THE EFFECT OF PRIOR ABUSE ON BEHAVIOURAL RESPONSES TO EMOTIONAL EXPRESSION IN THE DOMESTIC HORSE (*EQUUS CABALLUS*)

by

Brooke Evelyn Marie Greenwood

Thesis Faculty Advisor: Dr. Shannon Digweed

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Abstract

Several domestic species have shown discriminatory abilities when judging the level of affect in human faces. In other words, they can distinguish between positive (happy) and negative (angry) human facial expressions. As a species that relies heavily upon humans for survival, such recognition abilities aid domestic species in their interactions with human handlers. What has yet to be explored is whether former experiences of neglect or abuse influences subsequent behaviours in response to varying degrees of human emotion, expressed through facial expressions. Previous research suggests that poor welfare conditions, such as former experiences of abuse and neglect, can affect subsequent judgments of future events. Such that abused horses may have a diminished expectation of positive events, which often leads to an enhanced awareness of threatening stimuli, thereby, eliciting avoidance behaviour.

The present study aims to add to the current literature by examining differences in behavioural responses to positive (happy) and negative (angry) human facial expressions, between horses with and without former experiences of abuse and neglect. Eleven horses were assigned to one of two experimental groups; 5 horses with known, prior experiences of abuse, and the remaining 6 horses served as the control group, with no prior experiences of abuse. Horses were presented with counterbalanced photographs of positive and negative human facial expressions, and their behavioural responses were recorded.

Our results indicated that horses with previous experiences of abuse were more likely to hold a pessimistic bias, involving a diminished anticipation of positive events (decreased optimism), and an increased occurrence of stress-related behaviours. Alongside the insights that these findings provide into interspecific communication, they highlight the impact of welfare conditions on domestic horses wellbeing, cognition, and related behaviours.

Introduction

In many species, emotions provide valuable social and environmental information, that serve as a powerful influence upon animal behaviour (Waller & Micheletta, 2013). Emotions can be expressed through different modalities; visually via body language and facial expressions, by vocal expressions, and by olfactory cues (Waller & Micheletta, 2013; Briefer, 2018; Kikusui, Takigami, Takeuchi, Mori, 2001). The recognition of emotion could be a fundamental mechanism in promoting social communication. Recognition ability may permit animals to evaluate the social intentions and motivations of others, and the manner in which they behaviourally respond has adaptive functionality (e.g. showing fearful submission to aggression), that may facilitate social interactions (Spinka, 2012; Waller & Micheletta, 2013).

Specifically, strong discriminatory abilities of emotional affect in domestic animals in reference to conspecific and heterospecific faces provide evolutionary advantages, especially for negative emotions, as these tend to imply a high level of aggression and possible danger (Todorov, 2008). In terms of survival, it is adaptive for animals to scan their surrounding environments for threat. As such, facial discrimination and emotional recognition play a key part in the working relationship between domestic animals and humans. Domesticated species rely heavily upon humans for food, shelter, and protection. Thus, interactions between humans and domestic species serve a functional role, as they can develop, shape, and influence the type of relationship formed and an expectation of future events, as either positive or negative. Particularly, recognition of emotion through facial expressions is important as it is evolutionary advantageous to recognize emotions, as this guides behavioural responses that are crucial for survival, reward attainment, social interaction, and in avoidance of harm and punishment (Todorov, 2008). Several domestic species have demonstrated abilities to perceive, discriminate, and accurately recognize the emotions of others, and thus, alter their behavioural responses accordingly.

Dogs

Domestication has been thought to enhance interspecific communication and emotional perception, by shaping the behaviour of animals to better adapt to human environments (Albuquerque et al., 2016). Specifically, it may be advantageous for dogs to accurately recognize the emotions of humans as well as other dogs, to predict their relative intentions and subsequent behaviours. Using a cross-modal preferential looking paradigm, Albuquerque et al. (2016) examined domestic dogs' ability to recognize combinations of visual and auditory cues to categorize emotions. The results of this study and similar studies indicated that dogs can accurately integrate bimodal sensory emotional information, and discriminate between emotional valences, an ability previously known only in humans (Albuquerque et al., 2016; Muller, Schmitt, Barber, & Huber, 2015).

Further analyses suggest that dogs use their memories and other visual cues of real emotional human faces to successfully accomplish discrimination tasks (Muller et al., 2015). Further supporting this idea, research has indicated that domestic dogs attend to human gaze, and in many cases alter their behaviour according to gaze direction, for example, to acquire information about where desired food objects are located (Kaminski, Tomasello, Call, & Brauer, 2009). Other dog research lends evidence to physiological determinants of behaviour, such as the function of lateralized brain patterns influencing emotional processing in dogs. Specifically, with prevalent usage of the right hemisphere in analyzing negative emotional valence (i.e. fear, sadness) and the left hemisphere in analyzing positive emotional valence (i.e. happiness) (Siniscalchi, D'Ingeo, Fornelli, & Quaranta, 2018).

Sheep and Goats

Likewise, studies performed on other domestic species such as sheep and goats, yield compelling evidence for the use of facial cues in both identification and recognition of emotional state and associated brain specializations (Tate, Fischer, Leigh, & Kendrick, 2006). Under free viewing conditions, Peirce et al. (2000) found that sheep learn to discriminate between the faces of socially familiar individuals to obtain a reward, with an overall left visual-field bias (right-hemisphere advantage) for familiar, but not unfamiliar conspecifics. Interestingly, sheep did not show this visual-field bias for human faces (Peirce et al., 2000), suggesting a familiarity requirement in the functionality of right hemispheric bias. This research indicated that sheep seem to have a specialized ability for identifying faces comparable with non-human primates.

Further exploration of emotional recognition in regard to familiar conspecifics, was also of interest in a study conducted by Bellegarde et al. (2017). Here, the researchers investigated whether dairy goats would show different responses to familiar conspecifics, that were displaying positive or negative emotional states. The spontaneous behavioural reactions that were measured included ear postures, and interactions with the facial stimuli. Results of the study suggested that the goats spent more time with their ears forward when the negative faces were shown, compared to the positive, indicating a greater interest in negative faces (Bellegarde et al., 2017). So, if domestic animals can discriminate, recognize, and behave in response to emotions from conspecific and heterospecific faces, does this mean domestic animals have a bias in emotion perception?

