

Consciousness and attention are two preconditions to measure P300. For example, Sommer and Matt (1991) mentioned vivid and intense attention to the target leads to the largest P300, whereas tired and preoccupied attention to other matters cause smaller P300.Regarding this, the P300 becomes more prominent when the subject contests trains of stimuli to whom s/he is attending (Picton, 1991). And if the amount of conscious attention is directed to stimulus, then the amplitude of the P300 varies. In the elicitation of P300 perception and motor resources are regarded as two separate entities because P300 is mainly associated with the resources of perceptual kind. In their study Israel et al. (1980) informed that P300 was mainly attached with the resources of the perceptual kind and it was not affected with the increase motor demands of the secondary task.

Some studies on eliciting P300 indicated that the amplitude of P300 varies with the time. This is because the target stimuli presented at rapid time increased larger P300 (Woods and Courchesne 1986). Again, in another study conducted by Verleger and Berg (1991) the amplitude of P300 increased over a sequence of three adjacent target.

Sometimes P300 wave is affected by the variables of experiments. For instance, Picton et al. (1978) mentioned that in their experiment when the stimulus used as feedback stimulus rather than 'just being counted', the amplitude was much larger but there was no change in its latency. Additionally, Picton (1992) reported that in the experiment if there was a complexity in semantic categorization, the latency of P300 increased.

When accuracy is emphasized, the reaction time leads to follow peak latency of P300. At the same time, due to emphasizing the speed, the reaction time occurs well before the peak latency of the P300. The amplitude of P300 wave gets broader in the noise condition than in the "non-noise" condition (Picton, 1991). Accordingly, in scalp distribution there appear widespread P300 the noise condition (Vaughan and Ritter 1970). Stapleton & Halgren (1987) stated that P300 observed over the right hemisphere was larger than that found over the left. Regarding intracerebral recording, Halgren et al. (1980) confirmed large potentials from electrodes in the hippocampus and amygdala for P300. Finally, Johnson (1992) concluded that the overall scalp distribution of P300 significantly varies in different experiments.

2.6 P3b: the proper P3

Regarding percentage of recording the tasks, there appear two types of P3. These are P3a and P3b. More specifically, P3a occurs near 250ms, whereas P3b appears near 350ms. Squires at al. (1975) and Ruchkin et al. (1990) consider these two positive waves overlapping P300 latency range as two different components because these are the sources of controlled and observable variabilities (Donchin et al., 1978). In addition, Hruby & Marsalek (2003) assume P3b as proper P3 wave since this happen in 20 to 60 percent of recording the task. Accordingly, some research experiments identify P3b as the symbol of memory storage that serves as a link between stimulus characteristics and attention (Näätänen, 1990). So, P3b wave become larger during the task of attention.

In terms of scalp distribution, it has already been mentioned that the amplitude of P3 wave can be seen at the parieto-occipital and fronto-central areas. So, according to Picton (1992), both P3a and P3b are frontal, and another slow wave of this positive component of ERP appears in the parietal area. Considering the above aspect, it can be firmly stated that the maximum amplitude of P3 wave occurs at the Pz electrode site (Hruby & Marsalek, 2003). At the same time, different ERP experiments on objects categorization support the view that Pz appears to be sensitive to objects identification hence category specification.

3. Literature review on the aspects of categorization

In the recent literature of ERP there have already appeared many research experiments which investigated the nature of the categorization of different objects surrounding us, especially food and non-food, animals, landscapes etc. The main research findings of some of these representative studies can be stated here with a view to getting the basic nature of ERP experiment of object categorization.

3.1 Behavioral study on categorization

Prass et al. (2013) conducted a study to investigate which category give rise to better performance - animate or non-manipulable animate. The result of behavioral data shows a very sharp dominance of superordinate level over the basic as well subordinate level in human categorization process. It is worth mentioning, that according to the taxonomy of categorization (Ungerer & Schmidt, 2006), the members of a category which shows more general features and attributes called superordinate level, whereas level exhibiting generic recognizable gestalts are identified as basic category. For this reason, superordinate level was more different than the basic level. At the same time, the visual characters of superordinate category were prominent than that of basic and subordinate.

