The influence of motivation and prior learning on response selection in a go/no-go task

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May 2010

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Abstract

We make decisions everyday which involve us either producing a specific behaviour or withholding certain behaviours, based upon the desired goal. These decisions are strongly influenced by motivation and the learned associations between stimuli and their predicted value. Here, we measured the response times and error rates for stimuli assigned either a ‘go’ or ‘no-go’ status, after being seen in a value learning task involving the win or loss of points. We found that low gain associated stimuli significantly enhanced response times compared to low loss associated stimuli, and that high loss associated stimuli elicited significantly more errors from participants, compared to low loss associated stimuli. It was concluded that arousal is the key factor in motivating behaviour, and when we are aroused, we have less control over our actions.

Key Words:	Motivation	Value Learning	Go/ No-go Task	Attention	Arousal

Motivation can be defined as a psychological construct, which is an incentive to induce an action or behaviour in order to achieve or obtain a certain goal. This goal-oriented behaviour is directed firstly by prior learning; interactions with objects in the past result in expectations of likely outcomes, i.e., rewards or losses, should one encounter them again in the future, and secondly by visual attention which allows one to attend to salient stimuli in the environment that are relevant to the desired goal. The actual course of action chosen is therefore determined by the expected values of the stimuli, in hope of achieving the desired goal. For example, if an individual encounters a dog, they are either going to have a positive or negative experience. When a similar situation arises in the future, the dog is likely to capture the individual's attention and a choice will be made between approaching and avoiding it. The goal of the chosen behaviour is to either to enjoy playing with the dog or to avoid possibly being injured, depending on what the individual expects to happen (as previously learnt). Here, we examine how quickly a response selection is made, and how successfully an action is inhibited, based on the motivational salience of the stimuli. This research is important because it looks at why people make certain perceptual decisions within a constantly changing environment and how these decisions can be dramatically influenced by prior experience with the objects around them. Although there is previous research into the effects of prior learning, this revolves more around the recognition of targets (Raymond & O'Brien, 2009), whereas the present research aims to look at the motor movements of making an actual go response or withholding a response action.

A research area that has provided much information on the way motivation and the likelihood of rewards has an impact on attention, and our ability to inhibit responses, stems from research on addiction. Research has found attentional biases towards smoking-related stimuli in smokers, and also that smokers will make a faster approach response to smoking-related stimuli, than an avoidance response, compared to control groups of non-smokers (Bradley, Field, Mogg & De Houwer, 2004). There are also suggestions that stimuli with relative personal importance will stand out in an environment and be attended to efficiently (Robinson & Berridge, 1993, 2001). This appears to reflect the liking versus wanting aspects of motivation; whereas 'liking' has more of a hedonic affect, 'wanting' is a much stronger desire that creates anticipation and arousal due to prior experience and knowledge of the desired goal. This 'wanting' is critical to motivation; it drives behaviour and allows us to place value on things in our environment (Goldstein *et al,* 2010). Other evidence looking at selective attention and substance values comes from Bradley, Field, Healy and Mogg (2008) who extended previous research by investigating the causes behind attentional and approach biases in addiction. Using a visual probe, stimulus-response compatibility, and rating tasks, they found that where as attentional biases were due to motivational salience (valence), approach biases were due to the affective properties, or emotional values. The author's conclusions were consistent with others in saying that the initial attentional biases express the 'wanting' part of an addiction, and that the actual liking part is a separate cognitive process (Robinson and Berridge, 1993, 2003).

In a related vein, within the topic of attention, the impact of emotion on attentional processes has been widely researched. Evidence has shown that primary emotions, for example anger, fear, disgust and joy, may initiate neural circuits of attention, which, in turn, initiate appropriate goal- oriented behaviours. For example, attentional circuits responsible for identifying danger and flight may be triggered by the emotion of fear (Lang, Davis & Öhman, 2000). Other evidence suggests that a link between emotion and visual attention may be intertwined with specific emotions such as sadness and anxiousness, which could contribute to the control of behaviour (Jefferies. Smilek, Eich & Enns*,* 2008). Emotions therefore motivate us to behave in particular ways, and it has been found that positive emotions initiate more of an approach system, and negative emotions tend to initiate more of an avoidance system (Carver & Scheier, 1990). Whereas motivation may be seen as a controlled response to satisfy a specific desire, emotions elicit a more reflexive response which directs behaviour in response to stimuli. A study by Ohman, Flykt and Esteves (2001) found that participants were much faster at identifying and responding to fear-related stimuli than fear-irrelevant stimuli, and even more so if they were afraid of the fearful stimuli already. Similar results have been seen in other studies (Fox & Damjanovic, 2006; Miyazawa & Iwasaki, 2009), which highlight the influence of past experience and subjective stimulus values on response selection. However, results from research studying emotional stimuli share a common pitfall in that participants are likely to be affected by various emotions differently, and to different extents (depending on their previous experiences with those emotions), a factor that may confound the results.