To address this question, Nawroth, Albuquerque, Savalli, Single, & McElligott (2018) sought to determine whether non-companion animals (goats), would have a preference towards positive or negative human faces. The goats were presented with photographic stimuli of happy and angry human facial expressions. Following the completion of a discriminatory task, results indicated that goats performed more approach behaviours as they interacted first, more often, and for longer with the happy rather than the angry face. This lends evidence that being a companion animal is not necessarily a prerequisite for the ability to distinguish between human emotions based on facial expressions. Thereby suggesting that not only can domestic animals discriminate between different emotional valances expressed in human faces, but rather it suggests that a preference may lie to those faces that are happy and joyful.

Horses

Careful consideration of emotional preferences and the impact of welfare conditions in animals play as large determinants of behaviour. Further exploration of the motivations and meaning behind domestic species emotion recognition and discrimination abilities in horses has focused upon the importance of interspecific human-horse interactions in learning, the type of relationship, and subsequent behaviours (Brubaker & Udell, 2016; Proops & McComb, 2010; Smith, Proops, Grounds, Wathan, & McComb, 2016). More specifically, Brubaker and Udell (2016) state that healthy interspecific interactions involve synchronous relationships that are reliant upon three factors; the level of attachment, the emotional state of the human, and the horse’s previous experiences with humans. Again, this reinforces how heavily domestic animals rely upon humans.

Horse cognition and behaviour is a widely studied topic within comparative cognition. Horses perform successfully on a range of tasks: discriminative learning, memorization, and concept formation (Gabor & Gerken, 2010; Hanggi, 2003; Hintze et al., 2018). By using multisensory information, they can distinguish between humans and accurately assess human attentional state. Firstly, familiarity is a key aspect in determining the occurrence of stress-related responding. Otherwise implying that a horse will react differently in the presence of unfamiliar people within their environment. Previous research has shown that horses will consistently occupy the presence of a familiar person, or an empty space, over someone who is unfamiliar to them (Brubaker & Udell, 2016). Additionally, by attributing their attention and utilizing human-given cues, such as facial expressions, horses can recognize and remember individual handlers and trainers, regardless of whether their past interactions were positive or negative (Brubaker & Udell, 2016; Proops & McComb, 2010). Consequently, sufficient evidence demonstrates domestic horses preferred degrees of attachment to humans, and their assessment of human's emotional state through facial expressions, ultimately contributes to the development of synchronous relationships with their human handlers.

Further understanding of these essential aspects of horse behaviour, it becomes apparent that the emotional state of humans greatly affects the relationship between humans and horses. Since horses are a domestic species that work closely with humans, Keeling, Jonare, and Lanneborn (2009) investigated the effects of a nervous human upon horse behaviour. Nervous individuals tend to display somatic and physical symptoms such as increased heart rate, high muscular tension, and other anxious-related behaviours. Keeling et al. (2009) was interested in examining whether these nervous human handler behaviours had an overall effect on horse behaviour. Results indicated that nervous individuals increase the likelihood of a startle reaction or anxious responding in their accompanying horse. This research suggested that not only can horses pick up on visual human-given cues, but that they can also sense overt and covert changes in physiological arousal. Indicating that horses become sensitive to salient human behaviours and alter their behaviours accordingly depending on the nature of the human's attentive state (Keeling et al., 2009).

Since horses can adequately perceive both visual and physiological changes in emotional affect of humans, Smith et al. (2016) investigated domestic horses functionally relevant responses to differing human facial expressions of emotion. This study was the first evidence of horses' ability to spontaneously discriminate between positive (happy) and negative (angry) facial expressions in photographs. Horses were presented a photo of two males displaying both facial expressions, and their behavioural response were observed and analyzed. Results indicated that the horses performed stress-related behavioural responses to the angry faces, which was indicative of a functional understanding of the stimuli (Smith et al., 2016). The horses also displayed a left gaze lateralization bias that De Boyer Des Roches, Richard-Yris, Henry, Ezzaouia, and Hausberger (2008) would identify as being a behavioural response associated with stimuli perceived as negative. Overall, the study suggested that horses can readily discriminate between differing emotional expressions in humans, and their perceptions are validated in their subsequent behavioural responses.

Review of the current available literature indicates that few empirical studies have been conducted investigating the natural, untrained behaviours that follow from an animal's real, lived, former experiences of welfare conditions. Since domestic animals are reliant upon humans, and research has largely focused upon living environments conducive to positive interactions and idealistic welfare conditions of domestic animals (Todorov, 2008), what becomes apparent is a lack of exploration into how former experiences of poor welfare conditions such as neglect or abuse, may result in changes in domestic animals’ response to human facial expressions.

The present research builds on domestic species abilities to recognize and discriminate a human’s emotional state through their facial expression. Specifically, reflecting the findings of Brubaker et al. (2018), our study may further elucidate findings that reinforce the role of social communication, as a major component in determining whether a synchronous relationship is formed between a horse and their human handler, or not. Therefore, these type of recognition abilities may aid species in their interactions with humans, and thus provide a functional benefit. Furthermore, this study aims to explore how previous experiences of abuse and poor living conditions could change an animal’s behavioural responses to differing human emotions, portrayed through facial expressions. Such that, abused animals are more likely to anticipate future events as harmful, suggesting that their former experiences of neglect have led to the development of an accustomed pessimistic, negative bias (Briefer & McElligott, 2013). Consequently, if abused horses attend more to negative facial stimuli within their surrounding environment, then this may ultimately affect their human-horse relationships, interactions, and more importantly their perceptions of humans in general.

Using the methodology of Smith et al. (2016), we explored if former experiences of abuse affects domestic horse sensitivity to human emotional expressions. If this is the case, then we predict that the horses with previous experiences of abuse will attend more to negative emotional expressions, in comparison to horses with no prior abuse.

Materials and Methods

Subjects

Horses involved in the study were housed at Keno Hills Stable in Ardrossan, Alberta. Keno Hills' barn owner, Susan Fyfe, founded a charity called Rescue 100 in 2008, that became the first charitable foundation to service the rescue and rehabilitation of abused horses within the province of Alberta.

The present study sample included 11 horses from Keno Hills Stable. Of the 11 horses, 5 of them were from the Rescue 100 herd, as they had been rescued with prior experiences of abuse and neglect [3 geldings (ages: 4, 10, 13 years old), and 2 mares (ages: 14, 17 years old)]. Their experiences consisted of numerous years of physical abuse, emotional abuse, and instances of neglect, such as food and water deprivation, inadequate shelter, and ill care (i.e. poor grooming practices, grown out hooves from not regularly seeing a farrier, and ignorance of presenting health issues). The remaining 6 horses were from Keno Hill's herd, with no former experiences of abuse [2 geldings (ages: 9, 11 years old) and 4 mares (ages: 11, 13, 15, 19 years old)]. Use of these individual horses was approved for by the MacEwan University Animal Research Ethics Boards (Protocol-Digweed #101654).