In their study Batty & Taylor (2002) conducted both behavioral and ERP study to explain animal/nonanimal visual categorization. In this study the subjects were 48 children (7-15 years of age) and 14 adults. The behavioral data showed that average percentage of correct response was 98.78%, and the task performance of both children and adults was identical. But reaction time decreases with age.

Ragusa et al. (2016: 77) conducted an experiment to scale 'the main deep-learning-based representations on the task of food vs non-food images classifications'. The task was to discriminate between food and non-food images as a classification problem. The result concludes that the accuracy was 94.86% and the performance was balanced with regard to both food and non-food classes.

3.2 EEG study on categorization

In an EEG study El-Lone et al. (2015) investigated the nature of object recognition, especially distinguishing animals from objects and identifying the topographic map in the brain. In this study they found that during animal categorization there appeared high activation in the bilateral occipital zone, whereas for object recognition the only occipital zone was more activated.

Daliri et al. (2013) conducted an EEG experiment to get the differences between ERP of target/rest and target/non-rest signature of signals. The result indicated that for the ERP of target task which was compared with the rest time, the most involved electrodes occurred in F3, F4, C3, C4, Fz, Cz. On the other hand, in the condition of target/non-rest, for target stimuli two positive peaks appeared about 400ms and

250ms after stimulus onset, and in non-target stimuli only one positive peak occurred about 400ms after stimulus onset. In the context of reaction time, flower category had lowest reaction time, and stationery category showed the maximum one. In fact, this study gets different activation areas in the brain scalp.

VanRullen & Thrope (2001) conducted a study to examine the nature of categorization on the basis of the presence and absence of a clearly artificial category. This ERP study has shown that human beings can successfully distinguish complex categorization in less than 250ms. They can similarly perform 'animal' and 'means of transport' tasks. And for the later task there was no significantly longer reaction time.

In their study Ghosh et al. (2015) investigated the cognitive function of the brain in the task of memorizing and categorizing an object from the list of similar one. In this experiment the EEG signals were extracted when subjects performed cognitive task of memorization and categorization of objects. The result indicated that classification accuracy of the subjects was above 79%. Accordingly, they found that memorization task signaling at the frontal and temporal lobes, whereas during object recognition task signals from temporal and parietal lobes were dominant.

Zhu et al. (2016) conducted a study to investigate whether human beings possess the capability to categorize complex natural scenes that exist when they are unaware. In this study ERPs were recorded during the task of recognizing animal and nonanimal/vehicle stimuli in both aware and unaware conditions maintaining Chronic Fatigue Syndrome (CFS) paradigm. The result stated that the brain responded differently to animal and nonanimal/vehicle images even in the unseen conditions.

Rutters et al. (2015) conducted an EEG experiment to identify the neural representation of food and non-food items in the working memory of the brain. the result shows that compared to non-food items P3, Late Positive Potentials (LPP) and System Power Control Network (SPCN) were larger when food was memorized. In also indicated that food items are strongly represented in the working memory.

4. Present Study

From the above literature it has been firmly established that P3, especially P3b- the third positive wave of EEG signal with near 350ms- is mainly responsible for categorization of different objects. But different recent studies indicate that the role P3b in object categorization for 'food' and 'no-food' have not been fully investigated. At the same time, in the experiment Donchin et al. (1986) found that P300 is observed by the task which involved working memory. More specifically, since P3b become larger during the task of attention and it reflects the memorization processes (Hruby and Maralek, 2003), it is potential enough for the task of object categorization. At the same time, by giving insight into the underlying mechanism of the brain activity, we can take a look at the role of ERP (P3b) in object categorization for 'food' and 'no-food' by measuring the electrode location at Pz with the peak latency range 350-500ms (*See Fig 1*).

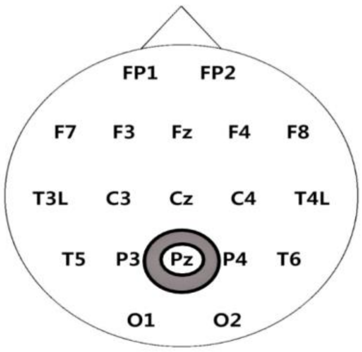


Fig 1: Pz scalp distribution of ERP

Considering such proposition, we assume that in the categorization task of 'food' and 'no-food' there will be different amplitude in P300 and reaction time wave in the scalp distribution. So, the present study aims at investigating the nature of amplitude and reaction time difference in 'food' and 'no-food' objects categorization task experiment. Accordingly, the above assumption as well as aim gives rise two hypotheses for behavioral and ERP recording. These are as follows.

a. Hypothesis for behavioral data

We hypothesized that in the behavioral data, there will be significant difference in reaction time (RT) and error rate (ER) between food and no-food.

b. Hypothesis for ERP recording

In the ERP study the grand average of P3b amplitude in the Pz location for 'food' will differ significantly in comparison with 'no-food' items.