In the present study, a value-learning paradigm is used where participants will learn the value and probability outcome of faces. The faces will have neutral expressions so as to avoid any biases based on emotional content. Value-learning paradigms are commonly used in research (Delgado, Li, Schiller & Phelps, 2008; Armel, Pulido, Wited & Chiba, 2008) and are useful as participants' prior history with the stimuli is known. Evidence has shown that response selections are made more on the basis of the assigned value of the stimulus, rather than simply following task demands (Padoa-Schioppa & Assad, 2006). This therefore provides a useful method to study what effects certain stimulus values have on behaviour. Raymond and O'Brien (2009) investigated how predictive values of stimuli effect visual perceptual decisions when attentional resources are fully available or limited. Using a value-learning paradigm and attentional blink task, their results from short lag (200 ms) and long lag (800 ms) conditions showed that recognition was more accurate for highly predictive stimuli in the long lag condition. In the short lag condition there were no attentional blink effects for win-associated stimuli, but there were for loss-associated stimuli. These results emphasise that when attentional resources are limited, the prediction of a gain improves recognition processes to a greater extent. This study is of particular relevance because it shows how previous experience and learning dramatically influences and guides goal-oriented behaviour. However this experiment was not so much about response selection, but more to do with memory, recognition and cognition. The present study uses a go/ no-go paradigm immediately after the value- learning task, which focuses on the ability to inhibit a response rather than just detecting a target. We are exploring how prior learning of stimulus values affects how quickly participants actually go (response selection), or not go (response inhibition) to a stimulus.

Response inhibition can be defined as the repressing of thoughts and prevention of an action. Across research, response inhibition is regarded as a major component of executive control (Dowsett, 2000; Davidson *et al.*, 2006) and a useful method for investigating aspects of it is the go/no-go paradigm. In the go/no-go paradigm stimuli are presented and participants are asked to either withhold a response to 'no-go' stimuli or make a response to 'go' stimuli. It is used to measure participant's reaction times and how many errors are made by making a response to no-go stimuli. These errors may be due to a wide variety of causes and it has been found that arousal is a key factor because it initiates motivational systems which, in turn, trigger different behavioural responses (Kenrick, Neuberg, Griskevicius, Becker, & Schaller, 2010). Verbruggen and Logan (2008) used the go/no-go paradigm (and the stop-signal paradigm) to examine the automatic and controlled aspects of inhibitory processes. Their method consisted of a learning phase and a test phase; go stimuli in the learning phase were changed to no-go stimuli in the test phase, and vice versa. From previous research, they predicted that participants reaction times would be slower for the go stimuli in the test condition as the ‘no response’ prompt will have been retrieved from memory due to consistent associations in the learning phase (controlled inhibition would be needed to override the automatic response). Their results supported the hypotheses and therefore provide evidence that prior learning of stimulus-response associations effects later response inhibition and speed of response selection. However, although this study shows how the go/no-go paradigm is effective for measuring how quickly and successfully participants attend to stimuli, it does not incorporate the important influence of motivational salience of the stimuli on response selections. Research conducted by Kertzman *et al.* (2008) used a modified version of the go/no-go paradigm to investigate the effects of motivationally salient stimuli on response times and response inhibition in pathological gamblers. Their version of the go/no-go task involved some conditions having a higher percentage of go or no-go stimuli to create increased feelings of anticipation or hesitation, respectively. They found that participant’s reaction times were slower and less accurate compared to a control group, suggesting that when stimuli require a controlled and voluntary response, but generate an automatic one, pathological gamblers tend to experience conflict between the two processes. This could mean that the slower reaction times in pathological gamblers are due to them being misled by periods of constant no-go stimuli, and any errors made could be due to succumbing to feelings of anticipation, therefore being unable to control a previously learnt action.

Our goal here was to use the go/ no-go paradigm to investigate whether prior learning affects response inhibition. Based on research into addiction, attention and the effects of expected values on recognition, and also response inhibition using go/no-go paradigms, we predict that negative expected values should produce more response inhibition than positive expected values. If stimuli are associated with highly predictive loss outcomes, it is expected that participant’s reaction times will be significantly slower (compared to less predictable loss outcomes) when the stimuli requires a response action. On the other hand, stimuli associated with highly predictive gain outcomes, are expected to impair response inhibition ability when participants are told not to elicit a response to the stimuli, compared to less predictable gain outcomes.

In summary, participants first completed an instrumental value-learning task where pairs of faces with varied probability outcomes and values were presented. In this task, participants were required to press one of two designated keys to choose a face. Once the stimuli values were learnt, participants completed a go/no-go task where faces from the first task (along with new novel faces) were presented as either go stimuli or no-go stimuli. Participants were required to press a designated key to make a response to go stimuli, and refrain from pressing it for no-go stimuli.

Experiment 1 examined response times to go stimuli and Experiment 2 focused on error rates to no-go stimuli.

