Investigating the effect of a top down instruction impacting cue competition within contextual cueing Tasks

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The work submitted in this report is my own and has not been submitted in substantially the same form towards the award of another degree or other qualifactory work by myself or any other person. I confirm that acknowledgement has been made to assistance given and that all major sources have been appropriately referenced.

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The research documented in this report received ethical approval on: Wednesday 23rd October 2019

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Abstract:

How is it that we are able to visualise an abundance of stimuli and deduce implicit associations that guide our attention? The psychological phenomenon of contextual cueing provides an explanation for how repeated configurations of stimuli facilitate the search of a target. This experiment investigated whether learning associations between a configuration cue and a target 'T' was impacted by a second predictive cue, called cue competition. Participants completed a series of visual search tasks involving both random and repeated configurations with the aim of detecting the target as quickly as possible. To establish the influence of cue competition, blocking phases were introduced using a top down instruction (the presence of an arrow) which indicated the side of the screen the distractor was present. In a second condition, the explicit understanding of contextual cueing was tested by asking participants if they consciously recognised any of the repeated configurations. The findings concluded that there was evidence of contextual cueing and that cue competition had no significant impact in relation to implicit associative learning. There was also no significant evidence found of explicit knowledge of contextual cueing. This contradicts the findings of the blocking theory by Kamin (1969) that predicts a reduction in associative learning between a second predictive cue and a target once an association has previously been formed.

Keywords: visual search, contextual cueing, blocking, associative learning, attention

Word Count: 217

Introduction:

The context in which an object appears plays a significant role in detection of stimuli. For example, it is much easier to detect fellow students within a classroom environment compared to a shopping centre due to the context of the school improving both pace and accuracy of detection. This cognitive function allows us to walk into a new supermarket to find a loaf of bread and use cues previously seen at other stores and apply them to the context, such as looking for the eggs, or bakery section to find what we are looking for. Our cognitive system has developed the ability to extract regularities from an abundance of stimuli present in our everyday lives to improve visual search. This paradigm is called contextual cueing; this advanced operation allows for large amounts of sensory input to be implicitly and automatically processed during our everyday lives, saving both time and energy (Chun & Jiang, 1998). This ability to single out stimuli in a cluttered environment is essential to making decisions, but what is it that encourages the singling out of objects to occur?

Contextual Cueing:

The development of associative learning within Psychology was originally derived by Pavlov in 1927. Pavlov produced his theory of classical conditioning which states that when stimuli are presented together over time, a new learned response is formed as a result of associative learning. The experiment began with an unconditioned stimulus (UCS) of food being given to a dog which produced an unconditioned response (UCR) of pleasure. Pavlov then introduced a bell as a neutral stimulus (NS) every time the dog was given a bowl of food. Over time, the NS took the properties of the UCS and the UCR occurred every time the dog heard the bell, despite no food being present. This automated learning association provided the basis of the term contextual cueing as the repeated exposure of the bell and the food led to a conditioned association. This new phenomenon led the way to developments in cognitive psychology and paved the way for the development of contextual cueing.

The original research into contextual cueing was done by Chun and Jiang (1998) who conducted an experiment where participants were asked to complete a visual search task. This involved identifying a target ‘T’ amongst a configuration of ‘L’ distractors as quickly as possible. The configurations of distractors and a target were shown in both repeated and random configurations. Chun and Jiang found that during the repeated configurations, the response time and accuracy of detecting the target amongst the distractors improved compared to the random conditions. Therefore, the repeated configurations were processed using cognitive abilities to implicitly form associations between distractor and targets to aid in quicker and more efficient detection. This phenomenon was labelled as contextual cueing.

An abundance of research has been completed within the past decade that concludes there is a presence of automaticity involved within contextual cueing tasks. This has mainly been found in relation to implicit formations of associations without conscious knowledge (Schneider & Shiffrin, 1977; Goujon, Didierjean & Thorpe, 2015). Jiménez and Méndez (1999) produced a study involving participants analysing sequences of locations whilst performing a counting task during a serial reaction time task to test for implicit learning processes. Upon analysing the results, they claimed that implicit learning is an automatic association operation and is not reliant on paying specific attention to the aspect of the task. This raises the idea of attention being an automatic and constant concept, not a controllable cognitive ability.

Smyth and Shanks (2008) found that during contextual cueing tasks there is evidence of explicit knowledge which relates to the conscious ability to recall events (Squire, 1992). In order to understand conscious awareness, participants completed a visual search task and were asked to locate the ‘T’ amongst ‘L’ distractors as quickly as possible. They were then given a generation task, where previously seen configurations appeared, and participants were informed to predict where on the screen the substitute distractor would appear (where the previous distractor was in the detection trial). There was higher accuracy in results for the repeated configurations, suggesting participants had partial conscious awareness of their associative learning. During Experiment Two, all participants completed the same detection task as Experiment One. Participants in the generation condition were shown a detection task and told they had seen all of the configurations before. They were required to detect the distractor ‘L’ where they believed the distractor had been present in Experiment One. In the recognition group, participants were told that the configurations that they were to be shown would be similar to those previously shown in the detection trials. They were asked to indicate whether they recognised the configurations. Smyth and Shanks (2008) found that participants were able to respond quicker to the repeated configurations on the detection tests and to produce accurate responses on the target detection generation tasks. Therefore, a conclusion can be drawn that the knowledge associated with a contextual cueing task is accessible in memory and awareness as a result of successful generation tasks. This concludes that explicit understanding does play an important role in learning associations, rather than the task being entirely implicit and automatic. This is supported by Conci et al (2011; 2013) who also found that although there were more accurate than inaccurate responses when acknowledging if the patterns were novel or not, there was no significant effect concluding that there is some conscious awareness but that this is not reliable.