Visual Stimuli

Stimuli were (8'' x 10'') laminated, high-quality, coloured photographs of two male models mounted on a white poster board (20'' x 30''), each with one positive (happy) and one negative (angry) image (Figure 1). Facial expressions to the visual stimuli were analyzed and coded for using the Equine Facial Action Coding System (Wathan, Burrows, Waller, & McComb, 2015).

Set-Up and Procedure

Horses were tested individually in a large, familiar stall. They were attached by two cross-tie ropes (one on each side of the head). Trials were conducted between September and December 2019, by a team of female experimenters. First, experimenter 1 walked the horse into the stall and attached the ropes to each side of the halter. This stabilized the horse to be in the correct visual position, preceding the presentation of the stimuli. Experimenter 2 was responsible for camera set up and recording each trial for an amounted time of 30 seconds/facial expression presentation.

Once this set-up was complete, experimenter 1 then walked towards the horse and presented the photographic stimuli in the horse's binocular field of vision, as the top of the poster board was held at wither height to standardize placement of stimuli, and importantly, the board covered the face of experimenter 1. Stimuli were held 1 meter from the horse's nose for 30 seconds (Figure 2). Each horse saw both positive and negative expressions of either model 1 or model 2 at least two months apart, counterbalanced equally by emotion and model.

Between presentations, each horse was taken out of the stall for a brief intermission, by walking them up and down the halls of the stable for approximately two to three minutes. This allowed for the horses to have a break between testing and improve their focus and attention to the subsequent stimuli. Trials were recorded with an iPhone 10 and a Samsung digital camcorder. Each individual trial video was reviewed using the Equine Facial Action Coding System (Wathan et al., 2015) to code for the horses' behavioural responses (i.e., Table I – looking durations, approach and avoidance behaviours, and occurrences of stress-related behaviours) in .wmv format, on an Asus laptop.

Results

Each behavioural response was coded for either by frequency of occurrence or duration of looking time, which formed both continuous and discrete data sets. To explore this data fully, a Mann-Whitney U (2-sided) statistical test was administered to find the median within each of the 12 horse behaviours that were tested for (Table I, Table II, Table III).

When viewing positive (happy) stimuli, the horses with no prior abuse engaged in more approach behaviour (Figure 3, $U=7.5$, $p<0.05$), and in forward ear posture (Figure 5, $U=13$, $p<0.05$) towards the stimulus. Similarly, in response to viewing negative (angry) stimuli, the horses with no former abuse engaged in more avoidance (Figure 4, $U=123$, $p<0.05$) and backwards ear posture (Figure 6, $U=134.5$, $p<0.05$) behaviours to the negative (angry) stimuli. These findings also remained true for the horses with prior abuse, as these horses also engaged in more approach behaviour (Figure 7, $U=12.5$, $p<0.05$) and forward ear posture (Figure 9, $U=7$, $p<0.05$) in response to the positive (happy) stimuli. Mirroring the behaviours of the non-abused horses, the horses with former experiences of abuse also exhibited more avoidance behaviour (Figure 8, $U=107.5$, $p<0.05$) and backwards ear posture (Figure 10, $U=118$, $p<0.05$) in response to negative (angry) stimuli.

However, significant differences were found in behavioural responses to viewing negative stimuli. Specifically, the horses with prior abuse engaged in more stress-related behaviours, which included longer monocular looking durations (Figure 11, $U=91$, $p<0.05$) and a higher frequency of increased eye whites (Figure 12, $U=105$, $p<0.05$) in response to the negative (angry) stimuli.

Discussion

The behavioural results reported above support the findings of previous literature, in that horses are able to recognize and respond in a functionally relevant way to heterospecific (human) facial expressions of happiness and anger (Smith et al., 2016). Horses with and without prior experiences of abuse, both demonstrated approach behaviours and forward ear posture to positive (happy) stimuli, and avoidance behaviours and backward ear posture to negative (angry) stimuli. On the basis of previous literature, these results are consistent with what we would typically expect within animal behaviour (Nawroth et al., 2018; Smith et al., 2016; Tate et al., 2006). Also as hypothesized, the horses with previous experiences of abuse attended more to the negative (angry) human facial expression in comparison to the horses with no former history of abuse. Significant differences were found in relation to the previously neglected horses, as they were more attentive and performed more stress-related behaviours in response to the negative emotional expressions. These findings raise interesting questions about the nature of emotional expression recognition, including the relative roles of learning and innate skills in its development.

There are numerous possible explanations for the emergence of horses' abilities to discriminate particular human facial expressions. Horses may have adapted a pre-existing (ancestral) ability to respond appropriately to negative emotional expressions of conspecifics, and throughout their coevolution with humans, transferred this ability onto a morphologically different species. Whether it is an ability favored by selection pressures during domestication and artificial selection thereafter, or, indeed, whether the capacity to read emotional expressions in heterospecifics is an ability that occurs commonly in mammals (Muller, et al., 2015).

Alternatively, horses may have to learn to interpret human expressions during their lifetime experience with humans (Nawroth et al., 2018). To support this argument, familiarity is found to be a significant factor in dogs' recognition of human expressions; they perform better when faced with their owners or with people as the same gender as their owners (Merola, Prato-Previde, Lazzaroni & Marshall-Pescini, 2014; Nagasawa, Murai, Mogi, & Kikusui, 2011). Additional considerations can be made in regard to horses previous background history and experiences with humans. Given the diversity of roles horses play in society, the experiences surrounding the horse-human relationship is an important area of study. Brubaker and Udell (2006) suggest that understanding the human-horse bond is imperative to the safety of horses and humans. The relationship appears to be complex and dependent upon a variety of factors, including the horse's past experience with humans. Horses and humans are often closely bonded, as most handlers describe their relationship as synchronous. However, we mustn't be naïve. Unfortunately, not every human-horse relationship is as positive, happy, and ideal as previously described. It becomes important for us to further explore the consequences of circumstances where the bond may be weaker, unhealthy, and/ or dangerous. Particularly, in regard to domestic horses with previously lived poor welfare conditions, that have experienced months, if not years, of neglect and abuse by their human owner(s).