Experiment 1

Participants firstly completed an instrumental learning task where the aim was to gain as many points as possible. Within-subject variables were valence (gain, loss, and null) and predictability (.80, .20, and 100% of getting nothing for null faces), and between-subject variables were gender (whether male or female images were shown to a participant). The valence and probabilities of face pairs were counterbalanced across participants to avoid image effects. Male and female conditions were used for counterbalancing purposes and the data from both were then collapsed together for analysis. We used three pairs of faces (consisting of six male or six female faces depending on the condition randomly assigned to), where one face pair was assigned to the gain, loss, or null conditions, providing a combination of five different expected values (-.8, -.2, 0, .2, .8). Each of the three face pairs were presented 100 times in a self- paced random order, providing a total of 300 trials. There were 100 trials in each block, followed by a break. Immediately after the learning task, participants completed a go/no-go task. An additional twelve faces (six male, six female) were used here, making a total of 24 face images consisting of six expected value (EV) faces (High Gain, Low Gain, High Loss, Low Loss, Null One and Null Two), six new novel faces of the same gender seen in the learning task, and 12 novel faces of the opposite gender to that seen in the learning task. There were four groups (group A having been exposed to only male faces during the learning task, and group B being exposed to only female faces); group A1 (Go for males, No-go females), group A2 (Go for females, No-go males), group B1 (Go for males, No-go females), and group B2 (Go for females, No-go males). The variables were the learning conditions (HG, LG, N, HL, and LL), and there were a total of 72 practice trials using 24 face images (12 male, 12 female), which were seen only in these trials. The purpose of the practice trials was to provide an estimate of mean response time on go trials for each participant so we could identify responses that were too slow or too fast. Participants' mean response time for correct responses was measured and any values above or below three standard deviations of this mean were identified as unusually slow or fast responses. The experiment consisted of 5 blocks of 120 trials with a break in between each block. Therefore there were a total of 600 trials in the experiment.

Method

Participants

A total of forty- eight healthy young adults from Bangor University (25 females; mean age 21 years) participated in exchange for course credit. Participants had normal or corrected to normal vision and informed consent was obtained. Only those who reached at least a minimal level of learning (as defined by having a mean performance of at least 65% in the last 30 trials) in the instrumental learning task were used for analysis. Fourteen adults (13 females; mean age 21 years) participated in the Experiment 1.

Apparatus

A Pentium computer, running E-Prime (version 1.0; Schneider, Eschman, & Zuccolotto, 2002), recorded data and presented stimuli on a 35-cm colour monitor. Participants gave their responses by pressing the appropriate key on a standard keyboard. The viewing distance was 64 cm.

Stimuli

Stimuli used in the experiment were chosen from the Karolinska Directed Emotional Faces image bank (KDEF, Lundqvist, Flykt, & Öhman, 1998). Faces were static grayscale with neutral expression. Hair was cropped and teeth and glasses were not shown. The images measured 3.7 cm wide by 5.29 cm high. In the instrumental learning task feedback was presented in Helvetica font of 60 point size. Other alphanumeric stimuli (+, -) were presented in Courier font, point size 18, and in black against a white background.

Procedure

Instrumental learning task.

A trial began with the appearance of a black central fixation cross for 1000 ms. This was followed by a randomly selected face pair, arranged vertically above and below a central fixation cross (see Figure 1). Participants made a choice between the faces and delivered their response by pressing “T” for the top face or “B" for the bottom face. The stimuli remained on the screen until the participant had responded. Once a response was made, the outcome (gain, loss, or nothing) was shown immediately on the screen in green, red, or black letters, and with an accompanying encouraging sound, a discouraging sound, or no sound, respectively. A running total of earnings was also displayed (+ referring to gain, - referring to loss).

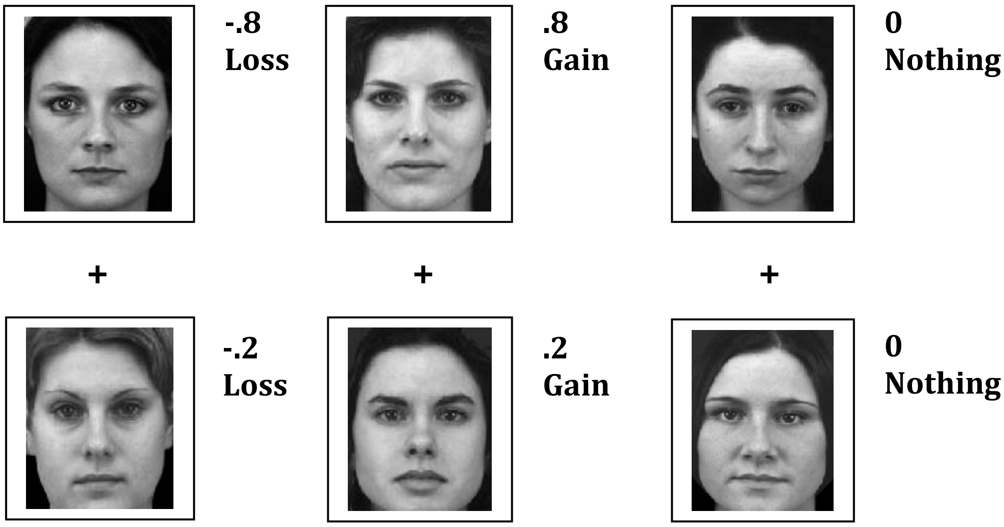

Figure 1: A figure to show the arrangement of face pairs in the value learning task, including their assigned probabilities and values.