Research has investigated how controllable contextual cueing association formations are in visual search tasks (Luque, Vadillo, Lopez, Alonso & Shanks, 2017). During Phase One of the first experiment, participants were shown a visual search task (including random coloured targets with both random and repeated configurations of distractors) with the aim of detecting a target ‘T’ at four locations at the ends of a hypothetical cross located in the centre of the screen. In Phase Two, the targets were always located in the centre of the screen. In Experiment Two, the stimuli were larger than the previous experiment and all were placed within an invisible grid where there was a central column and row where targets were placed. Phase Two consisted of repeated configurations with different orientations of the ‘T’ and ‘Y’ targets. Lastly in Experiment Three, the ‘Y’ targets could appear on either the right- or left-hand side of the horizonal line that passed through the centre of the screen, with ‘T’ targets appearing in one of four locations either above or below the ‘Y’ target. Both targets were presented on the same side of the screen. Luque et al, (2017) concluded that participants voluntarily focused their attention on the important locations during visual search tasks. During Experiment Three, participants were able to infer where the target ‘Y’ would appear using knowledge from previously seen configurations from Phase One and use that information to guide them to detect the new target. This indicates some control as participates were able to use previous configurations to aid new tasks, which would not be expected if processes were entirely automatic. This therefore raises the question of how automatic attention actually is, especially when investigating contextual cueing and cue competition.

Blocking/Overshadowing:

This experiment aims to test the effects of blocking on associative learning of distractors and targets. In 1969, Kamin introduced the term ‘blocking’ which refers to a lessening of learning occurring between UCS and NS (A) due to the cue competition of a second NS (B). During Kamin's study, rats were presented with a light (NS A) and food (UCS) to produce salivation (CR). The rats were then presented with a sound (NS B) simultaneously with light (A) and given food. However, if the light (A) was removed and only the sound occurred, there was a weaker conditioned response to expect food. Thus, the association of light (A) with food (UCS) blocked that of sound (B) with food and so a weaker conditioning response occurred. Due to competition when presenting two cues simultaneously, one is overshadowed as a result of the other cue being present and a lessening of association occurs.

The Rescorla-Wagner model (1972), also known as the contingency model of classical conditioning, describes the circumstances in which conditioning occurs through a mathematical formula. The theory focuses on the strength of the association (V) in relation to associative learning (the change Δ in the prediction and the outcome); the more salient a stimulus is, the stronger the reinforcement. The strength is related to the difference between the actual (λ) and the expected (ΣV) outcomes; α and β refer to the learning and salience of the conditioned stimuli.

$$\Delta V = \alpha\beta(\lambda - \Sigma V)$$

If the first cue is salient and reliably predicted by the unconditioned stimuli, then further cues will not be as reliable at predicting the unconditioned stimuli. This provides evidence that when the second cue is presented that predicts the UCS, no clear association will be formed between the cue and the unconditioned stimuli and the prediction error will be zero. The two cues compete against one another as a result of cue competition, and the more salient of the two cues forms the association and results in less prediction error.

Mackintosh (1976) supported Rescorla and Wagner's model of classical conditioning. An experiment was conducted into the effects of overshadowing using auditory and visual cues on rats. In Experiment One, the more salient component of the two overshadowed the other. When the two components were presented with equal salience there was no competition, they overshadowed one another, and no association was formed. This study supports the Rescorla-Wagner model. Instead of concluding that stimuli are competing to form an association due to limited capacity, they concluded that the overshadowing occurred due to the salience of the cues. The rats did not learn the stimuli that were not strong predictors of the reinforcement. Thus, the first cue blocked the associative learning of the second; supporting the theory of blocking produced by Kamin (1969).

The concept of blocking has been supported by many animal studies. Prados et al (2013) found that snails struggled to form new associations between odour and food once they already have formed an association between the two. This supports the concept of blocking posed by Kamin in 1969. However, despite there being support for the theory of blocking, there have been many animal researches studies that have failed to find the effect of blocking despite following similar mythologies to published research papers which stated effects of blocking (Maes et al, 2016). Therefore, there is a lack of agreement and knowledge about the true effects of blocking in animals.

Cue Competition:

Research by Olson and Chun (2002) expressed that distractors directly around the target were more salient than those further away. Brady and Chun (2007) suggested that associative learning is restricted to local context, rather than the global configuration. They produced a computational model in order to understand in more depth what exactly is learned during contextual cueing experiments. They designed the model to act like a human brain processing contextual information. The network receives input from the display screen and processes it using values created for each location of the presented distractors and targets. An estimation of the likelihood of a target being presented in a given location is produced. When locations occur more frequently, the network adapts the likelihood so there is a higher chance of rating the right target location. The model replicates human understanding as learning occurs once repeated locations have occurred over time. To calculate the predictive reaction time (RT), the model works out how many possible locations the target could appear in before the target is detected appropriately. The change in weight of the locations is dependent on the quantity of predictive errors that are made: if the amount of errors decreases, so will the weight change. This produces a learning curve also produced during human trials. Brady and Chun (2007) tested the model's ability to learn local contexts as shown in research by Olson and Chun (2002). They concluded that there is an effect of contextual cueing despite only two neighbouring distractors predicting the target location. This model relates to cue competition as a result of error correction processes. This means that when two cues predict the location of a target, there is a weakening of association connection between cue and target.

