Context influence of familiar objects under violations of background in a change blindness task

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PSB3E- BT15: Bachelor Thesis

Group number: BT06

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January 8th, 2023

Abstract

Our cognition is constantly overwhelmed with information from our surrounding environment. Attention is what brings objects into visual awareness and makes it possible to notice visual changes (Luck & Vogel, 2013). However, people often fail to notice changes that happen right in front their eyes. This could have a terrible effect in one's life, such as failing to notice the appearance of a pedestrian while driving. This process is termed change blindness (CB). It is still not clear how one can instantly know an object's identity, which leads up to a 'binding problem'. Moreover, it is also not clear what role does the background play in the object identification and whether it facilitates the change detection task. The present study investigated the process of CB using the conceptual network theory and the neural mechanisms of binding (de Vries, 2004). We assessed whether the background and target context increase the response accuracy in a change blindness task. The experiment tested two questions. Firstly, it was tested whether the target's spatial location influences the response accuracy. Secondly, the interaction effect between background and target context was tested. A total sample of 42 (N =42) participants took part in the study, completing an online change detection task. The findings of our study suggest that the object's context in terms of its spatial location and background compatibility does not have a significant effect on one's performance in a CB task.

Key words: Change Blindness, Visual Working Memory, Binding, Conceptual Network

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Change Blindness

Human cognition is constantly being challenged with loads of information. People are usually aware of some details of their visual environment and objects they interact with. However, some changes go undetected. Empirical research outlines that people fail to notice visual changes in visual displays or in real-world settings (Simons & Levin, 1998). For example, people fail to notice the use of a stunt double in a movie. This phenomenon where an observer fails to notice a change in a visual display is termed ‘change blindness’.

Lamme (2003) suggests a way of neutralizing the effect of change blindness using retro-cues. Introspection illustrates the limited nature of conscious awareness, but the change blindness experiments reveal it much more strongly. When people watch a scene in which one of the elements changes location, color, identity, or simply disappears, change blindness can happen. Subjects, very often, do not notice the change, even when it is dramatic, if the visual transients of such a transition are concealed, for example, by interposing a brief blank interval between the two versions of the visual display. Change blindness refers to a selective process in which certain things in a scene reach a privileged status. Stimuli are not detected until that condition is reached. Attention appears to be crucial in this circumstance and it is critical that attention is focused on the item at the time of change. Cueing the necessary item before a probable change, can prevent change blindness from happening. Consequently, in our study, we use retro-cues in order to facilitate the change detection task.

To recognize an object, a temporary connection between its location and its identity must be established. Location and identities of objects are represented separately in our cognition. Alternatively, we would have to infer the presence of memory traces unique to each potential combination of objects and locations. Given the number of objects that humans can distinguish in different places, such an assumption is unreasonable (de Vries, 2004). Since location and identity must have separate representations, temporary connections must exist between them, in order to distinguish one item at location X from the same type of object at location Y. This process is known as “binding”. For example, binding allows people to recognize two different recently encountered laptops, even though they share the same identity (de Vries, 2004).

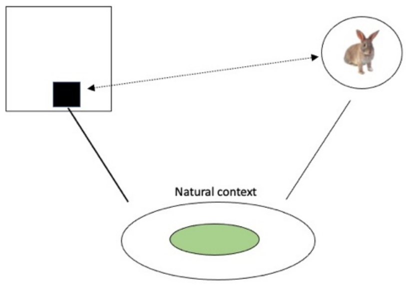
Different levels of description, specifically functional and structural, can be used to describe binding. The levels of description refer to the same system, which is viewed in different ways. This can be compared to the Necker cube illusion where two perspectives of the same object can be seen, but not at the same time (de Vries & Dalenoort, 1998). Functional models refer to goal-directed explanations. They suggest that the environment has a significant impact on human behavior and mental states (O’Reilly & Munakata, 2000). They are also known as top-down processes in which the subcomponents of a process are understood in terms of their function for the system as a whole (de Vries & Dalenoort, 1998). In a structural model, how-questions are addressed. They employ a bottom-up method, which means that it begins with biological facts and progresses to higher level cognitions (O’Reilly & Munakata, 2000).

Considering binding at a structural level brings up a ‘binding problem’. When seeing an object, many excitation patterns occur simultaneously in the brain. These may signal either the location or the identity of the objects. Our study focuses on analyzing the relationship between the location and identity of an object in a change blindness task. It is still not known how these patterns ‘get together’, so that binding happens. Moreover, different memory traces of location and identity get activated. It is still unknown how the neurons of these memory traces find their way together, which leads up to a binding problem.

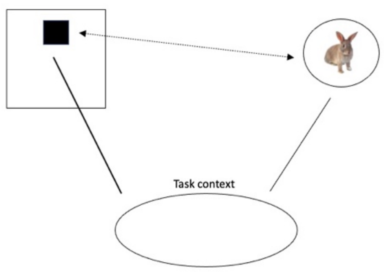
According to the network model (de Vries, 2004), context is necessary for the binding to happen. We hypothesize that by placing an object in its natural context, the binding will become stronger between the memory trace of the object and the memory trace of its natural location. This effect can be seen in figure 1a. The object's natural location excites the memory traces according to the neural binding mechanism, as its presented location is linked with its natural context.