EV Go experiment

As illustrated in figure 2, a trial began by the appearance of a black fixation cross in the middle of the screen for 500 ms. A single face image (male or female depending on the participant's assigned group) then appeared for 600 ms (as a pilot study showed 85ms did not work), followed by a blank screen for 1000 ms. Participants had to make a speeded response to go stimuli by pressing the "spacebar" key on the keyboard; they had to inhibit responding to no-go faces. If participants were slower or faster than the cut- off point they got a warning in the form of a beep followed by "Too slow" or "Too fast" appearing on the display respectively. Go and no-go stimuli were presented an equal 50%.

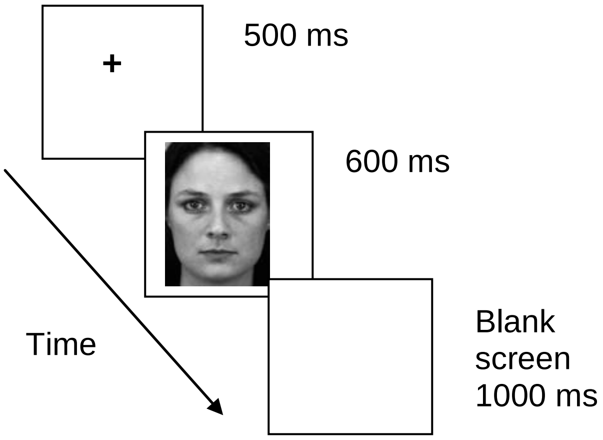

Figure 2: An illustration of how the EV Go experiment ran. A black central fixation cross marked the start of an experimental trial and preceded the face stimuli which was presented for 600 ms, followed by a blank duration.

Ethics

All participants were briefed on the experiment and informed consent was obtained. After being told the instructions to the tasks, participants were asked if they had any questions or concerns. At the end of the experiment participants were debriefed and again asked if they had any questions or concerns. Confidentiality was maintained as none of the participants' names were used and all the data was kept in a secure file. The experiment did not put participants at any risk of psychological harm and ethical approval was granted for the research.

Data analysis

Whether or not participants learned in the instrumental learning task was determined by calculating the probability of choosing the optimal choice within 10-trial bins (10 trials = 1 bin). The final criterion for learning was that participants had to reach a mean performance of at least 65% within the last three bins. Any participant that did not reach the learning level was removed from further analysis. The mean response time for each participant in each condition was recorded. Anticipation errors, identified by any response time under 200 ms, were removed from analysis, as were outliers, which were defined by values three standard deviations above the condition mean. The condition means calculated were used in three separate ANOVAs. First, a one-way, repeated measures ANOVA using null and novel condition means as factors was conducted to test for familiarity effects. Second, another one-way repeated measures ANOVA was conducted using EV (HG, HL, N, HL, and LL) as a factor. Pair-wise comparisons using Fisher's LSD was also conducted using this factor to look for specific differences between EV conditions. Finally, a 2-way ANOVA was conducted using valence (gain and loss) and predictability (high and low) as factors (and excluded data for EV = 0). An alpha level of .05 was used for all statistical tests.

Results

Instrumental learning task

After participants finished the learning task (i.e., after seeing 100 randomly ordered trials for each of the three face pairs), learning reached a plateau (as can be seen in Figure 3). Participants learnt gain face pairs significantly better than loss face pairs ($t(23) = 6.05$, $p < .001$), which is most likely due to gain faces having more motivational salience as they gave participants points rather than taking them away. More specifically, for gain pairs, the high- probability face (EV=0.8) was chosen on average on 88% of trials; for loss pairs, the low- probability face (EV=0.2) was chosen on average on 73% of trials; and for null control pairs (EV=0) a randomly selected face was chosen on 48% of trials.

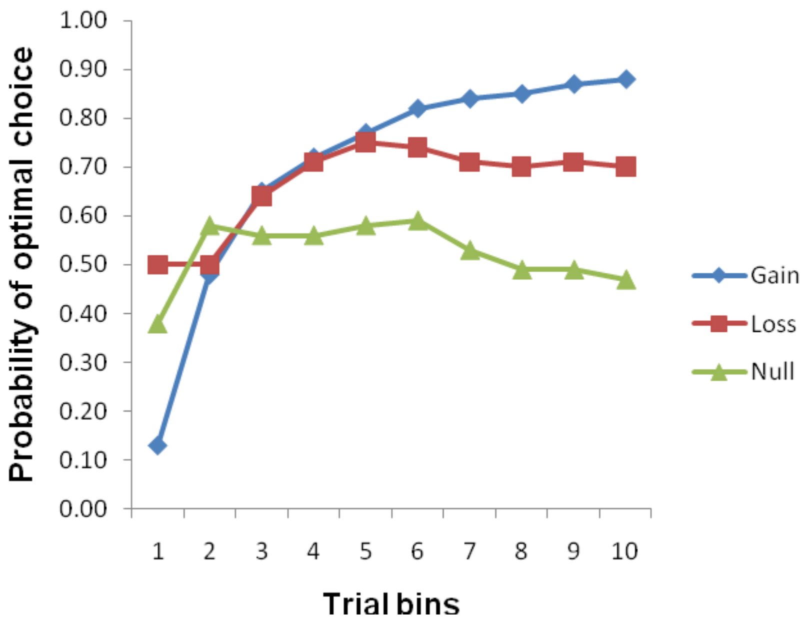

Figure 3: An example of one participant's learning curves for gain, loss, and null face pairs. A plateau was reached by the end of the learning task.