Beesley and Shanks (2012) set out to investigate if blocking could occur in the computational model presented by Brady and Chun (2007). They investigated the impact of cue competition in contextual cueing tasks. The concept of cue competition refers to the learning of a cue and outcome being impacted by the predictiveness of a second cue competing (Packheiser et al, 2019). They wanted to determine if cue competition occurred by using a study based on the computational model. During Experiment One, participants were given a basic visual search task to familiarise themselves with the concept of the study with targets being randomly rotated across the four sessions with different sets of distractors predicting a specific target. Experiment Two involved a larger sample size and involved the Ap patterns being trained alone and being presented with random distractors (ApBr) in order to counteract the decrease in predictive errors as a result of the training phase. The experiment concluded that there was no evidence of any cue competition occurring in either of the experiments. However, they did find a strengthening of associative learning in Experiment Two. This then contradicts the previous theory stated by Brady and Chun (2007) which suggests a lessening of learning due to cue competition as learning about the weights of targets will be delayed and increase the prediction error.

Chun & Jiang (2001) aimed to investigate the impact of selective attention on implicit associative learning. Participants completed contextual cueing tasks with stimuli presented in red to attend to and in green to ignore. They found evidence for blocking and contextual cueing in a visual search task. When colours were constant and paired with a target and distractors there was a contextual cueing effect. During one condition participants were shown distractors in green and red and were told during the task to ignore the green distractors. When the red attended distractors were indicators of location, they saw an effect of blocking and no implicit learning of associations. Therefore, the cue competition between the red and green distractors lessened the learning of associations despite participants being told to ignore the green distractors.

The main purpose of this research experiment is to aid an understanding of factors that impact contextual cueing, specifically investigating the influence of overshadowing, defined by Kamin (1969), on implicit memory processing and learning. This experiment aims to introduce a third stimulus (a top down instruction) during the training phases where the two original stimuli (configuration and distractors) are being conditioned. The study investigates if contextual cueing still occurs while the blocking arrow is present during the initial training associative learning phase. This allows us to understand the effect of contextual cueing by presenting two predictive cues during a visual search task to determine the impact of overshadowing from the second predictive cue on the overall learning in relation to contextual cueing.

Many experiments state that the information processed during association tasks is all implicit, incidentally and automatically learned (Chun & Jiang, 1998). This study aims to understand if participants have any conscious recollection of the configurations shown during the experiment. Previous studies and theories by Kamin in 1969 indicate that the blocking effect will limit learning associations. Therefore, within the study we can hypothesise that during the training phase there will be an overall reduction of learning due to blocking, which will limit the likelihood of contextual cueing occurring in the test phase. Research has also suggested that during the recognition phases, participants should have a higher than chance ability to detect previously seen configurations.

Methods:

Participants:

34 university educated participants completed the experiment, including 28 females and six males with an age range of 18 - 49 (*M* = 20.74, *SD* = 5.29). Participants were primarily students of Lancaster University and were recruited via SONA in exchange for course credits or enrolled through opportunity sampling via word of mouth. All participants completed all conditions of a computer based visual search task at Lancaster University which lasted approximately 30 minutes. When recruited, participants were asked if they had any visual impairments; those with severe impairments were excluded and those with mild impairments were informed to wear their glasses for the whole duration of the experiment. All participants had to sign a consent form before they could continue with the study. The experiment was approved by Lancaster University Ethics Committee.

Design:

A 2 (random vs repeated configurations) x 2 (arrow present vs arrow absent) within-subjects experimental design was used. Within the study there were two independent variables each with two levels (repeated/random configurations and target with the arrow present or absent). The dependent variable relates to the time it took participants to detect the target stimulus. Repeated configurations contained the same location of distractors and the single target stimuli, whereas random configurations had varying novel configurations of distractors with the target appearing in no consistent position within the display screen. The first phase consisted of four separate conditions that were repeated throughout the training trials. These conditions consisted of: repeated configurations; repeated configurations with the presence of a predictive cue (arrow); random configurations, and random configurations with the predictor cue. During the second phase (test phase) there were no predictive cues present indicating the location of the target. Participants were presented with both repeated configurations from Phase 1 and novel configurations. Upon completion of the two phases, participants were shown an amalgamation of repeated configurations (that occurred within the previous two phases) and novel configurations and they were requested to indicate any recognition. There were a total of 320 trials divided into four conditions each with 80 trials. Rest breaks occurred every 60 trials for 30 seconds.

Materials/Apparatus:

The study occurred in a small quiet room where participants had access to a Windows computer screen (24" wide screen monitor, 1920x1080 pixels) that had the appropriate downloaded software and a standard keyboard. Matlab was used to create the computer-based task with Psychtoolbox providing the graphic display and instructions whilst also recording reaction time and accuracy. All of the target stimuli and distractors were shown in black on a light grey background. One target was shown among 16 distractors during each of the trials.

Procedure:

At the beginning of the experiment participants were asked to sit at a computer and complete a series of demographic questions including age, handedness and native language. A set of instructions then appeared stating the nature of the task and indicating to the individuals that they were completing a visual search task and that their goal was to identify the target, 'T'. Once participants had found the target stimulus, they were informed to press either the N key if the target was rotated to the right, or the C key if it was rotated to the left. A screenshot was then presented to the individuals of a target (rotated 90° to the left) among distractors (see Appendix), showing the correct key to press and demonstrating what they were to expect during the study.

Within the trials involving a blocking phase, a black arrow was shown on a grey background indicating which side of the screen the target appeared on. During the second phase participants were tested by removing the presence of an arrow for both the random and repeated configurations.