5. Method

5.1 Participants

Total 8 participants took part in the experiment. They were students of Technical University, Kaiserslautern. Among these students 5 were males and 3 females. The age range of the participants was 18 to 30 years, hence mean age was 25.2 years. They were all right-handed, vision was normal or corrected-to normal. They reported to the researcher that they had no any psychological or neurological disorders. So, there was no apparent reason to exclude any participant from the experiment. But one of them was excluded since s/he performed very high error rate which was 87.3%.

5.2 Stimuli

Stimuli consisted of 1600 different color pictures taken from different website (like Google) which had no copyright restrictions. Where 50% category were animal and food. Among these pictures different 'food' and 'no-food' pictures were used for present study . In the 'food' category different types of basic food items like cookies, cake, ice-cream, various fruits were selected (*See Fig 2*). On the other hand, 'no-food' category includes drum, fork, piano, blender, calendar and so on (*See Fig 3*).

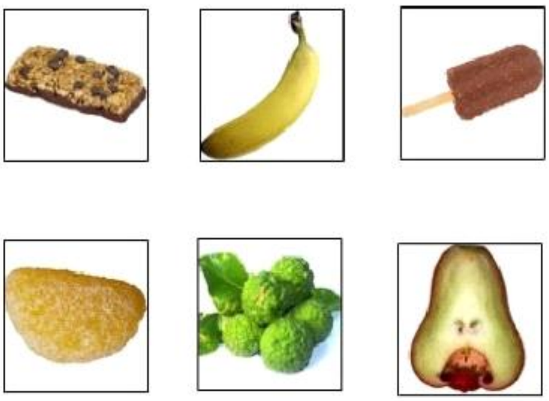


Fig 2: Different 'food' items

Fig. 3: Different 'no-food' items

5.3 Task and Procedure

In this experiment two different category-levels were examined, namely 'food' and 'no-food' items. And the task followed in this experiment was an ultra-rapid visual categorization task. In this task participants had to decide a shown stimulus belonged to food category or not. They had to push the button in response to the 'yes/no' question like 'Does the belong to the food category?