Go/No-go Task
Response time.

Overall, participants had a 98% accuracy rate and the overall mean response time was 407 ms. A planned comparison using a one-way, repeated measures ANOVA was conducted to check for familiarity effects and this revealed a main effect between the null and novel conditions ($F(1,13) = 8.33$, $p = 0.13$, $\eta p^2 = .391$). Participants had significantly faster response times to null stimuli (M= 403 ms, SE = 8.1) compared to novel stimuli (M= 414 ms, SE= 7.5), which suggests participants were benefiting from seeing the faces previously (see Figure 4). In other words, they could categorize these faces by gender more quickly due to recognizing them, which means that making a speeded response to a stimulus may not just be due to its previously learned values.

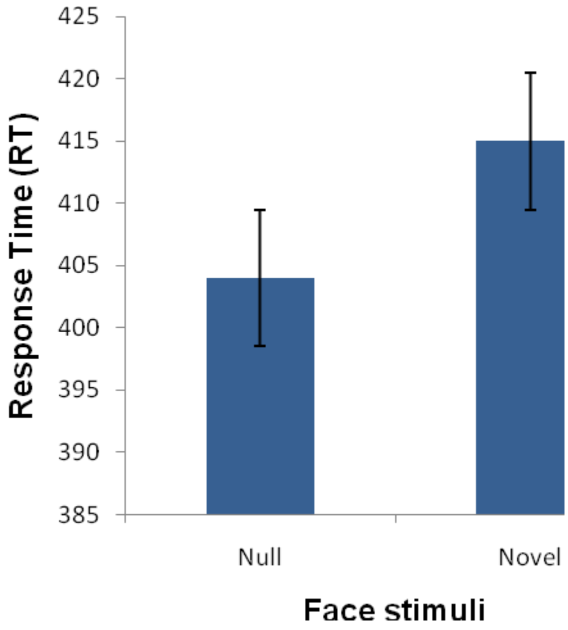

Figure 4: The response time for the null condition compared to the novel condition. Participants had significantly faster response times to null face stimuli than novel face stimuli.

The mean for each participant in each condition (the six EV conditions: HL, LL, Null, LG, HG, and Novel) was calculated and these means were used in a one-way, repeated measures ANOVA. Although non- significant (*F*(4,52) = 1.70, *p* = .164, ηp^2 = .116), as seen in Figure 5, pair-wise comparisons using Fisher's LSD revealed a significant difference between the LL (M= 414ms, SE= 8.73) and LG (M= 399ms, SE= 6.79) conditions (*p* = .015), which can be seen in Figure 6. The mean response time for the LG condition was 15 ms faster than the LL condition which is particularly interesting because in the learning task participants were choosing the LL faces (the optimal choice), whereas here, they are responding more quickly to faces that had less value. Other pair-wise comparisons were non- significant.

A two- way, repeated measures ANOVA using valence (gain and loss) and predictability (high and low) as factors revealed that there were no main effects for value (*F*(1,13) = 3.06, *p* = .104, ηp^2 = .191) or predictability (*F*(1,13) = 1.12, *p* = .308, ηp^2 = .080), which contradicts our prediction that gain and high- probability conditions would have significantly faster response times compared to loss and low- probability conditions. The interaction effect was also non- significant (*F*(1,13) = 2.24, *p* = .158, ηp^2 = .147). However, the results are quantitatively in our predicted direction for value (faster response times for gain over loss conditions).

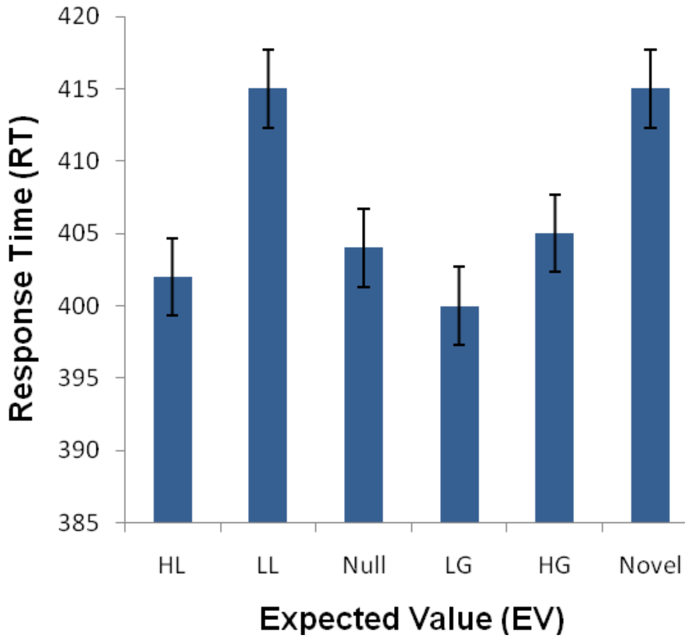

Figure 5: Mean response times for each of the six EV conditions.