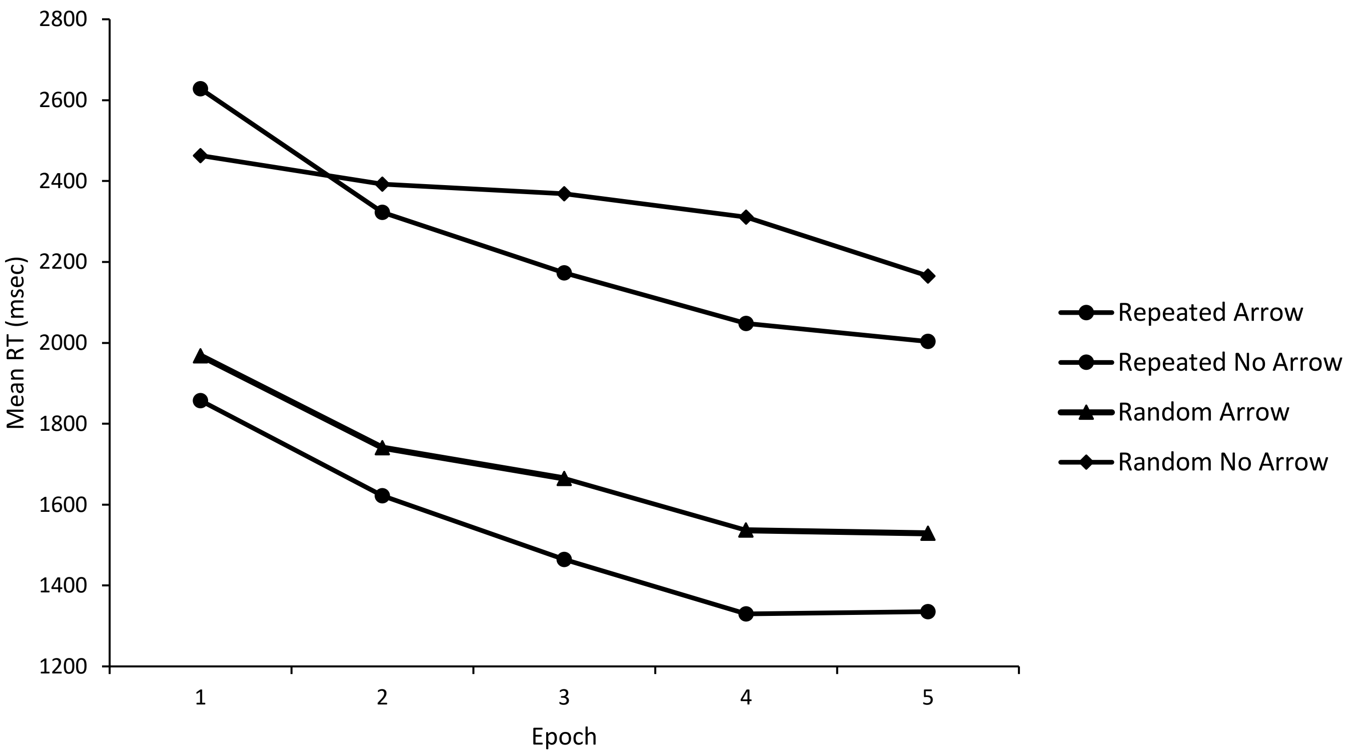
Trials started with a fixation cross ‘+’ presented in the centre of the display screen for 500 ms. The screen then changed to display a visual search task. Participants were instructed to search for a target ‘T’ either rotated 90° to the left or 90° to the right among 16 distractors. If participants took too long to respond, a time out screen would appear and the experiment would move on to the next trial. Likewise, if participants responded with the incorrect keys, an incorrect screen would appear before continuing with the next trial. After the trials were complete, participants were shown both previously encountered configurations and novel ones. They were asked to state if they recognised the configurations or if they were unfamiliar by pressing the up and down arrow. Once this phase was complete, the experiment ended.

Results:

The overall mean accuracy across all four conditions for the 34 participants was 97.5%. Any inaccurate responses were excluded from statistical analysis. As the experiment was investigating the effects of contextual cueing, the accuracy results will not be involved in any further data analysis.

Reaction times (RT) that deviated more than 2.5 SD away from the individual means were discounted from data analysis. The mean RT over the four conditions during Phase One (the training phase) are shown in Figure 1 (a) and the mean RT throughout Phase Two (the test phase) are displayed in Figure 1 (b). The RT data has been compiled into five epochs for phase one, and five epochs for phase two to ease data analysis and displayed data.

1 (a). Phase One (Training Phase)



1 (b). Phase Two (Test Phase)