Figure 1

(a.) Example of a successful process of binding



(b.) Example of an unsuccessful process of binding



Note. In our real-life environment, a rabbit is frequently presented in the lower part of our spatial location, which indicates the natural context of where a rabbit is placed. According to the conceptual network, this would imprint the rabbit's location as being in the lower location (de Vries, 2004). In Figure 1a, the rabbit is presented in the lower part of the visual screen. Because of the rabbit's displayed location linking with the natural context of the rabbit's position, it would excite the memory traces in our brain according to the neural binding mechanism. In Figure 1b, the rabbit is presented in the higher part of the visual screen implying that the context link is missing. As a result, the rabbit would be unable to excite the memory trace.

Binding of location and identity

In the present study, the binding of location and identity is of most relevance. In his paper, de Vries (2004) explains the mechanisms behind the process of binding of location and identity. A cognitive process is represented in different neural maps. The location of an object is represented as an excitation pattern in a spatial map, while the identity of an object is represented as a cell assembly. A cell assembly can be defined as a module of fluctuating neurons. An object achieves its identity through connection with other assemblies, being considered a memory trace or concept of an object. The whole network is known as a conceptual network. Context plays an important role in the activation of the network, making memory traces context dependent (de Vries, 2004). Figure 1a further explains the process of binding, and how natural context can influence it.

The process of binding is a way of neutralizing the effect of change blindness. Binding happens through the priming of neurons and pathways that are more likely to fire together later (de Vries, 2004). Because of this, the brain makes an expectation of what the future changes will be. Therefore, if binding does not take place, people are not able to accurately remember the location and identity of objects. In this situation, without the process of binding being present, change blindness takes place.

Dalenoort (1985) elaborated on the concept of a cell assembly (CA) by introducing the notion of a critical threshold, claiming that a CA possesses one. This indicates that once neurons in a CA are sufficiently excited from the outside, the excitation will remain active inside the CA even when there is no longer any outside excitation. A critical threshold exists for an excitation pattern in the spatial map too. When the CA's excitation level surpasses the threshold, the location or identity is stored in short-term memory, or "receives attention," as de Vries (2004) puts it.

On the functional level of description, the critical threshold may be utilized to comprehend CB. When the activation of the CA surpasses the critical threshold, the corresponding memory trace is said to be stored in explicit-working memory at the functional level. If the threshold is not attained, the trace will be stored in implicit memory, and explicit recall of the observed memory will be unattainable. This failure to recall is equivalent to change blindness.

Donald Hebb (1949) has first introduced the concept of a memory trace. He has also supported the idea that when neurons fire together they create a cluster of neurons. If the excitation level of the cluster of neurons is activated sufficiently strong, the excitation is similar to an avalanche, in which a small movement contributes to a larger event that grows over time (de Vries, personal communication, 2022). Consequently, the level of excitation of a cell assembly must reach a critical threshold so that from a functional level, the memory traces of location or identity enter short-term memory (de Vries, 2004). Furthermore, if the critical threshold of the excitation level is not fully reached, then people are not aware of the objects at a functional level, and therefore are not aware of a change happening.

Moreover, if an excitation in the spatial map and an excitation in a memory trace occur simultaneously and they are also activated by the same context, a temporary connection will form. Figure 1a represents an example of a successful binding for one object and one location. The memory trace of a rabbit is temporary linked to its natural context, the lower part of the visual field where a rabbit is usually located in a real-life environment. The rabbit's location in the lower part of the visual screen excites the memory traces according to the neural binding mechanisms since the rabbit's location in the visual display coincides is linked with the natural context of the rabbit's location.

To counteract the binding problem, de Vries (2004) came up with the idea of 'a scanning mechanism'. Memory traces become activated sequentially, thus only one excitation pattern in a memory trace for the identity of an item and one in the spatial map are active at the same time. Identity and location would be activated from the same context; therefore, the process of binding takes place. Consequently, an object's natural context significantly increases the occurrence of binding.

Figure 1a represents the binding process for one object and one location. For more complex situations, in which several objects are presented simultaneously, a more complex form of binding happens, which is serial binding (de Vries, 2004). It has been shown that temporary connections are produced between an object's identity and its location, but serial binding also demonstrates how temporary connections are made in relation to the task network. Serial binding states that an item is bound one at a time (de Vries, 2004). When one item is bound, a scanning mechanism is activated, allowing the binding of other things in the visual field. This procedure is thought to occur so rapidly that it appears to the individual to be simultaneously.

Previous research (de Vries, 2004) indicates that as the number of identical letters in a display increase, quicker reactions are produced. This data supports the hypothesis that as the number of temporary excitations between a cell assembly and the spatial map increases, the critical threshold is achieved faster. As a result, the propagation of excitations in a conceptual network is faster, resulting in faster reactions.