Specifically, Mendl, Burman, Parker, and Paul (2009) discuss the effects of previous welfare conditions on species judgments of future events, and subsequent behavioural responses. Such that if domestic horses lived in "good" welfare conditions, meaning they had sufficient food supply, shelter, and protection, they are more likely to withhold an optimistic bias of future events. Whereas for horses who have experienced "poor" welfare conditions of abuse and neglect, their perceptions of future events are more likely to be of a pessimistic bias. Suggesting that welfare states can positively or negatively reinforce worldview perceptions and horses behavioural responses, to either attain rewards (optimistically) or avoid punishment (pessimistically). Inadequate and abusive welfare conditions may compromise horses anticipation of future positive events. The recognition of negative stimuli has particular functional relevance, as it allows domestic species to anticipate potential negative consequences, which facilitates survival (Mendl et al., 2009). Thereby, providing sufficient evidence to suggest that lifetime experience has a significant role in shaping emotional recognition.

Moreover, cognitive bias can be applied in explaining the observed difference within the horses that had prior experiences of abuse, as an increased pessimistic bias towards the negative (angry) stimuli. Previously lived experiences of poor welfare conditions and abuse diminished the horses anticipation of positive events and enhanced their attentiveness of their surrounding environments in search of threat (Mendl et al., 2009). Pessimistic bias was reflected within the comparably higher occurrences of two stress-related behaviours; monocular looking durations and increased eye whites, and these behaviours are functionally significant.

Horses have white sclera around the eyes, although generally this is not visible at rest (Wathan et al., 2015). In some situations, horses will display more of the white sclera due to a change in the opening of the eye or position of the eyeball. Often, the amount of visible white sclera is associated with the expression of fear in many animals, including horses and humans (Wathan et al., 2015). Thereby indicating that horses will adjust their vision in relation to their situation. By their nature, horses tend to turn their heads to look with both eyes (binocular vision) at objects of interest in their surroundings. However, in perceived situations of danger and fear, horses will use their monocular vision, to see different things through each eye, in their lateral fields (Hanggi & Ingersoll, 2012). The ability to scan their environment out of each individual eye helps horses assimilate what is going on around them. Should something trigger their senses, they can quickly switch to monocular vision to detect danger around them. A horse's sense of sight might not be their strongest, but it is certainly the most valuable to them in terms of survival.

The functional significance of these behaviours is relevant in discussing the observed difference amongst the stress-related behaviours. The horses with former abuse displayed greater durations of monocular vision and a higher frequency of increased eye whites, in response to the negative stimuli. Indicative of a sequence of behaviours that are functionally adaptive and reflective of an animal with a diminished expectation of positive events, enhanced attentiveness, and an increased awareness of their surrounding environment as they constantly scan for threat.

Our results provide evidence that horses use emotional cues from humans to guide their behaviour. Additionally, horses may adjust their behavioural response in accordance with their previous experience with humans. Such that, prior welfare conditions can influence horse behaviour, in terms of how they judge future events and anticipate the motivations of others. Established earlier, in general, animals tend to prefer positive, happy, joyous, human facial expressions (Nawroth et al., 2018). However, in animals who have been abused in their lifetime, this preference may shift to a fearful alertness for the negative (angry) expressions in their environments. Such observations occurred within the horses with poorer welfare backgrounds, consisting of abuse and neglect, as they displayed higher rates of stress-related behaviours. As a result, the horses with prior abuse showed more vigilance towards the negative (angry) facial expression (i.e., longer durations of monocular vision and a greater frequency of increased eye whites), in comparison to the horses with no prior instances of abuse.

Concerns for animal welfare are generally based on the assumption that non-human animals can subjectively experience emotional (affective) states, and hence can suffer or experience pleasure (Mendl et al., 2009). The primary function of emotions in these contexts is widely hypothesized to be to guide the animal's behavioural decisions in order to achieve survival goals – the attainment of valuable resources/rewards, and the avoidance of harm/punishment. Such that, prior experiences of poor welfare conditions (i.e., abuse and neglect), can create negatively valanced affective states within the animal, leading to an enhanced attention of threatening stimuli. In the horses that had former experiences of abuse, over time, this led to a pessimistic bias, showing a diminished anticipation of positive events. As a result, the horses with prior experiences of abuse were more attentive to the negative (angry) facial expressions and as a result, displayed more stress-related behaviours, when compared to the horses with no prior experiences of abuse.

Although the significant results of our study provide evidence to support the hypothesis, there is further research that could be conducted to more fully understand emotional recognition. Future research efforts could be directed at exploring whether emotion recognition is an ability that is common amongst other animals. To further elucidate the evolutionary mechanisms that may be involved in heterospecific facial recognition, the responses of various species with varying degrees of human exposure could be compared. Such that, new research studies could look at comparing heterospecific emotional recognition in, for example, wild animals compared to domestic animals. Other explorations could include continued study of the differences that arise from varying levels of previous welfare conditions, especially issues surrounding animal cruelty. Such studies could further illuminate if the effects of former abuse and neglect affect species the same, or differently, in regard to behavioural outcomes.

As familiarity may evidently play a large role in emotion recognition of heterospecifics, the horses may not have perceived either stimulus as overtly positive owing to the unfamiliarity of the humans depicted in the photographic stimuli. It is notable that in our study, the photographic stimuli were of two unfamiliar males. The generality of our findings could be further investigated through future research endeavours of particular effects of identity, familiarity, gender, and age on abilities to discriminate a range of emotional expressions.

Furthermore, future research could look at exploring if differences arise in physiological measures such as heart rate. Lastly, future studies could look at further exploration of the cognitive biases that are shaped from experience, by identifying and testing more tasks that could specifically study ‘optimistic’ or ‘pessimistic’ deviations from expected response probabilities.

Conclusion

The purpose of our present study was to determine the effect of prior experiences of abuse on domestic horse behaviour. As hypothesized, horses with former abuse attended more to the negative (angry) human facial expressions. Further analyses of these results are consistent with evolutionary and cognitive theories of animal behaviour. That is to say, that this research has helped to advance our understanding of the impact of former experiences of abuse on present day domestic horse behaviours. The current study indicates that prior abuse and neglect influences the behavioural decisions animals make following assessment of social cues and in anticipating the behaviours of others. Only by conducting behavioural studies and employing facial action coding system approaches, will we be able to move closer to understanding the way previously lived conditions of abuse and neglect, can profoundly affect the organizational and functional principles that operate within animal cognition and behaviour.