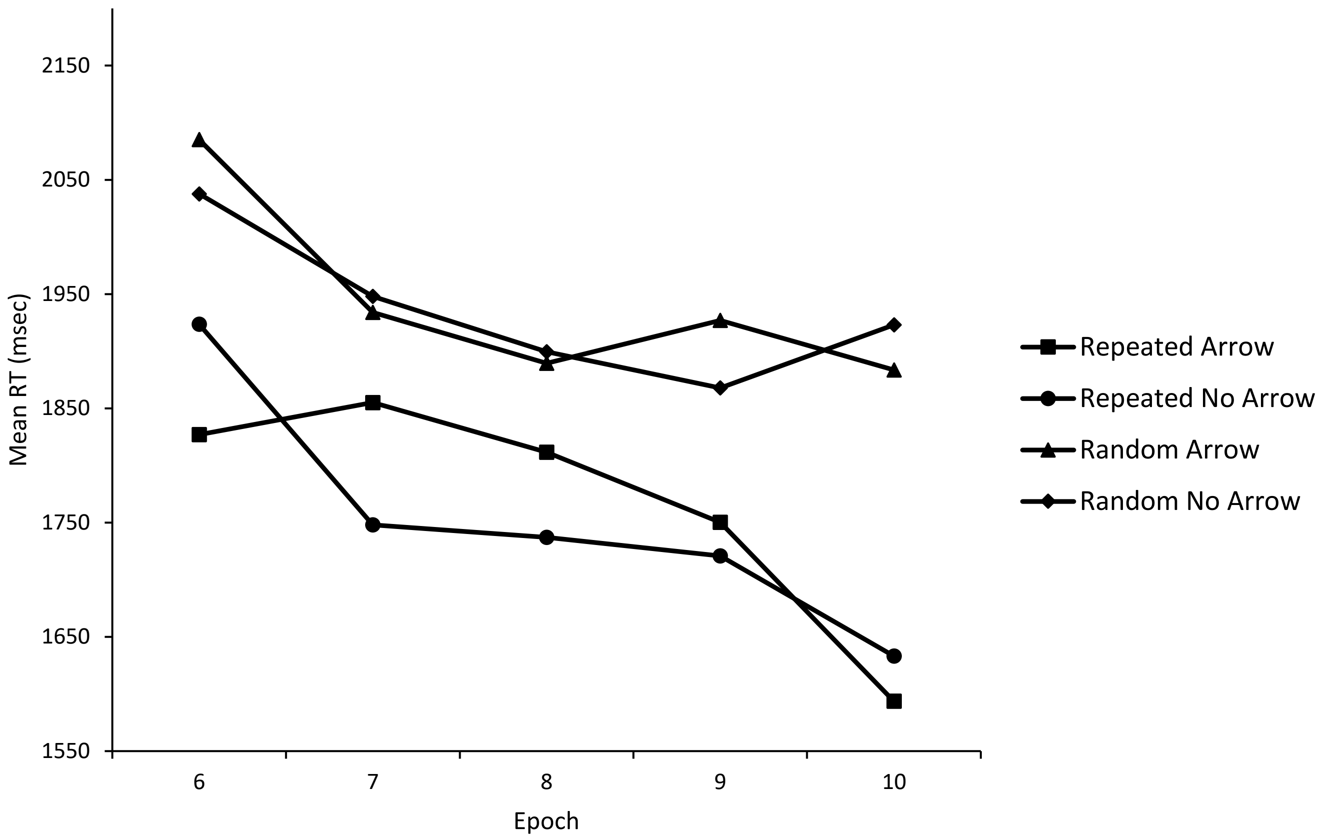


Figure 1. A Shows the mean reaction time data for all participants during the training phase collapsed into 5 epochs. B shows the test reaction time data after training has commenced for the last 5 epochs.

Phase One (Training Phase) Analysis:

A 2 (configuration: repeated vs random) x 2 (arrow: present vs absent) x 5 (epochs 1-5) repeated measures analysis of variance (ANOVA) was conducted on accurate RT data. Mauchly's test of sphericity has only indicated one violation of the assumption with epoch, $X^2(9) = 24.29$, $p < 0.05$. Therefore, the Greehouse-Geisser correction was applied to the following degrees of freedom. The ANOVA revealed a main effect of configuration, $F(1, 33) = 20.86$, $p < .001$, $\eta_p^2 = .39$. This highlights that there was a statistical difference in RT with participants performing quicker with the repeated configurations (*M* = 1878.39 msec) than the random configurations (*M* = 2103.91 msec). There was also a significant main effect of epoch, $F(2.87, 94.55) = 22.85$, $p < .001$, $\eta_p^2 = .41$. This shows that during the different epochs, there was as significant reduction in RT from epoch one (*M* = 2229.11 msec) and epoch five (*M* = 1758.21 msec). The presence of an arrow during the training trials also had a main effect of, F (1, 33) = 184.47, p <.001, η_p^2 = .85, suggesting that the predictive cue (*M* = 1604.78 msec) reduced the RT throughout phase one compared to an absent arrow (*M* = 2287.51). There was a significant interaction between configuration and epoch, F (4,132) = 4.36, p<.05, η_p^2 = .12. Simple main effects were analysed, and configurations were compared across the levels of epoch; Epoch @ Repeated, Epoch @ Random. Two one-way ANOVAs were used to determine the simple main effects which showed epoch was significant at both repeated, F (4, 335) = 3.41, p < .05 and random, F (4, 335) = 10.03, p < .001 configurations. This shows participants differed in their ability to recognise the target in various configurations. As the patterns are not different this shows no reliable cause of this interaction. In the second set of simple main effects, it showed there was no statistical difference between all epochs; one (F (1, 134) = .06, p = .80), two (F (1, 134) = .74, p = .39), three (F (1, 134) = 3.22, p = .08), four (F (1, 134) = 4.94, p = < 0.05) and five (F (1, 134) = 3.04, p = .08). There was no cause of the interaction. After examining both sets of SMEs, it is evident that the significant interaction between epoch and configuration has no causes. No significant interactions were found between epoch and arrow, F (4,132) = .57, p = .67. This was also the case for arrow and configuration, F (1,33) = 1, p = .33. The three-way interaction between; epoch, configuration and arrow were not significant, F (4, 132) = 2.41, p = .052, η_p^2 = .069.