Visual working memory

According to Lamme (2003), items can overcome change blindness by being stored in working memory. Therefore, the binding problem can also be viewed regarding visual working memory. Binding facilitates perceptual organization, which leads to visual awareness. In this paper, it is mentioned that change blindness can be overcome if the inputs are conscious to humans' perception. Conscious stimuli overcome the early feature detection stage and manage to offer a coherent perceptual interpretation of a visual display.

Pashler (1988) suggests that when familiar objects are given, prior knowledge regarding their identities can also improve the change detection task. How does this happen? It is assumed that the identities and locations of familiar objects are automatically stored. Hence, the alteration of the object can be detected by detecting changes in the object identities existing in certain locations. This information is highly relevant for our study, as we make use of the individual's prior knowledge about objects' identities and their natural locations. Thus, presenting a familiar object in its natural context can positively impact the response accuracy in the change detection task.

Familiarity is an important characteristic that objects need to possess, so it is easier for the individual to access their semantic memory. Consistent with Pashler's (1998) definition of familiarity, we can define it as in objects which are universally recognized. However, we also make use of familiarity in two more instances. The first instance would be that the objects are presented/or not in a familiar context, such as their natural context. The second instance would be, that we use two similar objects with a shared identity. Familiarity of the object was found to be more relevant than its position when its identity does not differ significantly from the original (Dzhurkov, 2021).

With their two-model theory, Luck and Vogel (2013) provide an explanation of change blindness at the functional level of description. In their paper, visual working memory (VWM) is described as the active maintenance of visual information to meet the demands of current tasks. They argue that visual working memory (VWM) plays a critical role in the change blindness tasks. When examining VWM capacity, they distinguish between two theories: slot-based and resource based. Resource-based theories consider VWM's capacity to be a resource that can be shared across all of the items shown. The attention in continuous resource models is provided to all items, therefore if too many items are shown, the attention per item diminishes until one is not able to detect a change. On the other hand, the slot-based theory assumes that the number of objects that can be kept in one's VWM is restricted. If the number of items during a task exceeds the k-maximum, on average, the number of four slots, the chance that change blindness occurs is increased. Attention is given to only a few objects, and when more are added only those already stored in VWM are remembered. This means that binding within the conceptual network has constraints, specifically that it is limited to a maximum of four objects. Applying this research to change blindness experiments, the slot-based model predicts that individuals would experience change blindness when a display set has more than four elements (Lamme, 2003). Accordingly, in our study, where six objects are shown, not all of the objects in the display would go through binding within the conceptual network. Both theories argue that once the attention limit of one's VMW is surpassed, binding does not occur.

Introduction to current research

In the present study we investigate the role of context in a change blindness task. The trials in the task present six familiar objects. Moreover, to increase the influence of familiarity in task, a background was used. The objects are either compatible or incompatible with the background. A compatible background aims to represent a real-life natural environment by having the lower half of the screen green (representing the grass), and the upper part of the screen blue (representing the sky). Therefore, the question we focus on is: What is the role of context in a change blindness task where familiar objects are placed either in or out of their natural context? Out of the six objects, four of them are out of context throughout the whole experiment, while two are either in or out of context. The four objects are considered non-targets, while the other two, including the target object can be both in and out of context.

In our experiment, we use many objects and a short duration of time, putting the binding process under stress as we want to study the facilitation by context. Consequently, to keep the task performable we use a location retro-cue. A location cue is a line pointing to the item that will change before the post-change screen of a change detection task. Generally, cue-based tests greatly decrease change blindness (Lamme, 2003). It is assumed that change blindness implies that some objects can achieve a 'privileged status' by a selective process, or they are left unnoticed. According to Lamme (2003), the elements retained in the VWM's limited capacity are dependent on attention. Attention is what enables one to not only bring objects to awareness (e.g., notice them), but also report them. Although not all objects require attention to reach a conscious state, they do necessitate attention to be reported in tasks (Luck & Vogel, 2013). Using this reasoning, drawing the participant's attention to the object that will change will assist them in detecting it, therefore preventing CB. (Lamme, 2003).

We are examining two hypotheses.

Hypothesis 1. We expect that the target in context condition will have a higher response accuracy than the target out of context condition. The object’s location in its natural context would have higher response accuracy.

Hypothesis 2. We examine the interaction effect between background and target context. We presume that the response accuracy will be highest when the target object is in context and in the compatible background. It is expected that when the target object is placed in its natural context, and in the compatible background (e.g., a plane is pictured in the blue part of the screen), it would lead to more accurate answers.

Previous research has focused on an isolated object on a homogenous background, but in real life, objects and backgrounds co-occur. Additionally, processing an object and the background scene is not mutually exclusive. Visual displays with a contextual background can influence human perception (Davenport & Poter, 2004). For example, in the recognition task, items were more accurately recognized when presented in a semantically congruent scene, than when provided with an incongruent scenario (Davenport & Poter, 2004).