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Figures

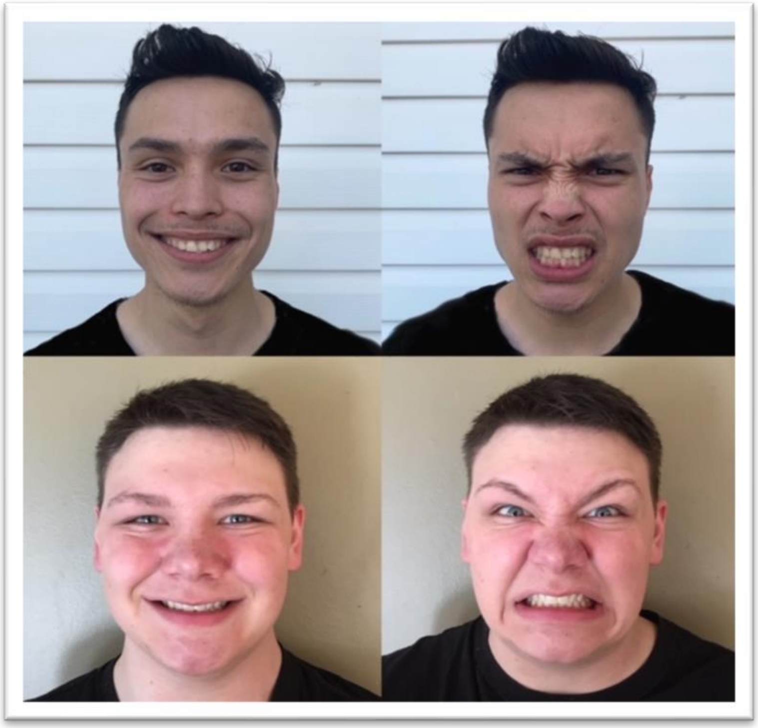

Figure 1. Photographic stimuli of two male models displaying both a positive (happy) and negative (angry) face (Model 1 – top, Model 2 – bottom).

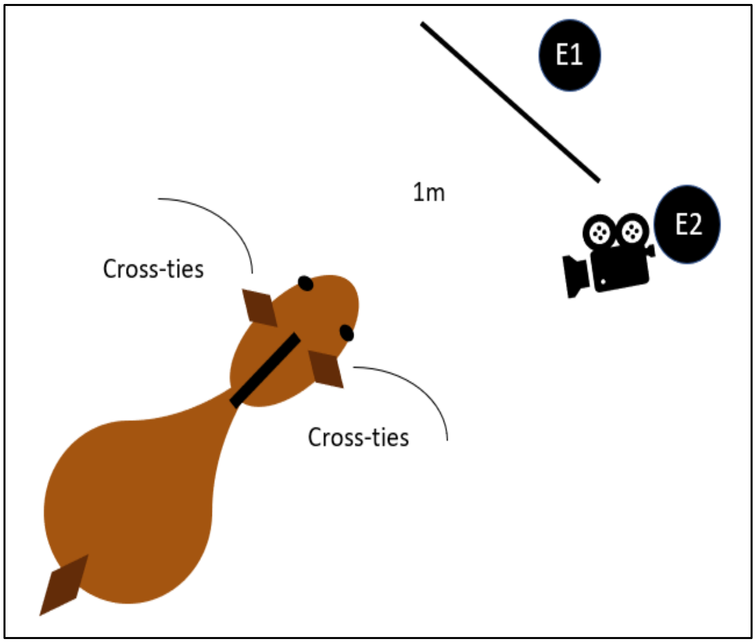

Figure 2. Experimental setup: E1= experimenter 1 behind board, holding photographic stimulus one meter away from the horse, E2= experimenter 2 records each trial for 30 seconds, with either the Samsung digital camcorder or iPhone 10.

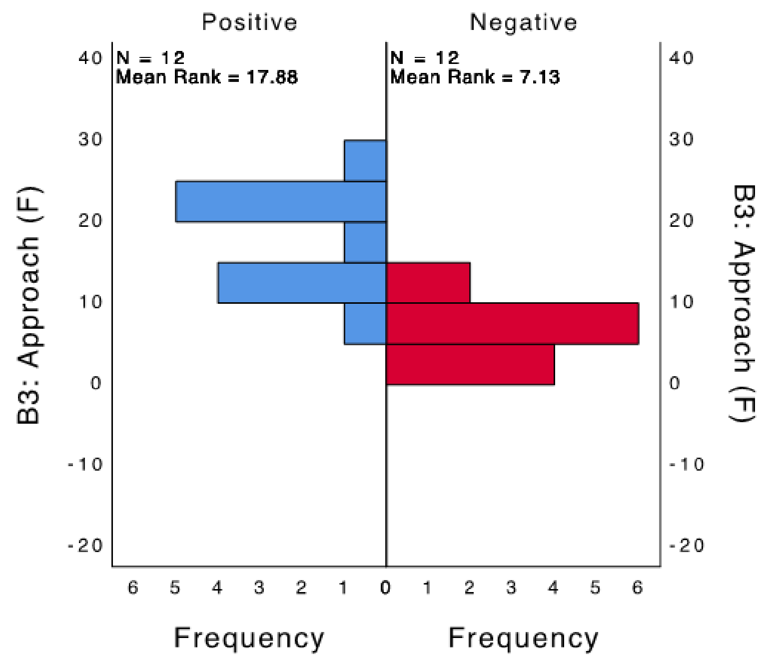

Figure 3. Graph representing approach behaviour, in horses with no prior abuse; with more behaviour occurring in response to positive (happy) stimuli (U=7.5, p<0.05).

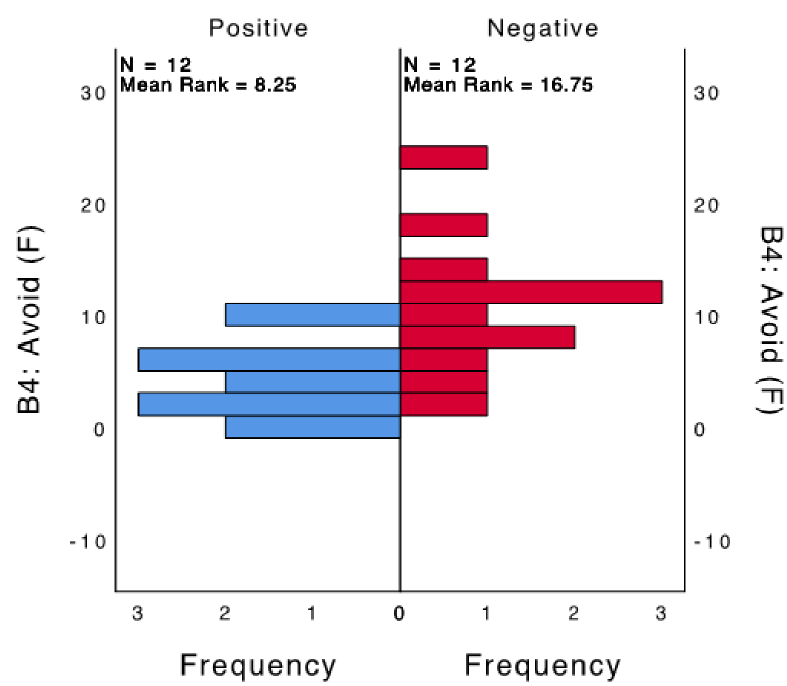

Figure 4. Graph representing avoidance behaviour, in horses with no prior abuse; with more behaviour occurring in response to negative (angry) stimuli (U=123, p<0.05).