Phase Two (Test Phase) Analysis:

A 2 (configuration: repeated vs random) x 2 (arrow: present vs absent) x 5 (epochs 6-10) ANOVA was completed on the data from phase two (the test phase). Mauchly's test of sphericity assumptions were only violated with the independent variable, epoch (X^2 (9) = 31.15, p < .001) and so the Greenhouse-Geisser correction was applied. Epoch revealed a main effect, F (2.61, 86.19) = 7.07, $p < .001$, $\eta_p^2 = .18$, highlighting quicker reaction times at the end of the study in epoch 10 (*M* = 1758.31) compared to epoch 6 (*M* = 1968.34) when collating all conditions into epoch. Configuration also had a significant main effect, F (1,33) = 39.94, $p < .001$, ηp2 = .55 which combined with the increase of reaction time and the evidence from Figure 1 (b) it highlights an effect of contextual cueing. It expresses that there is a much quicker response time in detecting the target in repeated configurations compared to random searches (*M* = 1758.15, *SD* = 543.80 and *M* = 1936.22, *SD* = 526.44). However, no significant effect was found with the training of an arrow, F (1,33) = .21, p = 0.65, η_p^2 = .006, suggesting no impact of the presence or absence of an arrow during training. No significant interactions were found between epoch and configuration (F (4, 132) = 1.89, p = 1.16, $\eta_p^2 = .054$), epoch and arrow (F (4, 132) = 6.08, p = .658, $\eta_p^2 = .018$) or configuration and arrow (F (1, 33) = .006, p = .938, $\eta_p^2 = .000$). There was also no significant interaction between epoch, configuration and the training of an arrow, F (4, 132) = 1.89, p = 1.16, η_p^2 = .054.

Explicit Understanding Test Analysis:

A paired samples t-test was completed to compare the accuracy in recognising previously seen repeated configuration's with aid of an arrow and the repeated configurations without the predictive arrow. There was no significant difference in the scores between random (*M* = .51, *SD* = .14) and repeated configurations that had the presence of the arrow (*M* = .54, *SD* = .27) conditions; t (33) = -.64, p = .53. This analysis suggests that the results found are likely down to chance and that participants are unable to detect configurations explicitly that they have previously seen, either being random or repeated with the presence of an arrow guiding their search. The paired samples t-test found a significant difference in the scores between random (M = .51, SD = .14) and repeated configurations without the presence of a predictive arrow ($M = .62$, $SD = .18$). The analysis produced the results, $t\ (33) = -2.91$, $p = <0.5$, which highlights that participants were able to explicitly comprehend a difference between being shown the random configurations and the repeated configurations without the predictor arrow. There was also a statistical difference between repeated configurations with the predictor arrow ($M = .54$, $SD = .27$) and without the arrow ($M = .63$, $SD = .18$), $t\ (33) = -1.45$, $p = <0.5$. This indicates that participants struggled to learn configurations when given the predictor of an arrow directing them to where the target was present.

Discussion:

Overall, this experiment investigated the impact of cue competition between a top down instruction cue and a configuration cue in detecting a target as quickly as possible. The theory of contextual cueing highlights that repeated configurations presented during visual search tasks have a quicker RT in acknowledging the target than random arrangements of targets and distractors (Chun & Jiang, 1998). Previous research (Kamin, 1969) has predicted a lessening of implicit associative learning between context and target when participants are presented with a second cue. This is down to the second cue competing with the first cue which results in the second cue being weakly attended and a lessening of learning occurs (Mackintosh 1975). Therefore, it was hypothesised that a lessening of learning of association would occur as a result of cue competition in contextual cueing tasks.

During Phase One of the experiment, participants were exposed to visual search tasks involving both random and repeated configurations with the aim of detecting the target. However, some trials involved a top down instruction (predictive arrow) indicating which side of the screen the arrow would appear. The impact of associative learning was tested during Phase Two without the presence of arrows, only the repeated and random configurations. The accuracy and RT to detect the target was calculated. The findings concluded that the concept of overshadowing predicted to be caused by the predictive arrow did not lessen the learning of association in relation to contextual cueing due to both cues leading to a decrease in RT from epoch 5-10. There was also no evidence of cue competition, therefore rejecting the research hypothesis predicted before the experiment. Despite the arrow cue providing slightly slower at the start and finish compared to the configuration cue, there was still an effect of contextual cueing. The findings from this study support that of Beesley & Shanks (2012) as previously mentioned in the introduction who investigated cue competition in contextual cueing tasks. They too found no evidence of cue competition or blocking.

The second condition of the experiment tested participants' explicit understanding of the repeated configurations. They were requested to indicate if they recognised several sequences of distractors and a target presented on a display screen by pressing a key on the keyboard. The findings indicated that participants were more accurate in recognising previously seen repeated configurations when they had not been presented with the arrow during the training phase. This highlights that the implicit training phase with the arrow absent was more influential in learning configurations than the arrow present, suggesting a presence of automaticity.

The Rescorla-Wagner model expresses how blocking effects occur during association tasks. The model highlights via a mathematical formula that the stronger the stimuli are, the stronger the reinforcement of the association between the two stimuli. Therefore, the stronger of the two cues competes with the other to form a more accurate association and weakens the impact of the second less predictive cue, resulting in a form of cue competition. However, this was not found to be the case in this experiment. Both the arrow and the effect of configuration both successfully predicted the location of the target accurately and quickly leading to an effect of contextual cueing occurring, discarding the relevance of salience. Due to the lack of cue competition between the predictive arrow and the configuration, this experiment contradicts what the Rescorla-Wagner model was devised to explain, as learning still occurred successfully between the cues.