Moreover, the process of binding depends upon the activation of a memory trace, which is context-dependent (de Vries, 2004).

This experiment is part of a bachelor thesis study. There are in total six studies, and they are all analyzing the effects of change blindness in object identification. Three of the six studies focus on analyzing the effects of a compatible or incompatible background and target context, while the other three analyze the effects of target context and non-target context using a neutral background.

Method

Participants

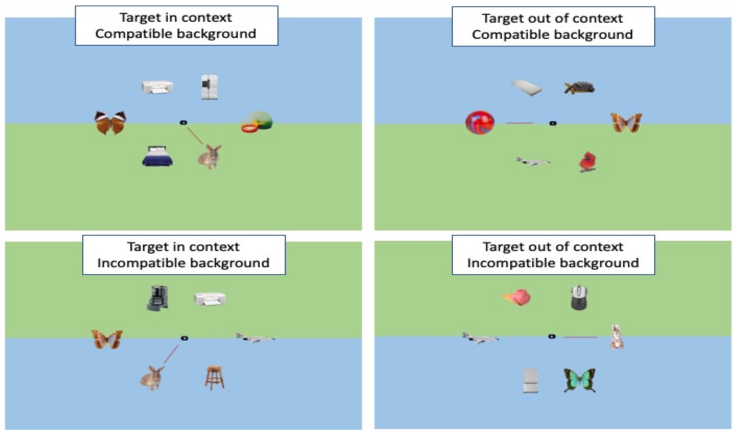
A total sample of 42 participants took part in the online experiment. Out of the total sample, 14 were recruited through SONA-Practicum, 19 were recruited through the platform Prolific (www.prolific.co) and 9 were volunteers and received a personal link from the student researchers. Participants recruited through SONA-Practicum Pool were 1st year Psychology students at University of Groningen and received credits as a compensation for taking part in the study. Participants recruited through Prolific received an incentive as a compensation for their participation. Volunteers received no compensation. The sample included 15 females, 8 males and 19 did not specify, resulting in a percentage of 35.7 %, 19.0% and 45.2% respectively. Participants' ages ranged from 17 to 27.

Design

The study utilized a within-subjects 2x2x2 factorial design. The first independent variable refers to whether the objects are presented in a compatible or an incompatible background (Figure 2). The second independent variable indicated whether the target object is presented in context, meaning that it is shown in the part of the visual field that represents its natural environment (e.g., a rabbit is presented in the lower part of the visual field), or out of context, the object is presented in an unusual spatial location (e.g., a rabbit is presented in the higher part of the visual field). The last independent variables indicates whether the pre- and post-change images are different, or they are the same. Based on these factors, 4 conditions per block can be distinguished. (i) The target object is in context and in the compatible background, (ii) the target object is in context and in the incompatible background, (iii) the target object is out of context and in the compatible background, (iiii) the target object is out of context and in the incompatible background (Figure 2).

Figure 2

Example of the four conditions used in the experiment



The study examined two dependent variables. The first dependent variable assessed the participants' ability to notice and disregard changes. Based on Wickens' (2002) signal detection theory, this dependent variable was assessed using d-prime (d') values. This is because d' controls for noise by considering participants' decision-making processes. For example, d' can identify when a person responds conservatively, which means that the participant observes minimal changes but also has a low number of false alarms. This is something that is neglected when comparing the proportions of correct responses from the various experimental conditions. The second dependent variable, location accuracy, examined the participants' ability to correctly identify whether the target object has changed.

Stimuli

The stimuli used in the experiment were obtained from http://konklab.fas.harvard.edu/ For the experiment, a total of 72 object images grouped in pairs were used. They were chosen by the student researchers and the supervisor to belong to the lower (LOW), the middle (MID) or the higher (HIGH) part of the visual field. The background of the images was first removed using an artificial intelligence website to match the experiment's background (www.remove.bg). The paired images were equally distributed among the three named categories. Withing each of the three categories, three subcategories were chosen. For example, in the LOW category, the three subcategories were: animals, furniture and games. In the HIGH category, objects could be identified as: planes, birds, and butterflies. In the MID category, there were: types of food, electronics, and kitchen appliances. The objects were selected based on their recognizability to ensure that the participants can easily identify them. Each picture had an equivalent picture with an object representing the same thing, but slightly different. This was done so that the participants would have to detect possible changes. For example, one image presents a brown bunny and the other presents a purple one (Figure 3).

Figure 3

Example of a pair of objects belonging to the lower part of the visual field.

Moreover, two types of background were chosen. Two objects, including the target object, was either presented in a compatible background, with the lower half of the screen green (color code: #008F00) and the upper blue (color code: #00B7C0), or in an incompatible background, with the lower part of the screen blue and the upper part green (Figure 2). The compatible background is aimed to create the impression of a natural visual setting (blue resembling the sky and green the grass), by presenting objects in their commonly known environment.

