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DOES RECOLLECTION OCCUR UNINTENTIONALLY? AN ERP STUDY

DETAYLI HATIRLAMA İSTEMSİZ OLARAK GERÇEKLEŞİR Mİ?

Rahmi Saylik[1*]

Abstract

This study is aimed to investigate whether memories can be recollected unintentionally. To investigate this, electroencephalographic activity (EEG) was recorded from 64 electrodes. Participants performed recognition tasks which consisted of celebrity names in an implicit way. They were asked to decide whether the presented celebrity names were actor/actress or not while event-related potentials (ERPs) recordings were taking place. In the study, ERP results from old names and new names were compared. In this comparison two effects, which were mid-frontal old/new effect (300-500 ms) and parietal old/new effect (500-800 ms), were set. The results show that old names triggered higher activation over a late left lateralized central and left parietal old-new effect (500-800 ms) during implicit task performance. The results indicated that memory can be retrieved unintentionally and this retrieval may be associated with recollection.

Keywords: recognition memory, episodic memory, old-new effect, recollection, familiarity, EGG

Özet

Bu çalışma, anıların istemsiz olarak hatırlanmasının mümkün olup olmadığını araştırmayı amaçlamaktadır. Bunu araştırmak için Elektroensefalografik aktivite (EEG) 64 elektrottan kaydedildi. Katılımcılar, ünlülerin isimlerden oluşan tanıma görevlerini örtük biçimde gerçekleştirdiler. Sunulan ünlü isimlerinden aktör / aktris olup olmadığına, olaya ilişkin potansiyeller (ERP) kayıtları yapılırken karar vermeleri istendi. Bu çalışmada, eski ve yeni isimlerin ERP sonuçları karşılaştırıldı. Bu karşılaştırmada, orta önlü eski / yeni efekt (300-500 ms) ve parietal eski / yeni efekt (500-800 ms) olan iki efekt belirlendi. Sonuçlar, eski adların örtük görev performansı sırasında sol yanal merkezli ve sol parietal eski-yeni efekt (500-800 ms) üzerinde daha yüksek aktivasyona neden olduğunu göstermektedir. Sonuçlar daha önce hafızada kaydedilmiş bilginin istemsiz olarak geri getirilebildiğini ve bu geri getirme durumunun detaylı hatırlama ile ilişkili olabileceğini gösterdi.

Anahtar Kelimeler: *tanıma belleği, olaysal bellek, eski-yeni etkisi, hatırlama, aşinalık, EGG*

[1] Department of Life Sciences, Brunel University London, Uxbridge, UK
[*]Corresponding author: Division of Psychology, Department of Life Sciences. Brunel University London, Uxbridge, UK E-mail: rahsay@hotmail.com

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1. Introduction

Recognition memory refers to remembering previously encountered episodes such as events, people or objects (Cruse & Wilding, 2009; Wilding & Ranganath, 2011). It is known that recognition memory is divided in two memory retrieval processes which are recollection and familiarity (Leding, 2015; Park & Donaldson, 2016). Recollection is defined as the retrieval of information with details related to a certain episode such as remembering a name with the other descriptive contexts such as face, occupation or an event including information when or where the event took place (Cruse & Wilding, 2009; Wilding & Ranganath, 2011). On the other hand, familiarity indicates a more superficial retrieval of memories (Bruett & Leynes, 2015; Topolinski, 2012) because it is described as a subjective feeling that certain stimuli (e.g. event, people, objects) may have been encountered in the past, but certain details about the first occurrence of that episode cannot be retrieved (Mandler, 1980; Tulving, 1985; Yovel & Paller, 2004). In a classic example, Mandler (1980) could not recognise his butcher when he saw him on the bus because the butcher was in a completely different context (i.e. butcher on the bus phenomena). The context of the bus was not related to the unit in which the butcher's identity was coded because Mandler had coded the butcher's identity in the context of the butcher's shop (Yovel & Paller, 2004).