An alternative explanation for the lack of cue competition and the presence of a contextual cueing effect is incidental learning, proposed by Schmidt & De Houwer (2019). An online study of colour-word contingency learning tasks occurred where participants saw a display showing a coloured word and were informed to react by pressing a key to respond to the colour of the text. They concluded that when participants were explicitly told to learn the contingencies, blocking effects were found which resulted in both the increase of RT during the word phase and errors made in the shape phase. However, if participants were not informed to acknowledge the contingencies, no effect of cue competition was evident. This can explain the lack of cue competition in our experiment due to incidental automatic learning of both cues leading to an absence of blocking which may have impacted associative learning as participants were not informed to learn the configurations of distractors and targets.

The concept of incidental learning not resulting in cue competition is supported by Jiménez and Vázquez (2011). They conducted a serial reaction-time task where participants were presented with sequences with informative contexts. They found evidence of learning the sequence and the context separately was equally as strong when the two were learned together. This significant finding supports this experiment as it expresses that cues do not need to compete with one another in order for learning to occur, as it is as strong when the two are learned apart. This highlights that the strength of association between the arrow or the configuration predicting the target is equally as strong when presented simultaneously rather than conditioned on their own. This also supports the claim by Schmidt & De Houwer (2019) who suggested that cue competition does not occur when stimuli are incidentally learned. Cleeremans (1997) used a research study very similar to the one used in this experiment. They used a very salient cue which involved a cross being placed near the location of the target. This is very similar to our second predictive cue as we presented an arrow that guided the participants attention towards which side of the screen the distractor was placed in to ease search. We concluded that the arrow cue being highly salient did not impact the learning of the contextual cue or significantly weaken associations. Cleeremans (1997) also found that the sequence learning was not affected by the presence of this highly salient cue.

This theory of incidental learning suggests a role of automaticity in relation to attention being focused on the contextual cueing task. This is due to the fact that despite two cues of the target competing against one another to form stronger associations. Kamin (1969) suggested that there should be a weakening of association between the second less salient predictive cue, resulting in less attention being focused the second cue association. However, this experiment found that attention was focused on both of the cues, despite previous research indicating this not to be the case. This incidental learning of associations, despite a cue being less salient than the other suggests an automaticity our attention and a lack of control. This allows for predictions of an automatic attentional focus on tasks.

Implications:

The results concluded from this experiment allow for several important implications to be made on the theory behind the reported statistical data. Most research reports producing evidence of contextual cueing base their explanations on the social learning theory of associative learning. For example, targets and distractor combinations are processed to aid identification of repeated configurations. Research highlights that cue competition is a result of determining the strength of the cue’s competing against one another and weighing them up to determine the more relatable cue relating to the target. However, this experiment has suggested that cue competition is not entirely down to weighing up both cues to determine the more salient of the two, rather inclusive of associative learning. As the experiment found no evidence of cue competition, and both configuration and the arrow presented improved RT and accuracy of detecting the target. This indicates that cue competition is down mainly to associative learning of cues and the outcome rather than the weighing up of the salience of cues. If cue competition was entirely down to the salience of these cues, then we would have expected to find evidence of cue competition, instead we found that both the arrow and configuration accurately predict the target in contextual cueing. Therefore, overall this experiment has led to theoretical implications on the cause and absence of cue competition and the reasons behind these cognitive processes. This theoretical implication also contradicts the main two models of cue competition. Due to competing evidence provided in this experiment, it can be drawn upon that more explanations of cue competition need to be derived in order to truly understand the complex cognitive process of cue competition.

In relation to practical implications of this research, this experiment can be applied to drug therapies for individuals suffering from depression or other abnormal personalities. This experiment can be applied to individuals who are exposed to both drug and counselling treatments to counteract the implications of depression on their self. Drug therapies such as the use of SSRI’s can represent a cue leading to the treatment of the individual, the competing cue of counselling services such as CBT can also result in the remedy, aiding individuals to get better. The Rescorla-Wagner Model predicts that the drug and the counselling treatments will compete against one another and one will override the other. However, this experiment found no evidence of cue competition. Whereas, Vitiello (2009) found that when drug and counselling treatments are presented alongside each other, they complement one another and lead to a more successful treatment. This practical implication of cue competition can provide explanations of therapies relating to abnormal personalities.

Limitations:

As with all research experiments, there were some limitations of the methodology used. One of the main restraints due to limited time and resources was the use of a within-subject design to conduct the study which resulted in all participants completing all of the conditions of the experiment inevitably leading to order effects. However, if a between-subjects design had been used then participants would have either been enrolled onto the control condition or the blocking condition. This would have provided more accurate and valid results as the within-subjects design meant that participants were exposed to both the arrow present and arrow absent. The presence of an arrow could also have weakened the strength of contextual cueing as participants focused less on identifying the target on all visual search tasks, than if the control and blocking conditions were completed by different participant groups. We can therefore conclude that the findings lack validity compared to an experiment completed as a between-subjects design.

A major limitation with the awareness task at the end of the experiment is the high probability that a large majority of participants were just guessing if they had previously seen the configuration shown on the display. As participants were not aware that they were being tested on their knowledge of the configurations shown in the previous phases of the experiment, many participants responded with comments stating that they had no knowledge of whether they had seen them before and stated that they had guessed their responses. This reduced the reliability of the awareness data and limits the consistency of the measure.

Therefore, no true conclusions can be drawn over the awareness data due to the lack of reliability of the data.