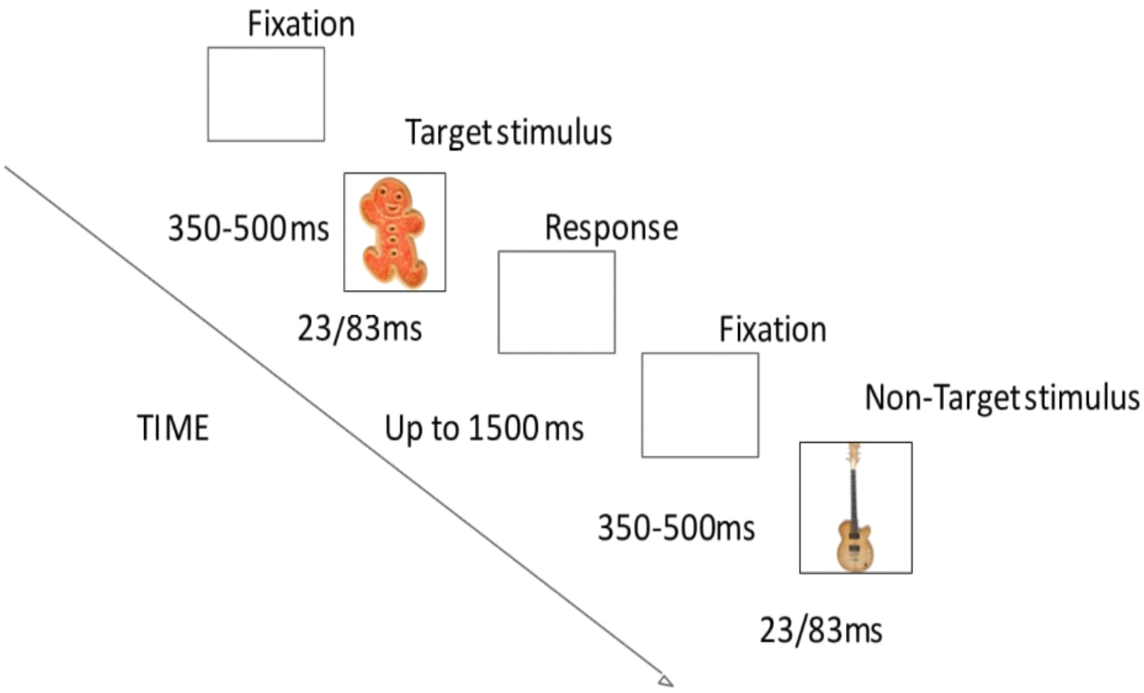


Fig 4. Stimulus presentation

These stimuli were presented randomly with 23ms and 83ms and centrally with a size of 3 x 3 degrees visual angle. During presentation there was a break every after 100 trials. Thus, the overall task and procedure of this experiment can be visualized in the above figure (*See Fig 4*).

5.4 EEG data acquisition conditions

For collecting EEG data Brain Vision amplifier was used. The data was recorded using 32 cap-mounted electrodes (by Easy CAP GmbH; EEG Recording Caps and Related Products) with eye electrodes. There was no bandpass filter. In this study the grounding was on the forehead (Afz) and reference was on the position of FCz. Grounding and reference were lower than 2 KΩ where other electrodes were 10 KΩ or less in impendence.
In the recording section there was a 14 inches VGA color monitor computer which was synchronized with the monitor retrace rate of 60 Hz. The software used in stimulus presentation and data collection was Presentation Software (Version 18.0, Neurobehavioral Systems, Inc., Berkeley, CA).

5.5 Data Analysis

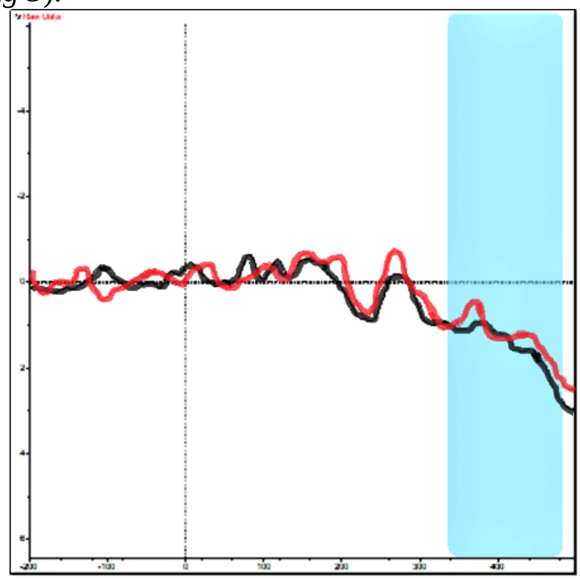
Before processing EEG data there was a pre-processing stage where Brain Vision Analyzer software was used. Every single data was manipulated to EEG correction procedure with a view to rejecting any remaining artifact. Before artifact rejection we inspected raw data set for physical artifacts. Then average of M1, M2 channels were used as new reference. Here filter criteria were- low cut off: 0.5hz,0.3133099s, order 4; high cut off:30hz, order 4 respectively. In linear derivation, we generated new channels from linear combinations of existing channels and calculated from coefficients. After that, influence of eye movements on the EEG eliminated in Ocular correction stage. Semiautomatic default setting was kept here (common reference-VEOG, HEOG; channels: disable eye and M1/M2; data used for ICA: interval, lenth:150s, bad interval free: 150s). Besides that, in segmentation data set divided into time sections of the same length. Moreover, baseline of every segment (-200.00 ms to 0.00 ms) was adjusted respectively. Finally, segment with artifacts removed in artifact rejection stage (all channel except eyes and M1/M2).

After prepressing EEG data, statistical software SPSS was used for statistical analysis. The EEG data trials were averaged by category (‘food’ and ‘no-food’). In this process the trials with incorrect behavioral response were eliminated. The component of Pz were measured on the basis of electrodes where the maximum amplitudes gathered. The mean area amplitudes were measured from pre-stimulus baseline, whereas the reaction time (RT)(latencies) were counted from stimulus onset, and error rate was found from the performance rate of every participants. To count the data gathered from amplitudes, and RT and ER paired sample t-test was used.