One distinctive way to investigate neural correlates of recollection and familiarity in the concept of recognition memory is event-related potentials (ERPs) (Hoppstädter, Baeuchl, Diener, Flor, & Meyer, 2015; Wilding & Ranganath, 2011). ERPs are a particular electroencephalography (EEG) method which allow to determine the specific brain waves that have occurred during the experience of certain events, such as during presentation of a name or face. A considerable number of studies explored the ERP correlates of recollection and familiarity by relying on a phenomenon known as the old/new effect i.e. successful discrimination whether an item previously has been presented before (old) or it is has been just newly presented (new) (Hoppstädter et al., 2015; Wilding & Ranganath, 2011). In more detail, in a typical old/new effect investigation there are two main phases which are testing and study phases (Topolinski, 2012; Wilding & Ranganath, 2011). While in the testing phase participants are presented a set of stimuli (e.g. images or names), in the study phase the set of stimuli in the testing phase has been intermixed with new stimuli (e.g. new images or names) and then participants are required to decide whether the stimulus has been seen in testing phase or not (Boehm & Sommer, 2005; Hoppstädter et al., 2015). If they remember that they saw the stimulus previously, they press an employed button which indicate 'old' and if they think they did not saw the stimulus in the testing phase then they should press another employed button which indicates 'new' (Boehm & Sommer, 2005; Hoppstädter et al., 2015).

Numerous experiments on item recognition have indicated that classification of retrieval ERPs depends on a comparison of old/new judgments (Bruett & Leynes, 2015; Leding, 2015; MacKenzie & Donaldson, 2009; Park & Donaldson, 2016). 'Old' responses refer to recollection meaning that recognition is followed by recalling particular details of the related study episode (MacKenzie & Donaldson, 2009). 'New' responses indicate recognition without a detailed memory and therefore they are assessed on the basis of familiarity (MacKenzie & Donaldson, 2009). A numbers of studies have found that generally recollection is associated with the mid-parietal lobe between 500 ms to 800 ms whereas familiarity is associated with prefrontal lobe activation which occurs between 300 ms to 500 ms (Boehm & Sommer, 2005; Cruse & Wilding, 2009; Wilding & Ranganath, 2011). However, there is still no consensus whether familiarity and recollection should be assessed as a component of implicit memory (i.e. unintentional recollection of memory episodes such as past experiences, and events) or explicit memory (i.e. intentional recollection of memory episodes such past experiences, and events)(Boehm & Sommer, 2005). One view suggested that the course of recollection primarily relies on intentional retrieval which means it occurs explicitly and that familiarity takes place unintentionally/implicitly (Boehm & Sommer, 2005; Boehm, Klostermann, Sommer, & Paller, 2006). However, another view proposed that recollection can take place both intentionally/explicitly and unintentionally/implicitly (Park & Donaldson, 2016; Topolinski, 2012).

The aim of the current study is investigating the process of recognition during unintentional encoding and retrieval using ERPs old/new effect method. To test this, neural correlates of recollection and familiarity in an implicit task were investigated while ERP activities were recorded from 64 electrodes in each participant. In contrast to typical old/new effect studies i.e where participants are required to assess whether they remember the stimuli or not as an explicit task (Wilding & Ranganath, 2011), in the current study participants were presented names of well-known celebrities and they were required to decide whether the image is an actor/actress or non-actor/actress so that the task was performed implicitly. In the study phase, the celebrity names were intermixed with a new set of celebrity names and then participants were asked to decide again whether the presented name is an actor/actress or non-actor/non-actress.If the old/new phenomenon occurs, then participants encode and retrieve the previously presented stimuli unintentionally/implicitly (Boehm et al., 2006).