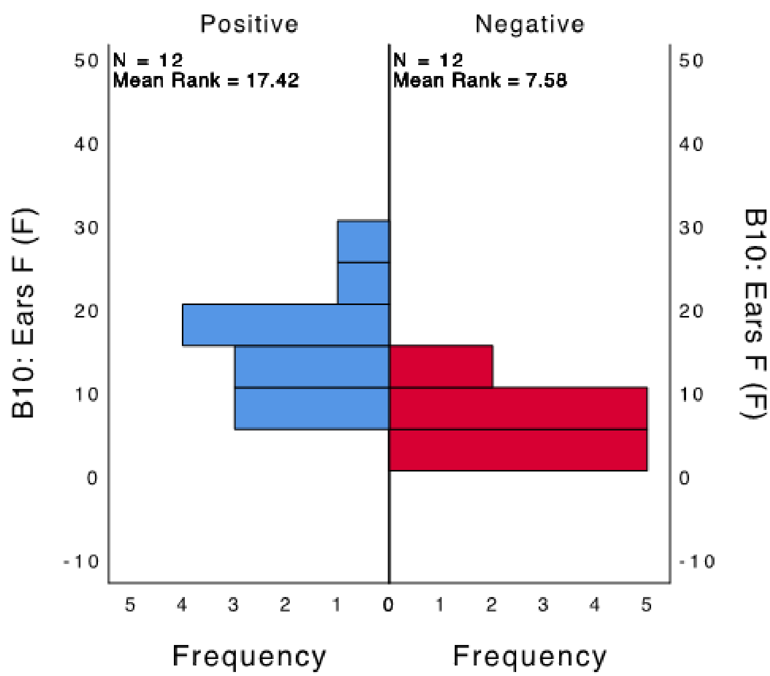

Figure 5. Graph representing ears forward behaviour, in horses with no prior abuse; with more behaviour occurring in response to positive (happy) stimuli (U=13, p<0.05).

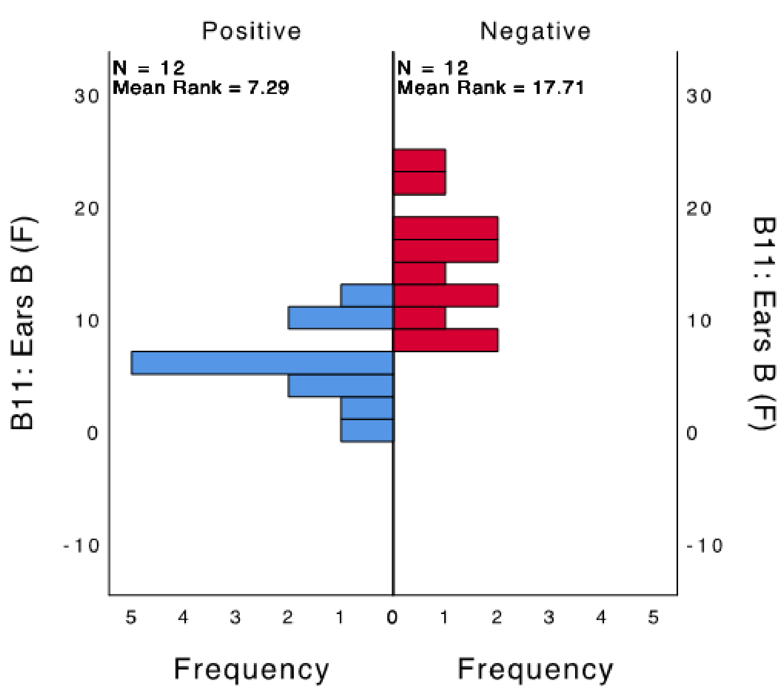

Figure 6. Graph representing ears backward behaviour, in horses with no prior abuse; with more behaviour occurring in response to negative (angry) stimuli (U=134.5, p<0.05).

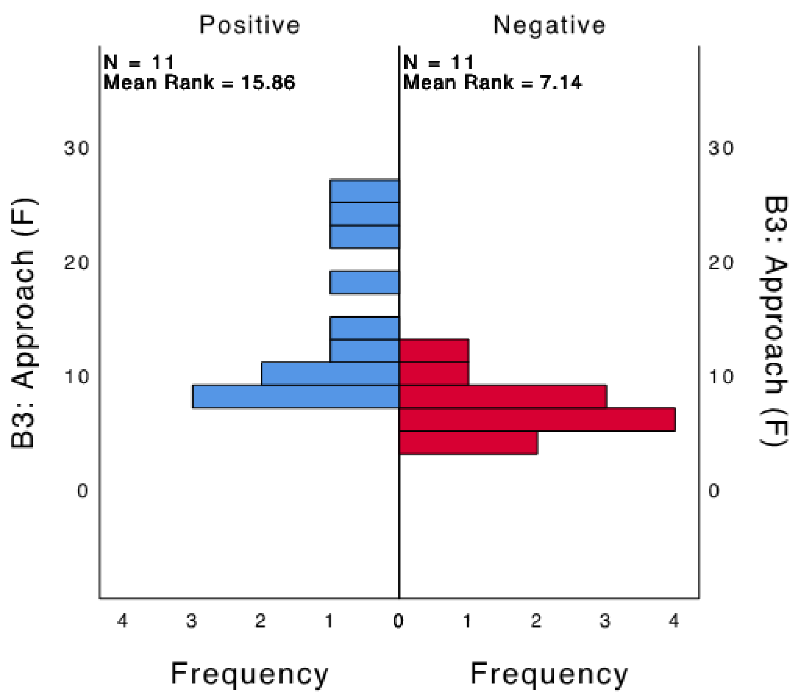

Figure 7. Graph representing approach behaviour, in horses with prior abuse; with more behaviour occurring in response to positive (happy) stimuli (U=12.5, P<0.05).