Procedure

Before the experiment began, participants were given a document that informed them about the ethical considerations surrounding the forthcoming experiment, which the ethics committee of the psychology department of the Faculty of Behavioral and Social Sciences at the University of Groningen had approved for the research design of this study. Participants would not encounter any repercussions, and they would be given information about how their personal and performance data will be used, as well as the freedom to withdraw at any time. To proceed, they had to choose the option indicating their approval.

Participants were then given a brief description of the upcoming procedure when they first entered the online experiment. It was mentioned that they need a computer with a mouse or a trackpad and that the experiment lasts about 20 minutes. The study's primary goal was presented as the investigation of the function of visual working memory in the detection of changes. In addition, participants were asked to agree to the requirements, which included the agreement of personal and performance data for research purposes. The platform used to administer the instructions and consent form was "Qualtrics" (www.qualtrics.com), while the experiment itself was developed on OpenSesame (Mathot, Schreij, & Theeuwes, 2012) and shown on its web add-on OSWeb. Participants were also informed that they will not have any direct personal benefits out of the participation in the study, and that the indication of the response accuracy for the detection of changes does not possess any diagnostic value.

After giving their consent, participants were given detailed instructions for the following procedure, as well as images of the actual trials. It was disclosed that one object may or may not change between the memory (pre-change screen) and the test display (post-change screen). It was also mentioned that the background of the images will change to distinguish one block of trials from the other. Participants were given two practice blocks of six trials each, before the experiment began. During the practice trials, participants received feedback after each response. After a correct response to a practice trial, the dot in the center of the screen turns from black to green, while after an incorrect response, it turns to red.

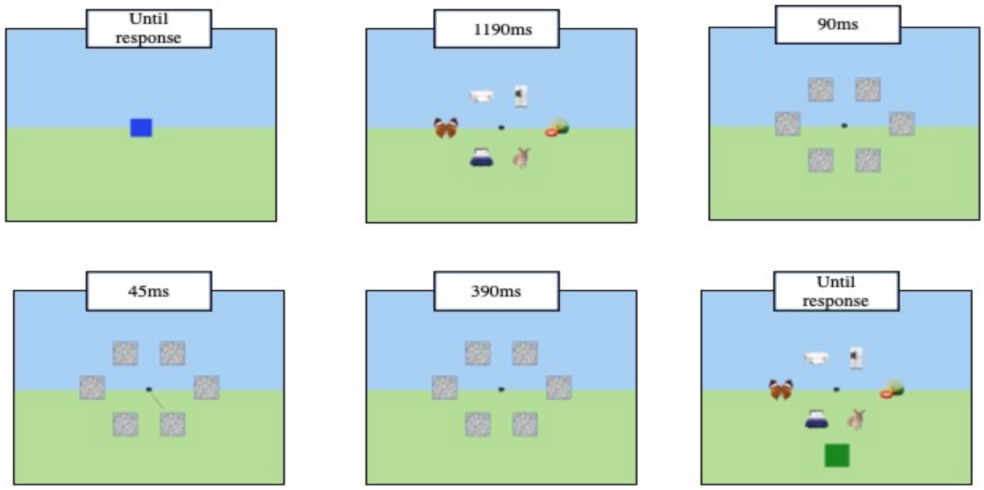
A trial begins with a pre-trial screen in which a blue square is presented in the middle. For the trial to begin the blue square needs to be clicked on, so that the mouse is in the center of the screen. The pre-change display then showed for 1190 ms, displaying the six stimuli. All the objects were presented in a circle at an equal distance from the center and from each other. This was done for the facilitation of the change detection task. After a brief period of 90 ms, a retro cue emerged for 45 ms, prompting participants to remember retroactively. A location cue was used in the form of a red line pointing to a masked stimulus where the change may occur. The mask involved pixelating the stimuli to disrupt visual working memory, forcing the individual to reactivate the relevant memory traces (Ricker & Sandry, 2018). After 390 ms, the post-change display emerged for a maximum of 3000ms until response, displaying the six stimuli again with the potential change. Participants were required to either click on the object they believed has changed or if they did not see any changes, they had to indicate it by clicking a green square located underneath the stimuli. During a trial, all the objects can be the same or one of them (the target object) can change with its pair, a slightly different object having a shared identity. Following each block, feedback specifying the performed response accuracy in percentages was provided.

Throughout the trial, randomization was applied. The categories and items within each category were chosen at random for each trial. Participants may naturally be better at distinguishing between specific object categories than others. For example, studies have shown that people are better at distinguishing between objects that they are familiar with (Hagen & Tanaka, 2019). As a result, participants who have a special interest in animals, for example, may score better in these areas, undermining the manipulation of the existing design.

The two experimental blocks start at the end of the two practice blocks (Figure 4). The experimental blocks consist of 48 trials each. After both experimental blocks, an overall performance response accuracy was provided. At the end of the experimental blocks, participants were asked whether they used a specific strategy when completing the trials. Some of the strategies participants used were: trying to remember the object's colors or just colors that stand out; focusing on the center of the screen; focusing on the location cue; and trying to remember the screen as a whole, not individual objects. Additionally, participants were given an explanation about what the experiment is investigating (the role of context in visual working memory with a change blindness task) and its importance in various settings (e.g., in the assessment of eye-witnessed reports).