Therefore, ERP recordings between 300 and 800 ms which includes mid-frontal old/new effects (300 ms to 500 ms) and parietal old/new effects (500 ms to 800 ms) were evaluated (Cruse & Wilding, 2009; Wilding & Ranganath, 2011). It has been suggested that ERP studies which are recorded from the human brain can provide an efficient time course of neural events using recognition memory tests between 300 and 800 ms after stimulus onset (Cruse & Wilding, 2009; Wilding & Ranganath, 2011). The hypothesis to be tested is that participants will recollect old names faster and more correctly than new names and at the same time greater electrophysiological activities will occur in the range of 500-800ms over parietal sites for old names compared with new names.

2. Materials and Methods

2.1. Participants

Thirty-two undergraduate students (15 male, 5 left-handed, 3 non-British, mean age 21 years, age range 18 to 41 years) from the Psychology Department of Bangor University were recruited. The experiments were approved by the Psychology Ethics Committee of Bangor University. All the non-British students have been living in the UK for at least three years and familiar with British culture. Also, none of the students were dyslexic. All of the participants were given course credits, as well as £15 or library credits. Before participation each participant gave written informed consent.

2.2. Stimuli and Procedure

The study consisted of four phases. The first phase was an eye calibration task including an arrow showing different directions. The eye calibration test consisted of five sections. The partipants must look at the direction of the arrow. Following that they must look at the screen and blink.

The second phase consisted of a name recognition task, e.g. the testing phase (Figure 1). The task included names of celebrities who are very well-known by public (i.e. George Bush, Bradd Pitt, Angelina Julie) ranging from 2 to 4 words. All of the names were randomly presented in white against a black background, measured 1 cm vertically and 3 to 11.5 cm horizontally for 600 ms. Names were presented centrally and the viewing distance was set to 50 cm. Participants were asked to press the letter J with their right hand as quickly as possible if they remember that the name belongs to an actor or actress; otherwise, they were asked to press the letter F as quickly as possible. In the study phase, each name was followed by a 0.5 cm × 0.5 cm white fixation cross for 1900 ms.

The third phase was an object recognition task which consisted of upright and up-down objects and was used as distractor In this phase, objects were presented randomly for 600 ms in greyscale against a white background; images measured 2 cm to 9 cm vertically and 1.8 cm to 8.5 cm horizontally. Each object was followed by a 0.5 cm × 0.5 cm black fixation cross presented against a white background for 2400 ms. The fixation cross was followed by the next object presented for 600 ms. Participants were asked to press the letter J as quickly as possible if the object was presented correctly; otherwise, they were asked to press the letter F.

The fourth phase was identical as the second phase (the name recognition task) except that is included new names, e.g. this was the study phase (Figure 1). Old and new names were intermixed and presented pseudo randomly. The order of the tasks was counterbalanced either 1,2,3,4 or 2,1,3,4 across participants. Finally, on completion of all of the tasks, a participants were debriefed.

2.3. ERP Recordings

EEG activity was recorded from 64 electrodes, the positions of which were determined using the International 10-20 system. An elastic cap (Easy Cap; FMS, Munich, Germany) was used to place the electrodes in 10 to 20 positions (American Electroencephalographic Society, 1991).

FCz was used as an initial common reference and digitised to a frequency of 1000 Hz and Fpz served as the ground electrode. Electrodes were amplified, filtered using a band-pass from 0.1 Hz to 250 Hz and digitised to a sampling rate of 1000 Hz. Impedance at each electrode