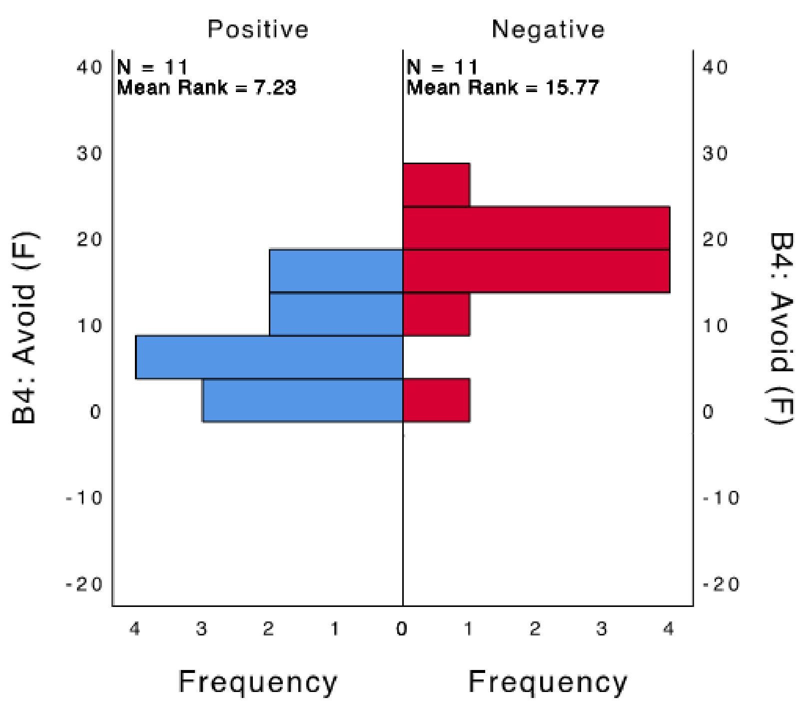

Figure 8. Graph representing avoidance behaviour, in horses with prior abuse; with more behaviour occurring in response to negative (angry) stimuli (U=107.5, p<0.05).

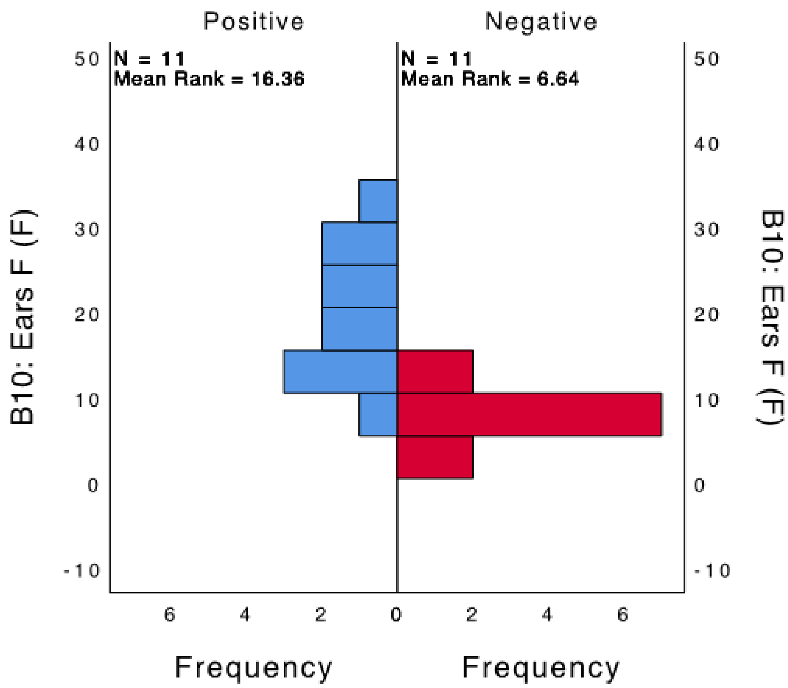

Figure 9. Graph representing ears forward behaviour, in horses with prior abuse; with more behaviour occurring in response to positive (happy) stimuli ($U=7$, $p<0.05$).

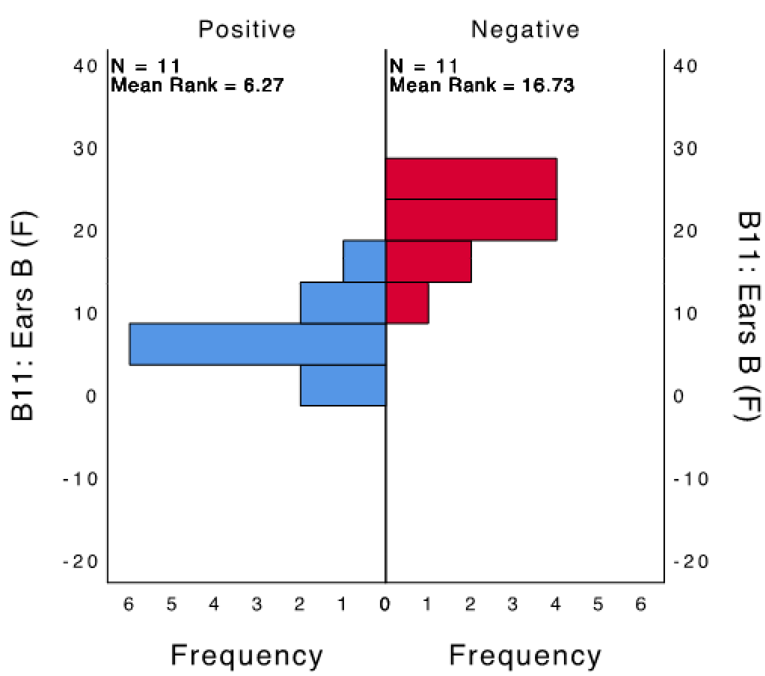

Figure 10. Graph representing ears backward behaviour, in horses with prior abuse; with more behaviour occurring in response to negative (angry) stimuli ($U=118$, $p<0.05$).