6. Result

In this study we have investigated the role of ERP (P3b) in object categorization for ‘food’ and ‘no-food’ by looking at the electrode location at Pz with the peak latency range 350-500ms. So, here we measured the nature of amplitudes for the categorization tasks of two above conditions. Accordingly, we counted the difference in reaction time (RT) and Error rate (ER) observed in these two conditions.

First of all, the P3b wave amplitude for food (black line) and No-Food (red line) condition is given below (*See Fig 5*).



P3b in Pz

Fig 5. P3b amplitude differences by target stimulus ‘food’ vs ‘no-food’

6.1 Behavioral Study

In the behavioral task we have investigated the differences in reaction time (RT) and error rate (RT) between the categories ‘food’ and ‘no-food’. But, interestingly no significant difference was found in reaction time (RT) for ‘food’ and ‘no-food’ categorization (mean RT Food = 494.31, SD= 36.13; mean RT No Food = 481.64, SD= 62.87; Paired T-test (RT Food*No Food: t (6) = .860. p= <0.423) (*See Fig 6*).

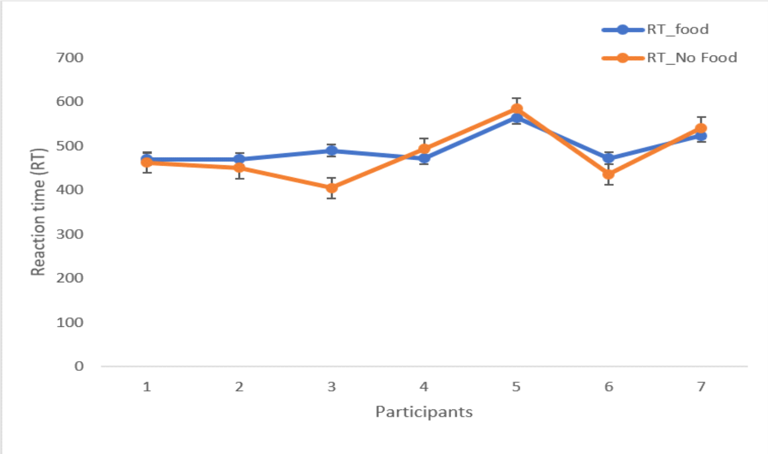


Fig 6. Difference in RT for 'food' and 'no-food'

At the same time, the identical result was found in error rate too. It indicates that no significant difference was found in error rate (ER) for 'food' and 'no-food' categorization (mean ER Food = .1506, SD= .0981; mean ER No Food = .0769, SD= .0206; Paired T-test (ER Food*No Food: t (6) = 1.965. p= <0.097) (*See Fig 7*).

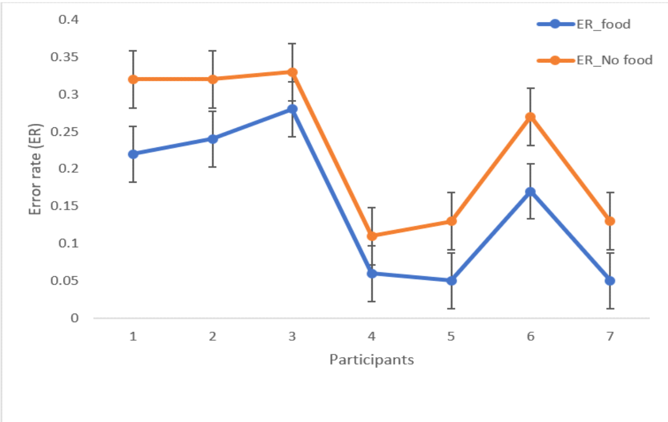


Fig 7. Error Rate difference for 'food' and 'no-food' items

The overall results of both ERP study and behavioral task indicate that-

a. There is no P3b amplitude differences for 'food' and 'no-food' category in the ultra-rapid categorization task.
b. Significant different is not observed in reaction time (RT) and error rate (ER) between 'food' and 'no-food' in the above task.