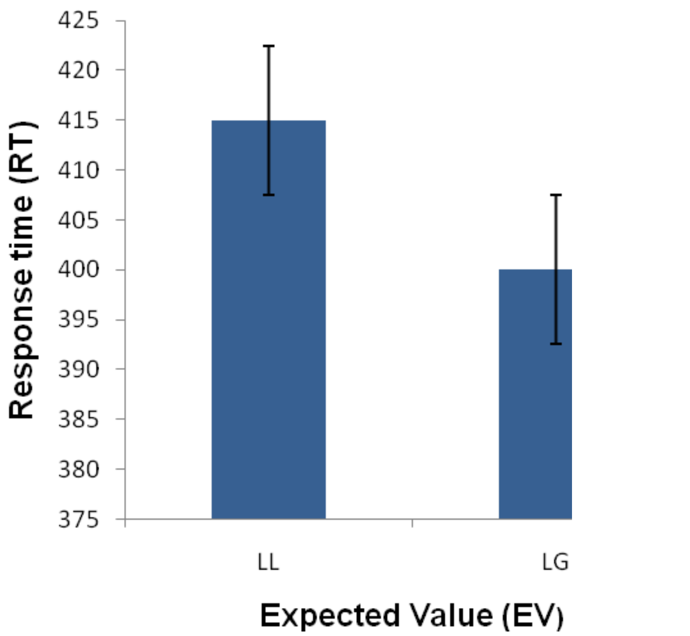

Figure 6: The response time in the LL condition compared to the LG condition. The LG condition shows a significantly faster response time to go stimuli than the LL condition

Discussion

Experiment 1 focused on the response times made to stimuli that were assigned a 'go' status in a go/no-go task. There were two main findings: first, significant familiarity effects were found when comparing null and novel conditions, and second, there was a significant difference between low loss and low gain conditions when looking at value learning.

The null and novel stimuli in the experiment had no expected values assigned to them and therefore the only difference between the two was that null faces had been seen prior to the go/no-go task. A significant familiarity effect suggests that approach responses were made based on recognition, because null faces were responded to significantly faster than novel faces. This is consistent with other research (Bornstein, 1989; Zajonc, 1968) because it shows that faces were coded if they had been seen before, and these codes were being used to facilitate approach responses in the go/no-go task. The surprising element to this finding is that there was a difference of only 11 ms. It could be said that the faces used as stimuli were easy to identify, and mere exposure to them has led to them being better recognized. However, because there was only a relatively small difference, and 98% accuracy of responses, it seems reasonable to suggest that there was also rapid identification of genders. This means task demands were being followed and the gender assigned as go stimuli was successfully being responded to.

The second finding that responses to low gain stimuli were significantly faster than responses to low loss stimuli was an intriguing result because in the learning task it was the low loss stimulus which was the optimal choice, and which was chosen most often in order to minimize losing points. Low loss stimuli should have therefore been more familiar and associated with an approach response to a greater extent than low gain stimuli. However, the current results contradict this view and hence suggest that prior learning of stimuli values through consistent associations does not influence later response selections. This belies other research where it has been found that consistent approach or avoidance associations with stimuli produces conflict between automatic and controlled responses, causing slower response times when the opposite behavior is required in a later task (Verbruggen & Logan, 2008). Both low gain and low loss stimuli were low-probable events, and therefore the observed behavior can only be explained in terms of valence. Our results are consistent with, and extend other research (Bradley, Field, Healy, & Mogg, 2008) because it appears that valence has an influence on attention, and also the motor movements of an approach response. More specifically, gain outcomes tend to initiate more of an approach response than loss outcomes, which is supported with research by Raymond and O'Brien (2009). This behavior relates to motivation because it seems that even the slight chance of gaining points is enough to drive motivation and direct behavior more so than the prediction of losing points. If there were no motivation driving behavior, task demands would have easily been followed (Padoa- Schioppa and Assad, 2006).

Experiment 2

In Experiment 2, instead of measuring response times to go stimuli we measured error rates to no-go stimuli.

Participants

Seventeen adults (12 females; mean age 20 years) participated.

Procedure

Instrumental learning task.

The instrumental learning task was as in Experiment 1.

EV No-go experiment.

The method was the same as for the Go experiment except for two aspects; first, 25% of the images were no-go (41 images) and 75% were go (96 images). This was to make the task harder, therefore increasing errors made. Second, face stimuli were displayed for only 85 ms (see figure 4).

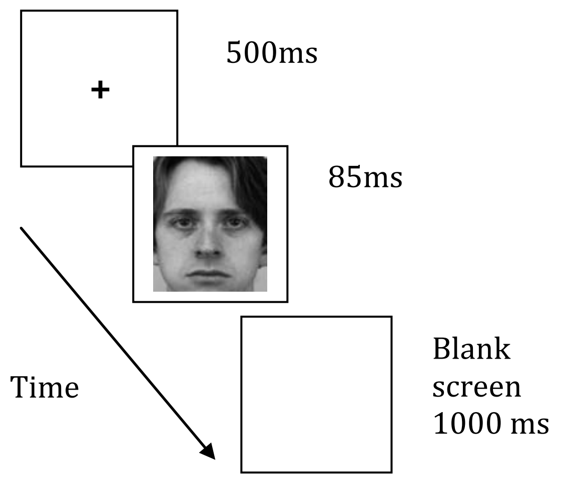

Figure 4: An illustration of how the EV no-go experiment ran. A black central fixation cross marked the start of an experimental trial, followed by the face stimuli for 85ms. A blank duration of 1000ms was then displayed.