Figure 4

Example of an experimental trial with time markings (compatible background, target in context)



Note. Since the pre-change and post-change images are identical, the participants should click on the green square.

Data Analysis

The raw data was collected on an Excel spreadsheet and analyzed with SPSS. First, raw data was classified into eight conditions: A (0,1) indicated whether a change had happened, B (0,1) indicated whether the background was incompatible or compatible, and C (0,1) indicated whether the target object was out or in context. For each condition, the average performance of each participant was shown separately.

Before calculating the d-prime, the data was cleaned, and the invalid answers were extracted. Someone who continuously clicked on the green square would have a perfect score on the same condition and a score of 0 on the change condition. The other way around is also possible. Therefore, three participants were removed before calculating the d prime.

The analysis was divided into two parts. Firstly, d-prime was computed and analyzed using signal detection theory (SDT) (Wickens, 2002). Signal detection theory (SDT) was utilized to evaluate discrimination performance (Wickens, 2002). Individuals can develop a response bias in a change blindness paradigm, therefore SDT is useful here. As a result, participants may be too or underly cautious in their response to a change. SDT enables for the calculation of discrimination sensitivity independent of a response criterion, which is useful for the current work (Georgeson, 2016). This decided whether participants could accurately distinguish between the pre- and post-change displays. Then a repeated-measures ANOVA was performed for the d-prime.

Secondly, it was crucial to check whether the individual was able to properly identify the exact area of the change on trials where a change had happened. Performance data was gathered when a change occurred in the trial. Therefore, only the data where the trial undergoes change was considered. A repeated measure ANOVA was used to see if the differences between the four conditions were significant.

Results

D-prime

First, the data was adjusted for extreme instances, such as 0 and 1, since perfect precision or inaccuracy would be attributable to limitations on the number of trials in the experiment and would be invalid as a probability:

$$0+(\frac{0.5}{12})$$

$$1-(\frac{0.5}{12})$$

The number 12 reflects the number of trials completed by the individual for each condition.

Then, for each participant, the sensitivity d-prime statistic was determined across the eight conditions. The d-prime statistic was calculated using excel with the formula of:

d'= NORMSINV (P(hit)) – NORMSINV (P (false alarm))

A hit rate represents scenarios in which participants accurately respond to a change in objects, whereas a false alarm indicates situations in which participants wrongly assume a change happened. The d-prime statistics were then imported into SPSS where a repeated measures ANOVA was performed to see if these circumstances produced statistically significant results.

For the analysis most assumptions were met. The normality assumption was not met, however due to the ANOVA's robustness to normality violations, no corrections were made. The sphericity assumption is met because of the experiment's design, which only utilized two levels for each variable. The independence assumption was met, as one participant's response did not have an influence on another participant's response.

Performance was categorized and ranked among the four testing conditions: incompatible background and target in context (M =.61, SD =.75); incompatible background and target out of context (M =.49, SD =.88); compatible background and target in context (M =.62, SD =.92); compatible background and target out of context (M =.41, SD =.88). The descriptive statistics values for both d-prime and location accuracy can be seen in Table 1.

Table 1

Descriptive statistics

	d-prime			location accuracy		
Condition	Mean	SD	N	Mean	SD	N
B1C1	.611	.750	39	.556	.208	39
B1C2	.495	.889	39	.548	.218	39
B2C1	.623	.920	39	.541	.180	39
B2C2	.415	.888	39	.510	.209	39

Note. B stands for the variable background with the following levels: B1 incompatible and B2 compatible. C stands for the variable target context, with the following levels: C1 out of context, C2 in context.

Hypothesis 1. Our first hypothesis stated that the target in context condition would yield more accurate answers than the target out of context condition. We were expecting that the target in context condition would yield significantly different results than the target out of context one. Contradicting our expectations, we did not find a significant result for the effect of the variable target context (F (1,38) = 2.72, p =.708). The high value of the F test (F = 2.72) for the target context goes into the direction of significance, which contrary to our expectations shows an out of context superiority. The results can be seen in Table 2 that is presented below.

Hypothesis 2. For our second hypothesis, we proposed that utilizing a compatible background when the target is in context will lead to the most accurate answers. However, our hypothesis was not supported as no interaction effect was found between background and target context (F (1,38) =.310, p =.58). Moreover, the effect of background was not significant either (F (1,38) =.142, p =.708), showing no significant difference when utilizing a compatible or incompatible background.