Another limitation is that nearly all of the participants that were involved in completing the experiment were Psychology students from Lancaster University and aged between 18-21. This means that participants would already have been exposed to knowledge of visual search tasks from modules within their degree. Consequently, there is a high likelihood that participants were able to guess the aims of the first part of the experiment when detecting the target amongst both repeated and random configurations. Thereby, limiting the validity of the visual search tasks. A further limitation was the lack of diversity in relation to age and education of participants also limits the generalisability of the results produced by the experiment. Therefore, the findings produced by the study lack generalisability to the wider population. In order to increase the generalisability of the study, participants of variable populations would need to be examined to produce a broader inference and more applicable results.

Strengths:

Despite limitations of the methodology and the experiment, it is important to note the strengths of the research. One of the main strengths of the research is that evidence of contextual cueing and no cue competition was found despite blocking conditions present during the experiment. This provides a new insight into blocking effects and cue competition. Whereas models such as the Brady and Chun (2007) computational model and the Rescorla-Wagner models focus on cue competition occurring and the more appropriate cue gaining control over learning, the results of this experiment contradicted these findings. This experiment provides new information about the role of cue competition research in human cognitive Psychology where there is not an extensive amount of research that has been undertaken.

Another strength of the experiment is that the study has validity due to their being a good sample size of 34 participants. This was a good sample size which allowed for more accurate means values to be produced. A larger sample size ensured that any anomalies or outliers did not significantly impact the overall spread of data, which resulted in producing more accurate results and statistical testing. Therefore, having a decent number of participants, ensured that an overall effect of contextual cueing was found.

As the duration of the experiment was around 30 minutes it meant that participants were asked to concentrate for a reasonably long period of time, so rest breaks were introduced every 60 trials for 30 seconds. The aim of this was to reengage and reactivate parts of the brain as the human brain has a lack of ability to focus attention on a given task for a long period of time. These rest breaks were also designed to allow participants to implicitly retain information they had previously seen, rather than being bombarded with large quantities of visual search tasks. As the experiment took place in a lab conditions, rest breaks and attention were able to be monitored by the researcher present in the room. This ensured that the participant stayed focused on the task and did not get distracted resulting in a lack of attention.

Overall Conclusion:

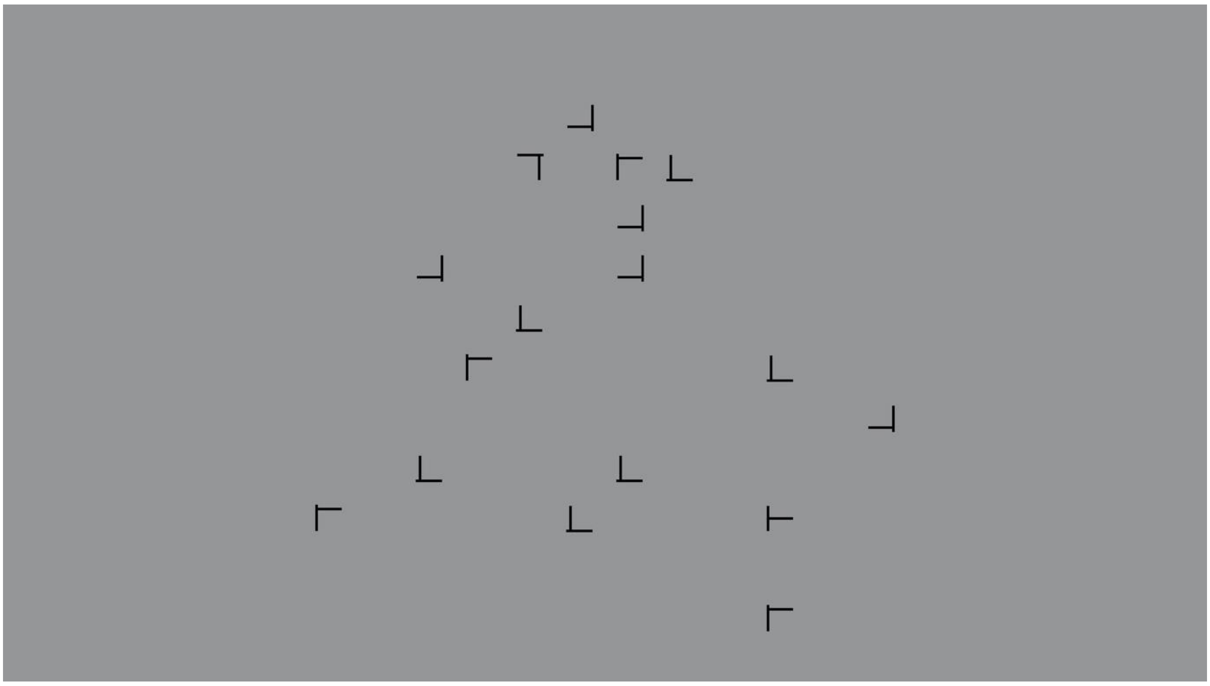
The experiment was designed to investigate the effect of cue competition in relation to a top down instruction cue and configuration cue within contextual cueing tasks.

Our findings have led to the conclusion that despite a top down instruction predicting the location of the target during visual search tasks, there was still an effect of contextual cueing and no presence of blocking via cue competition. The findings also indicated that there was no statistical evidence that participants were able to explicitly differentiate between previously seen and novel configurations. This contradicts the Rescorla-Wagner and the Computational Model by Brady and Chun (2007) which indicated that cue competition would occur due to the effect of predictive errors. Therefore, further research is needed to determine the factors that lead to cue competition occurring or not, as found in this experiment. It would therefore be beneficial to combine the previous stated models with this experiment to provide some information about why this experiment and Beesley and Shanks (2012) found no evidence of cue competition.

Word Count: 7028

Appendix:

Screenshot of Display Screen of Visual Search Task



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