Data analysis

Error rates were recorded which were defined by a participant pressing the key for no-go stimuli when it should not have been pressed. All other statistical analysis were the same as for Experiment 1.

Results

Instrumental learning task

As in Experiment 1, by the end of the learning task, learning leveled off (see Figure 3) and by then participants had learnt gain face pairs significantly better than loss face pairs ($t(23) = 3.96$, $p = .001$). For gain face pairs, the high- probability face was chosen on average on 88% of trials; for loss pairs, the low- probability face was chosen on average on 75% of trials; and for null control pairs a randomly selected face was chosen on 45% of trials.

Go/No- task

Overall, the accuracy average of participants was 88% and the mean response time for go trials was 336 ms. However, in this experiment we were interested in the error rates participants made to no-go stimuli. A one-way, repeated measures ANOVA was used for a planned comparison to evaluate the null and novel conditions against each other to check for familiarity effects. No main effect was found ($F(1,16) = .590$, $p = .454$, $ŋp^2 = .036$). A one -way, repeated measures ANOVA (using participant means for each of the six EV conditions) was used to evaluate the effects of value learning. As shown in Figure 7, although this proved non- significant ($F(4,64) = .145$, $p = .226$, $ŋ\ p^2 = 0.83$), pair-wise comparisons using Fisher's LSD revealed an intriguing difference between HL (M = .588, SE= .042.) and LL (M = .465, SE = .063) conditions ($p = .042$), as can be seen in Figure 8. This coincides with our prediction that high- probable events will enhance error rates compared to low- probable events. Finally, a two- way, repeated measures ANOVA using valence (gain and loss) and predictability (high and low) revealed a non- significant main effect of value ($F(1,16) = .005$, $p = .947$, $ŋp^2 = .001$), a non- significant main effect of valence ($F(1,16) = 2.71$, $p = .119$, $ŋp^2 = .145$), and finally, a non- significant interaction effect ($F(1,16) = 2.86$, $p = .110$, $ŋp^2 = .152$) .

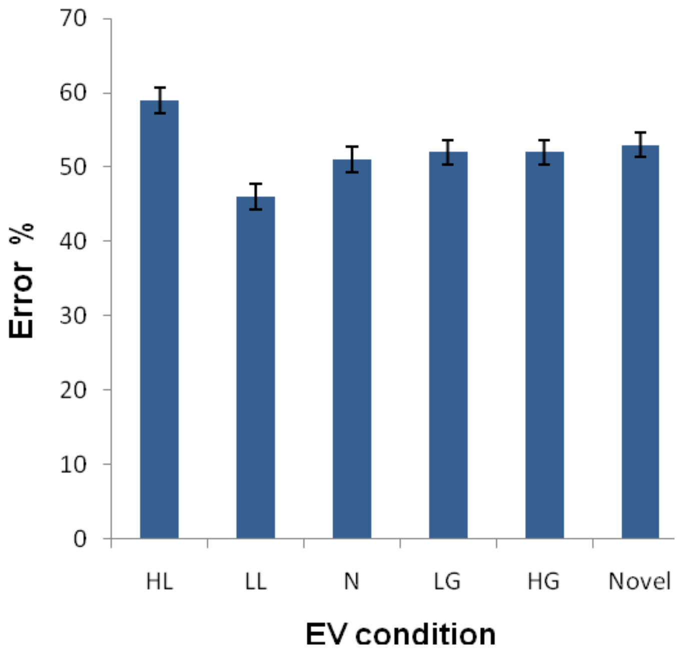

Figure 7: The error rates for each of the six EV conditions. A one- way ANOVA showed a non-significant difference between the six EV conditions.

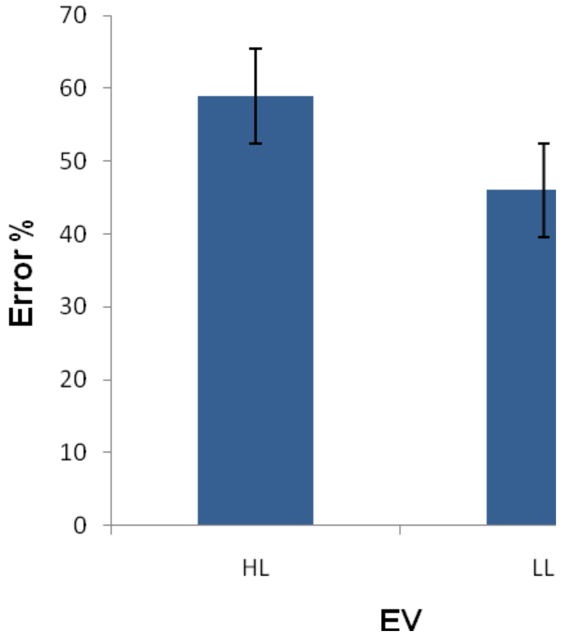

Figure 8: The error rates for the HL condition compared to the LL condition. Participants had 13% more error rates in the HL condition than the LL condition.

Discussion

Experiment 2 focused on error rates made when an approach response was given to stimuli assigned a 'no- go' status and requiring response inhibition. There was one main finding that was that high loss associated stimuli promoted significantly more errors (approach responses) than low loss stimuli.