Table 2

Tests of within-subjects effects for d' repeated measures ANOVA

	df	F	Sig.	Partial Eta Squared
Background	1, 38	.142	.708	.004
Target context	1, 38	2.728	.107	.067
background* target context	1, 38	.310	.581	.008

Note. *p<.001

The investigation of the estimated means shows a difference in response accuracy between the target in context condition and the target out of context condition. When the target was out of context and in the incompatible background (*M* =.61, *SD* =.75) or in the compatible background (*M* =.62, *SD* =.92), the response accuracy was higher than when the target was in context and in the incompatible background (*M* =.49, *SD* =.88), or in the compatible background (*M* =.41, *SD* =.88). The results show that the target context influenced the response accuracy.

These effects can be seen in Figure 5a. Since the lines are not parallel, a slight interaction effect can be seen, but it is too weak to be statistically significant. The target in context variable has lower means for both compatible and incompatible background, showing a target out of context superiority effect.

Location accuracy

The second part of the analysis focused on the dependent variable location accuracy taking into consideration only the trials that went through change. The results for repeated measures ANOVA for location accuracy can be seen in Table 3.

Table 3.

Tests of within-subjects effects for location accuracy repeated measures ANOVA

	df	F	Sig.	Partial Eta Squared
Background	1, 38	.770	.386	.020
Target context	1, 38	.976	.329	.025
background* target context	1, 38	.538	.468	.014

Note. *p<.001

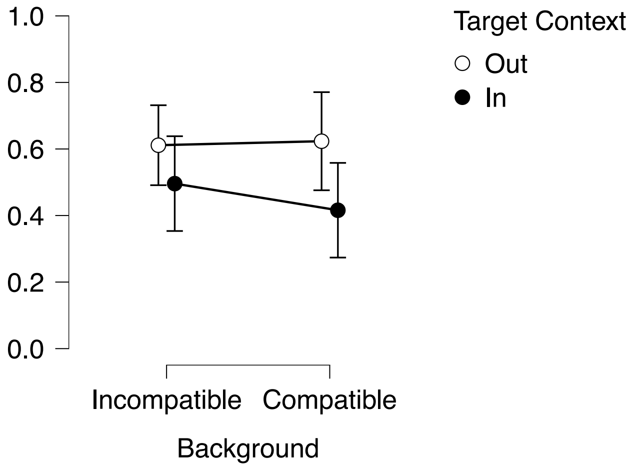
Hypothesis 1. We expected to find a significant difference between the target in context and target out of context condition. We proposed that the target in context condition would lead to more accurate answers than the target out of context condition. The effect for the variable target context was not significant (F (1,38) = .976, p =.329), contradicting our hypothesis. Under the factor background, the target in context condition produced a slightly higher location accuracy when the background was incompatible than when it was compatible (M =.54, SD =.21 vs M =.51, SD =.20).

Hypothesis 2. Contradicting our second hypothesis, the interaction effect between background and target context (F (1,38) =.538, p =.468) did not yield significant results. Moreover, the effect of the background variable was not significant either (F (1,38) =.770, p =.386). We expected to find significant differences regarding the response accuracies within the factors compatible background and target in context. Contrary to our expectations, utilizing a compatible background produced slightly lower response accuracies for location detection for both target in context (M =.51, SD =.20) and out of context (M =.54, SD =.18) than an incompatible background target in context (M =.54, SD =.21), target out of context (M =.55, SD =.20).

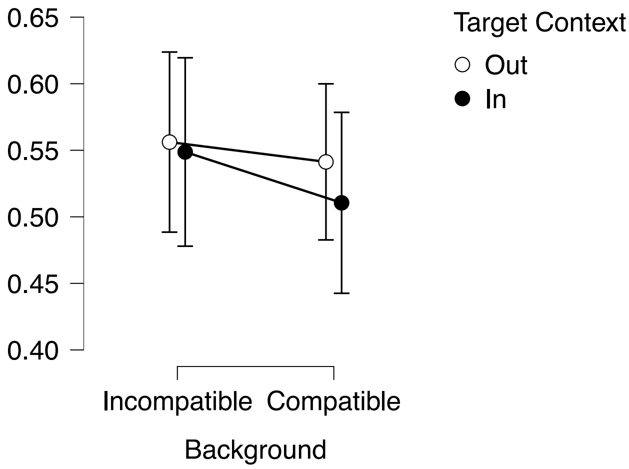
These effects can be seen in Figure 5b, where it can be observed that the target in context variable has lower means than the target out of context variable. Moreover, as seen in the graph, the compatible background variable has lower means for both target in context and out of context variables. Consequently, the response accuracy means increase for the incompatible background variable, with the incompatible background, target out of context condition having the highest response accuracy.

Figure 5

(a). *Graph for the interaction between background and target context for d prime*



(b.) *Graph for the interaction between background and target context for the location accuracy*



Discussion

The current study analyzed the influence of context, including background and target context, in a change blindness task. The neural mechanisms of binding in a conceptual network (de Vries, 2004) regarding change blindness are further addressed. We tested two hypotheses which propose that an object's natural context influences the response accuracy. The activation of a memory trace of the object's identity and its location is context dependent (de Vries. 2004). Therefore, we make use of the object's spatial location to increase or decrease the excitation level of a memory trace. By placing an object in its natural location, we expect to have a higher response accuracy than when placing it in an unusual place. Moreover, we aim to further facilitate this process by placing the object in its natural location against a compatible background, resembling a real-world environment.