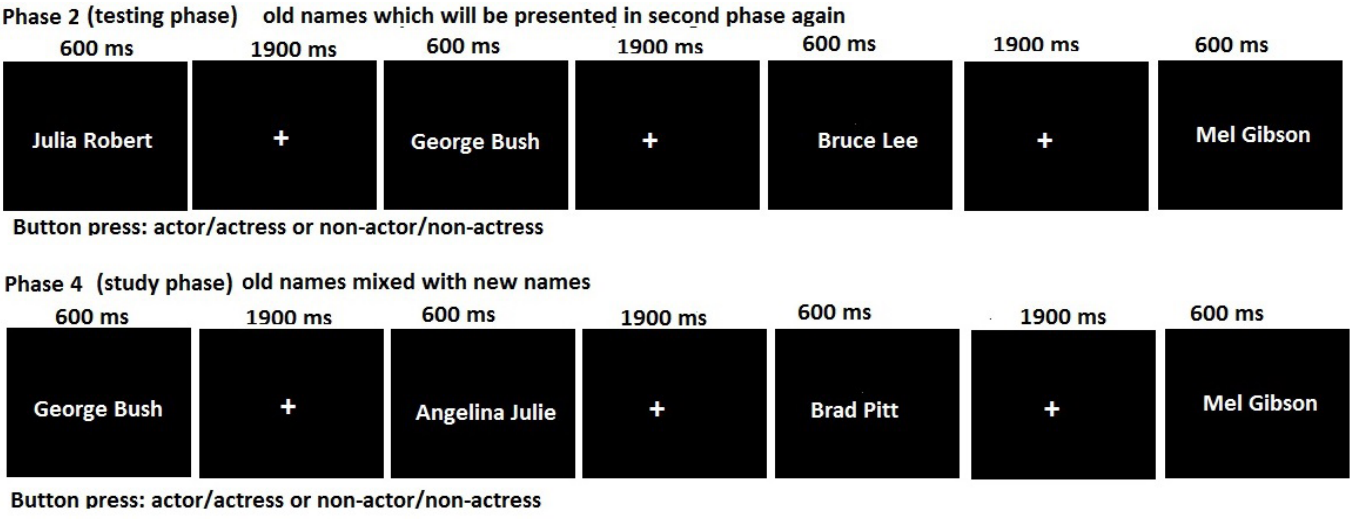

Figure 1: shows the design of phase 2 and phase 4. In phase 2, testing phase, a set of names was presented which are called "old names" because it will be presented in the forth phase again. In the fourth phase, the study phase, names of the second phase were mixed with a new set of names.

was maintained at 5kQ. To eliminate high-frequency noise, data were filtered using a high cut-off filter from 0.1 Hz to 35 Hz and a medium slope of 48 dB/oct. Selection of artefact-free episodes for eye movement and blink calibration data from 20 trials each (left, right, up, down, blink) was done by visual inspection. ICA-based correction of eye movement and blinks from EEG data was employed. For terminology, the names presented in the testing phase were called 'old names' and they were intermixed with a new set of names in the study phase called 'new names'. For each condition (old names and new names) in the study phase EEGs were segmented into 1700 ms epochs starting at 200 ms prior to the stimulus onset. Epochs were baseline-corrected based on the mean activity during the –200 ms to 0 ms pre-stimulus period for each electrode site. All epochs were free of ocular artefacts and contained responses that were correct according to the behavioural analysis and subsequently were averaged into ERPs for each experimental condition and channel. Also, each condition was re-referenced to the average reference.

2.4. Statistical Analysis

ERPs were extracted from frontal and parietal sites where according to previous literature old/new effects are associated with recollection and familiarity. Mean reaction times, error rates and ERP waves for the names in all tasks were calculated. For amplitude analyses, firstly behavioural phases of old/new (old names versus new names) were compared. This was followed by ERP recordings from related brain regions (frontal/parietal) which were compared separately (e.g. ERP recording in frontal regions compared for old and new names). The specific electrodes included in the analysis were AFZ, Fz, AF3, AF4, Fp1, Fp2, F3, F4, F6, for mid frontal sites and for parietal sites PZ, P3, P4, P1, P2, CP1, CP2, CP3, CP5, and CPZ. An analysis of paired t test was used for comparisons among conditions. The significance level was set to p = 0.05. Only significant results are reported.

3. Results

3.1. Behavioural Results

1The results show that on average participants have a higher accuracy rate in old names (mean = 85.44, SD = 7.19) than the new names (mean = 70.78, SD = 7.21), t(32) = 14.42, p < 0.01, Table 1.