6.2 ERP Study

In the ERP data analysis, we have measured the average of P3b amplitudes in the Pz location or both 'food' and 'no-food' conditions. The result showed positivity in 350ms to 500ms, but there was no significant difference found for 'food' and 'no-food' items (mean PzAvg Food = 1.4764, SD= 2.4213; mean PzAvg No Food = 1.3202, SD= 1.6293; Paired T-test (PzAvg Food*No Food channel: t (6) = .340. p= <0.746) (*See Fig 8*).

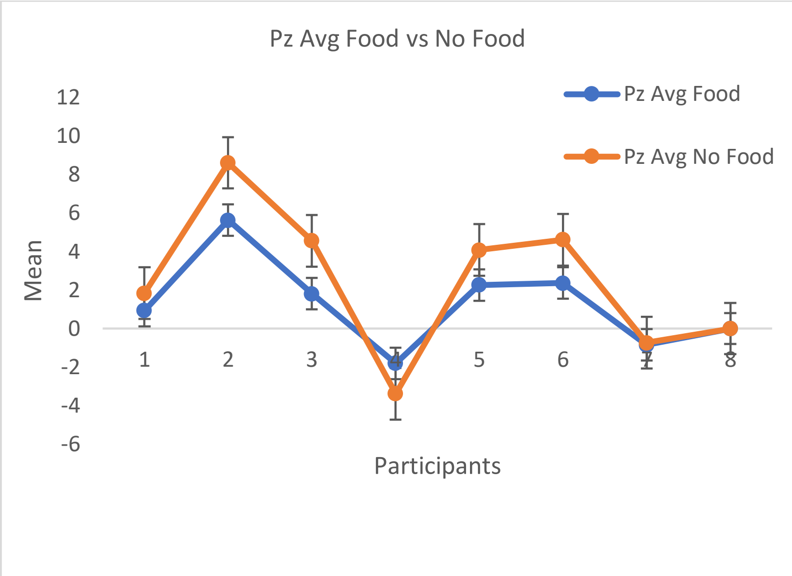


Fig 8. Pz average for ‘food’ and ‘no-food’ condition

7. Discussion

In this experiment we have investigated the nature of difference in reaction time and error time between ‘food’ and ‘no-food’ items performed by healthy subjects. At the same time, we also measured P3b amplitudes seen in these two conditions. But the result we observed did not support the hypotheses of both behavioral task and ERP study. This is because in these two tasks we did not find any significant difference in either P3b amplitudes or in reaction time and error rate during the task of categorizing objects such as ‘food’ and ‘no-food’.
The results of this experiment can be explained from different point of views. First of all, in the EEG study we observed that compared to other electrodes there were larger amplitudes in the P3b wave components observed in Pz scalp distribution for both ‘food’ and ‘no-food’ categorization task. It is worth mentioning that Pz scalp distribution of ERP measurement is highly associated with occipito-temporo-parietal lobe of the brain. This result is supported by Ghosh et al. (2015) because in their study they found that during object recognition task signals from temporal and parietal lobes were dominant. We need to remember that food and no-food categorizing task is a kind of object categorization task. So, in this regard this result is also supported by El-Lone et al. (2015) too. This is because in their study El-Lone et al. (2015) stated that for object recognition occipital zone of the brain was more activated. This finding can also be explained by Rutters et al. (2015) who found strong representation in the working memory for food items.
Secondly, in the behavioral study we have found no significant difference both in reaction time (RT) and error rate (ER) in the context of ‘food’ and ‘no-food’ object recognition. This result is also supported by Ragusa et al. (2016) who conducted a study to scale the task of food vs on-food image classifications. The result of their study showed that for both food and non-food classes the accuracy rate was 94.86%. In fact, there was a healthy balance in this regard, since the performance of the participants for both categories was almost identical.
Thirdly, the identical reaction time of this study for two different objects like ‘food’ and ‘non-food’ can be interpreted by VanRullen & Thrope (2001) who also found no significant longer reaction time for ‘means of transport’ item in comparison with ‘animal’. In terms of category specification, this result can also be applicable to the present study. Although ‘transport’ and ‘animal’ belong to two different categories no significantly longer reaction time was not observed for either of the category in the above study conducted by VanRullen & Thrope

(2001). Accordingly, the present study reflects the identical result for 'food' and 'no-food' items of two separate categories.