Implications

Target Context. For our first hypothesis, we analyzed the effect of target context on response accuracy. Pashler (1988) states that when highly familiar objects are shown, knowledge regarding the objects' identities contribute to the response accuracy. It is assumed that the identities and locations of familiar objects in the visual field are instantly and automatically encoded (Duncan, 1980), and that this is not possible for unfamiliar stimuli (LaBerge & Samuels, 1974). Thus, identities may contribute significantly to performance in the change detection task. Hence, in our study, we utilized familiar stimuli to facilitate the change detection task. Furthermore, participants may detect changes not only by comparing visual representations derived from the sequence of displays, but also by detecting changes in the object's locations. Thus, this implies that when familiar objects are presented in their commonly known locations, the change detection performance will be higher than when the familiar objects are presented in an unusual location. Contrary to the aforementioned evidence, we did not find a significant effect for the target context for both discrimination sensitivity and location accuracy. This contradicted our hypothesis, showing that the target context does not have a significant effect in a change detection task. The other five bachelor thesis from the bigger part of the project of this study also did not find a significant effect for the target context condition (Albarda, 2022; Kemper, 2022; Piso, 2022; Ridya, 2022). However, a significant effect for the factor target context was found in one of the studies (Eddes, 2022). Contradicting our hypothesis, the response accuracy for the target out of context condition was significantly higher than the target in context condition. This result is comparable to our study's result, where we also found that the target out of context condition has a higher response accuracy than the target in context condition.

Target In Context, Compatible Background. For our second hypothesis, we expected that the target in context, compatible background condition would lead to the most accurate responses. The reasoning behind this hypothesis is that, when temporary connection is established between an object's identity and its location, it activates all adjacent 'locations', even if the memory trace's excitation level does not achieve the critical threshold (de Vries, 2004). This implies that if binding is present, the many elements that comprise the item's identity will activate one another if connections between them are present. This would strengthen the neural binding and allow us to identify the object. We therefore expected that the process of binding will be further strengthened when the target object is presented in its natural context and against the compatible background. Utilizing a compatible background would increase the excitation level of a memory trace, which could facilitate the binding process. In contrast to the expected results, we did not find a significant interaction effect between background and target context, nor a significant effect for the variables target in or out of context for both the discrimination sensitivity and location accuracy. Similar results were also found in the other two bachelor thesis studies which utilized background. These studies also found no significant interaction effect between background and target context (Albarda, 2022; Ridya, 2022).

A possible explanation for the non-significant effect for the accuracy of location change could be based on the influence of "motion" rather than binding (Pashler, 1988). Because the pre-change and post-change screens are presented very fast against one another, the person may not bind to the object's identity and its location and instead perceive it as a "motion" between the objects. As a result, the object's location may not matter since the individual may notice a change in motion regardless of its location. The results of the other bachelor thesis studies of location accuracy largely support these findings, since they showed no significant effects. Consequently, when asked about the strategy used for completing the experimental tasks, participants did mention that they focused on the whole screen, not on individual objects.

Strengths and limitations

One potential limitation of our study can be the used stimuli. Within the current study, a pair of objects were chosen to represent each object identity. Therefore, in the change condition, the target object would change with its pair. However, if the objects are too similar, then the participant might not detect the change.

Moreover, the experiment was not carried out under controlled conditions. Each participant used their own laptop in a different location. Even though the participants were asked to complete the experimental tasks in a quiet environment with no distractions, it is a condition that we did not counterbalance. Distractions or loud noises may decrease the study's reliability.

Overall, our study provides valuable new information regarding the underlying mechanisms of binding and the role of context in object identification, which need to be further assessed. The current study is one of the first to address the role of background in studying the phenomenon of change blindness using a change detection task.

Future research

The study utilized objects from various categories against a background resembling a real-life outside environment. For example, a bed was presented against a green background. This is not a realistic representation of the object's natural context. Future studies should focus on presenting objects against their commonly known background, such as presenting a bed in a bedroom. This could be achieved by utilizing a virtual reality game that could better resemble a real-life environment.

Furthermore, future studies should pretest the familiarity of objects. The used stimuli should be easily recognizable for all participants. This would facilitate the completion of the change detection task. Lastly, it should be taken into consideration for future experiment to be completed in a controlled environment, such as a research laboratory.

Conclusion

The current study aimed to investigate the role of context in a change blindness task. This was investigated by utilizing a compatible or incompatible background when the target object was in or out of context. The hypothesis that utilizing a compatible background would improve performance was not supported. The second hypothesis that utilizing a compatible background when the target object is in context yields the most accurate answers was not supported either. We did not find significant evidence for our hypotheses. However, even if we did not find significant results for our hypotheses, our study provides valuable information regarding the underlying mechanisms of binding and context which need to be further assessed.

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