Table 1: Mean and Standard Deviations for error rates (accuracy) during processing of old names and new names

Conditions	Mean ms	Std. Deviation	N
Old names	85.44	7.19	32
New names	70.78	7.21	32

Furthermore, participants were faster responding to old names (mean = 824.93, SD = 154.68) than to new names (mean = 930.17, SD = 180.87), as illustrated by the on average slower RTs in the new names compared to the old names, t(32) = 82.06, p < 0.01, Table 2.

Table 2: Mean and Standard Deviations for response time during processing of old and new names

Conditions	Mean ms	Std. Deviation	N
Old names	824.93	154.68	32
New names	930.17	180.87	32

These results show that old names were recollected faster, leading to more reliable and more accurate memories while new names invoked longer and less accurate response times. To explore whether these behavioural differences regarding retrieval of old and new names were associated with recollection or familiarity, ERP results were analysed.

3.2. ERP Results

The trials associated with familiarity (i.e. mid-frontal effect, from 300 ms to 500 ms) and recollections (i.e. the parietal effect, from 500 ms to 800 ms) were examined separately. To determine whether recollection and familiarity responses differ, ERP recordings from old names were compared with new names using paired samples t-tests. Based on a literature review, for frontal effect between 300-500 ms following electrodes were selected; AFZ, Fz, AF3, AF4, Fp1, Fp2, F3, F4, and F6, from parietal effect between 500-800ms following electrodes were selected; PZ, P3, P4, P1, P2, CP1, CP2, CP3, CP5 and CPZ. Significant activations in these electrodes are suggested to indicate that memories come to mind in the specific sites either in the form of familiarity (300-500 ms) or recollection (500-800 ms) and that the absence of significance would indicate that memories do not come to mind (either in the form of familiarity or recollection) in the particular sites (Bruett & Leynes, 2015; Leding, 2015; MacKenzie & Donaldson, 2009; Park & Donaldson, 2016).

3.3. Stimuli Onset from 300 ms to 500 ms

The results regarding the mid-frontal effect in the range of 300 ms and 500 ms for old names versus new names were non-significant in mid-frontal sites (all pairwise comparisons: t(32)< (largest: 1.79/ lowest: .02), all p > (largest: .99/ lowest .49)]. The results indicate that no significant activities in the form of mid frontal effect (old new effect) in the range of 300-500 ms therefore, it might suggest that memories may not come to mind over mid-frontal sites that are associated with familiarity.

3.4. Stimuli Onset from 500 ms to 800 ms

The results regarding parietal effect in the range of 500 ms and 800 ms for old names versus new names showed significant activation over four electrodes in the parietal sites., ERP recordings shows significant activation over central parietal site for old names (mean = 4.97, SD = 3.30) versus new names in CPZ (mean = 4.20, SD = 2.94), t(32) = 4.44, p < .05]. The significant activations over left pariatel sites were observed in CP1 (old names: (mean = 4.54, SD = 2.90), new names: (mean = 3.71, SD = 3.01)),t(32) = 10.17, p < .01]; CP3 (old names:

(mean = 4.25, SD = 2.68), new names: (mean = 3.20, SD = 2.80)), t(32) = 14.5, p < .01], CP5 (old names: (mean = 2.00, SD = 1.13), new names: (mean = 1.45, SD = 1.17)), t(32) = 8.49, p < .01]. The results indicate that participants recollect old names () unintentionally as evident by significant elecrophisiological activities in the left-lateralised central parietal sites. The activations seem to indicate late lateralised old/new effects (500 ms to 800 ms) which is associated with recollection, – Figure 2.