Now a question can easily be raised about the result of the behavioral task of this experiment. Since the subjects of this study performed two different items like 'food' and 'no-food' in categorization task, why the differences in reaction time and error rate were not significant? In fact, the underlying cause of this result can be interpreted from the 'coarse-to-fine account' hypothesis (Prass et al., 2013). Put elaborately, in their study Prass et al. (2013) included the 'coarse-to-fine' hypothesis which states that we need coarse or common information if we want to perform global image features like objects of superordinate category ('animal'). On the other hand, detail finer perceptual information is essential to recognize objects belong to basic level category ('cat'). From this hypothesis it is indicated that to recognize objects belong to basic level category one needs detail information which needs sufficient time.

Our critical observation confirms that all color pictures selected in this experiment for 'food' and 'no-food' are classified as objects of basic level. In this sense objects belongs to these two different categories carry a similarity approach. So, to recognize or identify these pictures of both 'food' and 'no-food' categories there needed finer information with enough time. But since the present study included ultra-rapid visualization task, according to Prass et al. (2013) and Mace et al. (2009), participants of this experiment got limited processing time to perfectly isolate these two different objects categories. So, they performed more error rate for both category 'food' and 'no-food'. In fact, due to constraint of time there disappeared the advantage of basic level category hence participants performed both 'food' and 'no-food' items with almost identical speed and rate. For this reason, we did not find significant differences in reaction time and error rate in these two object categorization tasks.

8. Conclusion

Categorization of objects is part and parcel of our daily living activities. Since we are surrounded by various types of items and objects, no other way, we are to regularly categorize them. Among these categorization process ultra-rapid categorization task is the important one (VanRullen and Thorpe, 2001; Prass et al., 2013; Li et al., 2002). This is because we need to identify the objects moving around us as a part of our survival process. From this study we have learned that different objects like 'food' and 'no-food' are processed in the P3b ERP component wave which includes the occipito-temporo-parietal lobe of the brain. At the same time, it is also observed that compared to the objects of superordinate category, objects confined to the basic level require extra time to recognize because of requiring finer perceptual information. But if there a constraint of time during processing, the primacy of basic level category gets diminished and objects belong to different categories are processed in the brain with identical amplitudes and latencies.

References

Batty, M. & Taylor, M. J. (2002). Visual categorization during childhood: An ERP study. *Psychophysiology* 39, 482–490

Daliri, M.R., Taghizadeh, M. & Niksirat, K.S. (2013). EEG signature of Object Categorization from Event-related Potentials. *Journal of Medical Signals & Sensors* 3(1), 37-44

Donchin, E., Ritter, W. & McCallum, C. (1978). Cognitive psychology: the endogenous components of the ERP. In Callaway, E, Teuting P, Koslov S. (eds.). *Brain event-related potentials in man*. New York: Academic Press, 349-441

El-Lone, R., Hussan, M., Kabbara, A. & Hleiss, R. (2015). Visual objects categorization using dense EEG: A preliminary study. *International Conference on Advances in Biomedical Engineering (ICABME)*, 115-118

Fabiani, M., Gratton, G., Karis, D. & Donchin, E. (1987). The definition, identification, and reliability of measurement of the P300 component of the event-related brain potential. In Ackles PK, Jennings JR, Coles MGH (eds.) *Advances in psychophysiology*, vol.2. Greenwich, CT: JAI Press, 1-78

Fabre-Thorpe M, Richard, G. & Thorpe, S.J. (1998). Rapid Categorization of natural images by rhesus monkeys. *Neuroreport* 9, 303-308

Ghosh, P., Mazumder, A., Bhattacharyya, S., & Tibarewala, D.N. (2015). An EEG Study on Working Memory and Cognition. 21-26, Retrieved on 10 June, 2018 from http://dx.doi.org/10.1145/2708463.2709065

Halgren, E., Squires, NK., Wilson, C., Rohrbaugh, JW, Babb TL, & Crandall PH. (1980). Endogenous potentials generated in the human hippocampal formation and amygdala by infrequent events. *Science* 210, 803-805

Hruby, T. & Marsalek, P. (2003). Event-Related Potentials – the P3 Wave. *Acta Neurobiol. EXp.* 63, 55-63

Israel, JB., Chesney, GL., Wickens CD. &Donchin E. (980). P300 and tracking difficulty: evidence for multiple resources in the dual-task performance. *Psychophysiology* 17, 259-273