This was the most surprising result yet because it contradicts our prediction that highly predictive loss events would cause more response inhibition than low loss events. Our results show that there was actually more response inhibition to low loss stimuli, suggesting that prior learning of stimuli values does not influence later performance of inhibiting an action. This is inconsistent with other research which has found that approach and avoidance responses were affected by prior learning of stimuli values (Kertzman *et al*., 2008), and it also contradicts research on emotion, which has found that negative emotions initiate an avoidance system (Carver & Sheier, 1990). The high possibility of losing points should have produced negative feelings, therefore causing avoidance behavior, yet approach responses were being made to this type of stimuli. However, emotion, along with motivation, actually helps in explaining the observed behavior. Prior research has shown that arousal is the key to motivation (Kenrick, Griskevicius, Becker, and Schaller, 2010), and high loss outcomes are much more arousing than low loss outcomes, because there is a much greater chance of losing points. This arousal captures attention, directing behavior accordingly, and it is this arousal that we expected to motivate behavior away from the high loss stimuli; however, it appears that another behavior is being associated with the stimulus because behavior is being motivated towards the arousing stimuli, rather than away. It seems that the arousal produced is being misinterpreted, and this could be due to the fact that 75% of images in the no-go experiment were assigned a 'go' status, which creates feelings of anticipation and keenness. It seems that when arousing no-go stimuli are displayed, the arousal is misplaced, and out of anticipation an approach response is mistakenly made.

General Discussion

In two experiments that began with an instrumental learning task in which novel face stimuli were associated with different levels of expected value. Through learning, stimuli became associated with having a high or low probability of gaining or losing points (or having no outcome as was for the null control condition). When the stimuli were learnt, a go/no- go task was used where 'go' status stimuli required a response action (Experiment 1 used value learned faces as go stimuli), and 'no-go' assigned stimuli required the inhibition of a response (Experiment 2 used value learned faces as no-go stimuli). Experiment 1 found significant effects of familiarity, and a significant difference between low loss and low gain value learning conditions. Experiment 2 found a significant difference between high loss and low loss conditions.

As a whole, the experiment generated four interesting questions. Firstly, the effects of familiarity were sought out in order to see how much of an influence the recognition of faces had upon response selection. There was a significant result in the go experiment, but there was not in the no-go experiment. Due to the fact that the difference between null and novel stimuli in the go experiment was only small, it could be said that response selections made in the go/no- go task were based on the stimuli and their associated values (however results should be taken with caution). Another reason for this conclusion is that our results show that even when a stimulus should have become familiar, this did not later enhance responses made. This is important because if familiarity affects were not checked for, we could not be sure whether it was just the stimuli values causing the behavioral affects seen.

Secondly, the effects of value learning create an interesting question. Taking the results together, it is apparent that arousal produced from the motivational salience of the stimuli is an important influencing factor when making response selections. The prediction of a gain and a highly probable event are potentially arousing, and the current results suggest that arousal is exceptionally attention grabbing, and interferes with behavior, causing us to have little control over our behavioral responses. This links back into research on addiction where it has been shown that stimuli with particular importance to an individual are likely to arouse them more so than stimuli with no importance to them, and will capture attention, initiating an approach response (Bradley, Field, Mogg & De Houwer, 2004; Robinson & Berridge, 1993, 2001). Prior learning did not prove to affect how stimuli were responded to, and therefore, in the go/no- go task, all of the faces were task-relevant and could potentially initiate either approach or avoidance responses. This is supported by our finding that low loss stimuli did not facilitate response times and error rates as it was expected to. This proves inconsistent with research on emotion, where it has been found that emotions triggered due to prior interactions with stimuli in the environment greatly capture attention and direct behavior (Jefferies *et al.,* 2008).

The last two questions raised involve the effects of valence (gain and loss), and predictability (high and low). Together, the results show a trend where gain outcomes elicit an approach response more so than loss outcomes. We could speculate that with a larger sample, and more enticing rewards, this trend would become a significant result and provide support to other research which has used attentional blink and go/no- go tasks (Raymond & O'Brien, 2009; Verbruggen & Logan, 2008).

Overall, results from the current experiment suggest that motivation and arousal work together and have a significant influence on response selections which require an actual response action, or response inhibition. More specifically, they show that we have less control over behavior when we are aroused. Our experiment adds to research because although previous evidence shows that recognition of stimuli is affected by prior learning, the current results show that this is not true for when an actual motor movement of an approach and avoidance response is required. Our findings are important because they provide an insight into why people make certain perceptual decisions, and the implications of this involve being able to work towards forming strategies and techniques to help prevent bad choices being made on a day-to-day basis. By being able to predict how we will behave in certain situations in the future, we can be prepared, and gain control over our actions. It would be useful for future research to look at using more arousing stimuli to look in-depth at the affects of arousal on attention and behavioral responses. Personality types could also be taken into consideration, for example, extraverts and introverts, along with other samples such as children with attention deficit and hyperactivity disorder (ADHD). By becoming more knowledgeable on how arousal and attention interlink, new and effective strategies can be developed to help capture and hold the attention of ADHD children, therefore helping them in a variety of settings.

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