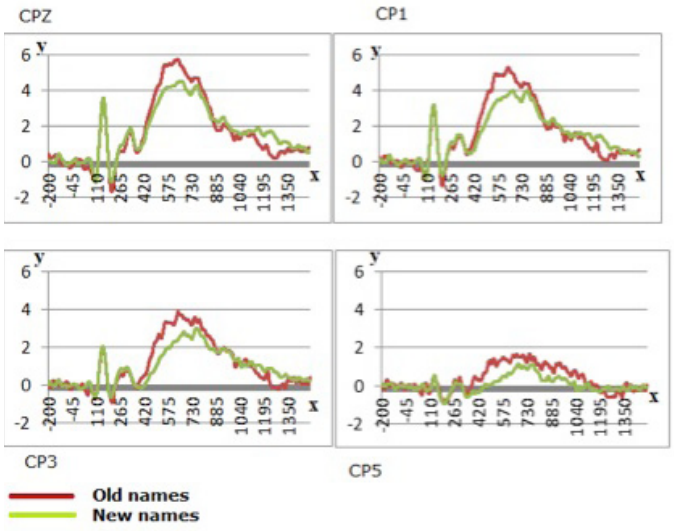

Figure 2: ERP waves for old names and new names over the parietal sites in CPZ, CP1, CP3 and CP5.

4. Discussion

The behavioural findings demonstrated that the participants were faster and more accurate in processing of old names retrieval as compared to new names retrieval. These faster and more accurate behavioural performances were accompanied by higher electrophysiological activities in the range of 500 ms-800 ms mainly along parietal cortex which indicates parietal old/new effect i.e. recollection. In more detail, comparing retrieval in old names with new names showed higher electrophysiological activities between 500 -800 ms in the central parietal cortex mainly over the CPZ and CP1 and extending in the left parietal cortex over CP3 and CP5. On the other hand, the same comparison for old and new names did not reveal significant electrophysiological activities in mid-frontal cortices in the range of 300-500 ms which indicates no mid-frontal old/new effect (i.e. familiarity).

These anatomical areas in ERP studies have been repeatedly reported previously to be involved in the old/new effect in the mid-frontal electrodes (familiarity: 300-500 ms) and parietal effect (recollection: 500-800ms) (Boehm et al., 2006; Bruett & Leynes, 2015; Cruse & Wilding, 2009; Park & Donaldson, 2016; Wilding & Ranganath, 2011). It has been emphasised that these regions are involved in recognition memory which refers to information related to an episode coming to mind either with specific details or without the contextual details (Boehm et al., 2006; Bruett & Leynes, 2015; Cruse & Wilding, 2009; Park & Donaldson, 2016; Wilding & Ranganath, 2011). In the current study, the observation that participants showed higher ERP activity for retrieval of old names than new names over parietal cortices in the range of 500-800 ms could indicate that participants recollected the old names which were presented previously. As it was mentioned in the introduction, in typical studies of old/new effects participants are required to decide explicitly whether the presented stimuli is old or new (Boehm et al., 2006; Jacoby, 1991; Tulving, 1985). However, in the current study this was not the case because similar stimuli were used in the testing and study phase and participants were given the same instructions for both phases. Therefore, it seems that in the study phase the participants recollected old names which were presented in the testing phase unintentionally/implicitly. In this context, the current results replicate previous studies that by showing late lateralised parietal old/ new effect which is often maximal over left parietal cortices associated with recollection (MacKenzie & Donaldson, 2009; Paller, Voss, & Boehm 2007; 2008, Curran & Friedman, 2004), and also shows that memories may pop into mind in the form of recollection implicitly/ unintentionally.

In conclusion, the study showed faster response times and higher accuracy rates in retrieval of old names compared with new names in the implicit task performance and this behavioural evidence was associated with higher electrophysiological activation over left parietal cortices (i.e. left and central parietal cortices) in the range of 500-800 ms. While previous studies have shown recollection occurs in the same regions between 500-800 ms, the current study suggests recollection may occur implicitly as evident by showing the same pattern of old/new effect in relation to recollection. Thus, the results presented here should be considered as a platform for future studies to build upon. The continued investigation in terms of implicit recollection is fundamental to move towards a more consolidated conceptualization of cognitive impairments in high neurotics.

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