Li, F.F., VanRullen, R., Koch, C. & Perona, P.(2002). Rapid natural scene categorization in the near absence of attention. *PNAS*, vol. 99(4), 9596-9601

Mace, MJ., Joubert, OR., Nespoulous, J.& Fabre-Thorpe, M. (2009). The time-course of visual categorization: you spot the animal faster than the bird. *PloS ONE* 4(6), e5927

Näätänen, R. (1990). The role of attention in the information processing as revealed by event-related potentials and other brain measures of cognitive function. *Behavioral and Brain Sciences* 13, 201-288

Patel, S.H. & Azzam, P.N. (2005). Characterization of N200 and P300: Studies of the Event-Related Potential. *Int. J. Med. Sci.*2(4), 147-154

Picton, T.W. (1992). The P300 Wave of the Human Event-Related Potential. *Journal of Clinical Neurophysiology*, 9(4), 456-479

Picton, TW,. Campbell, KB., Baribeau-Braun, J. & Proulx, GB. (1978). The neurophysiology of human attention: A tutorial review. In Requin, J. (ed.) *Attention and Performance VII*, Hillsdale, NJ: Erlbaum, 429-467

Prass, M., Grimsen, C., König, M. & Fahle, M. (2013). *Ultra Rapid Object Categorization: Effects of Level Animacy and Context*. *Plos One*. Vol. 8 (6), 1-10

Ragusa, F., Tomaselli, V. & Furnari, A. (2016). Food vs Non-Food Classification. *MADiMa'16*, 77-81

Rodin, E. (1991). Latency determination by global field power in normal subjects. *J Clin Neurophysiol* 8, 88-94

Ruchkin, DS., Johnson, R., Canoune, HL., Ritter, W. & Hammer, M. (1990). Multiple sources of P3b associated with different types of information, *Psychophysiology* 27, 157-176

Rutters, F., Kumar, S., Higgs, S. &Humphreys, G. W. (2015). Electrophysiological evidence for enhanced representation of food stimuli in working memory. *Exp Brain Res*. 233, 519–528

Sommer W & Matt, J. (1990). Awareness of P300-related cognitive process: a signal detection approach. *Psychophysiology*, 27, 575-585

Squires, NK., Squires, KC. & Hillard, SA. (1975). Two varieties of long-latency positive waves evoked by unpredictable auditory stimuli in man. *Electroencephalogr Clin Neurophysiol* 8, 387-401

Stapleton, JM. & Halgren, E. (1987). Endogenous potentials evoked in simple cognitive task: depth components and task correlates. *Electroencephalogr Clin Neurophysiol*, 67, 44-52

Sutton, S., Braren, M., Zubin, J & John ER. (1965). Evoked potential correlates of stimulus uncertainty, *Science* 150, 1187-1188

Thorpe, S.J., Fize, D. & Marlot, C. (1996). Speed of processing in the human visual system *Nature* 381, 520-522

Ungerer, F. & Schmid, H. (2006). *An Introduction to Cognitive Linguistics*. Harlow: Pearson Longman

VanRullen, R. & Thorpe, S.J. (2001) Is it a bird? Is it a plane? Ultra-rapid visual categorization of natural and artifactual objects. *Perception*, 30, 655-668

Vaughan, HG. & Ritter, W. (1970). The sources of auditory evoked responses recorded from the human scalp. *Electroencephalogr Clin Neurophysiol* 28, 360-367

Verleger, R., &Berg, P. (1991). The waltzing oddball. *Psychophysiology* 28, 468-477

Vogels, R. (1999). Categorization of complex visual images by rhesus monkeys. Part 1: Behavioral study. *European Journal of Neuroscience 11*, 1223-1238

Walter, WG., Cooper, R., Aldridge, VJ., McCallum, WC. & Winter, AL. (1964). Contingent negative variation: An electric sign of sensorimotor association and expectancy in the human brain. *Nature* 203, 380-384

Woods, DL. & Courchesne, E. (1986). The recovery functions of auditory event-related potentials during split-second discriminations. *Electroencephalogr Clin Neurophysiol*, 65, 304-315

Zhu,W., Drewes,J., Peatfield, N. A. &Melcher, D. (2016). Differential Visual Processing of Animal Images, with and without Conscious Awareness. *Frontiers of Human Neuroscience*, vol. 10, 1-19