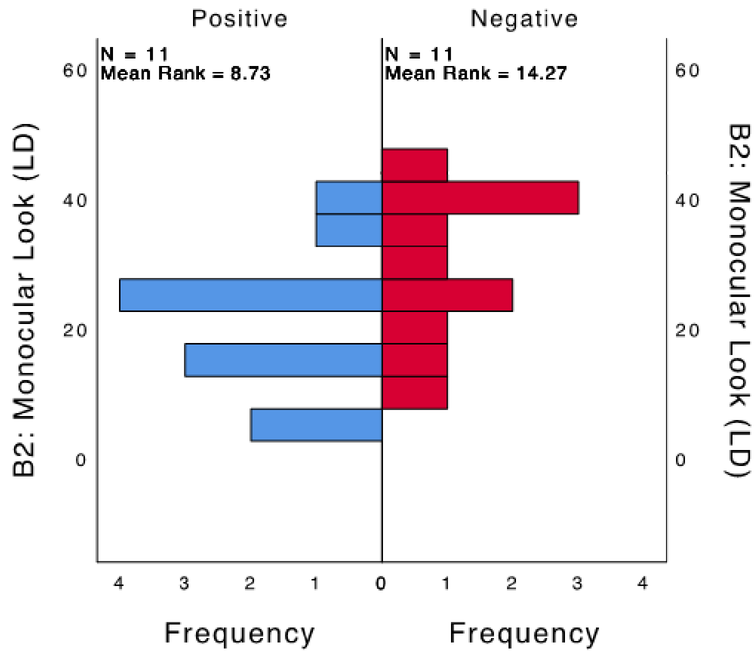

Figure 11. Graph representing monocular look behaviour, in horses with prior abuse; with more behaviour occurring in response to negative (angry) stimuli (U=91, p<0.05).

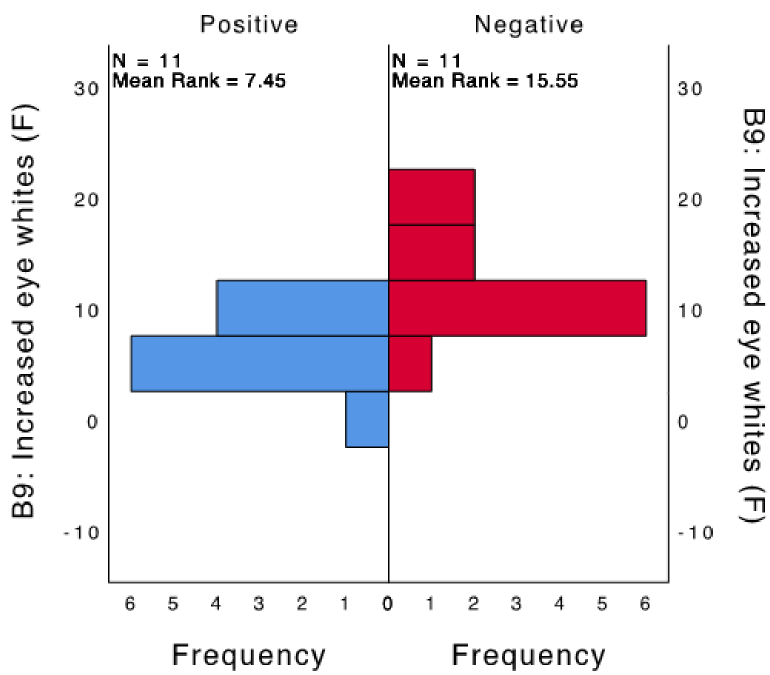

Figure 12. Graph representing increased eye whites behaviour, in horses with prior abuse; with more behaviour occurring in response to negative (angry) stimuli (U=105, p<0.05).

Tables

Table I. Definitions of behaviourally coded variables

Behaviour	**Coding Scheme Definition**
Looking Durations	
Binocular look	Horse's head is directed centrally towards the stimulus. If the trail begins whilst the horse is facing away from the centre (which was not a common occurrence), no looking behaviour is coded until the horse deliberately moves its head into a particular orientation.
Monocular look	The horse is attentive to the stimulus with its head turned to the left or right respectively. Attentiveness is determined by the horse having at least one ear and/or eye focused on the stimulus.
Approach and Avoid	
Approach	Any extension of the horse's head, or movement of the body, towards the stimulus from the horse's original position.
Avoid	Any increase of distance from stimulus combined with one or more concurrent stress-related behaviours (e.g. nostril dilation, head bobbing, etc.)
Stress-Related Behaviours	
Nostril dilation	The skin above the nostrils is inflated as the air is blown outwards; generally driven by a strong exhalation (blowing).
Tail swish	Horse moves tail several times to the left and right with visible 'swishing' movement.
Head bob	Horse moves nose and head up and down in tight, rapid movements whilst paying attention to the stimulus (attention determined by ear and eye directions).
Lick and chew	Horse chews and protrudes tongue with no external stimulus as a cause.
Increased eye whites	Horse's eye widens to show additional white sclera compared with their resting state.
Ears Forward	Horse's ears are turned or swivelled forward.
Ears Backward	Horse's ears are flattened or swivelled backward.
Yawn	Horse opens mouth for a deep long inhalation with mouth widely open and jaws either directly opposed or moved from side to side.

Table II. Non-prior abuse horses (negative vs. positive stimuli) statistical results on all behavioural responses using the Mann-Whitney U Test

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.
1	The distribution of B1: Binocular Look (LD) is the same across categories of Stimuli Type .	Independent-Samples Mann-Whitney U Test	.932[a]
2	The distribution of B2: Monocular Look (LD) is the same across categories of Stimuli Type .	Independent-Samples Mann-Whitney U Test	.932[a]
3	The distribution of B3: Approach (F) is the same across categories of Stimuli Type .	Independent-Samples Mann-Whitney U Test	.000[a]
4	The distribution of B4: Avoid (F) is the same across categories of Stimuli Type .	Independent-Samples Mann-Whitney U Test	.002[a]
5	The distribution of B5: Nostril Dilation (F) is the same across categories of Stimuli Type .	Independent-Samples Mann-Whitney U Test	.887[a]
6	The distribution of B6: Tail Swish (F) is the same across categories of Stimuli Type .	Independent-Samples Mann-Whitney U Test	.478[a]
7	The distribution of B7: Head Bob (F) is the same across categories of Stimuli Type .	Independent-Samples Mann-Whitney U Test	.799[a]
8	The distribution of B8: Lick and Chew (F) is the same across categories of Stimuli Type .	Independent-Samples Mann-Whitney U Test	.843[a]
9	The distribution of B9: Increased eye whites (F) is the same across categories of Stimuli Type .	Independent-Samples Mann-Whitney U Test	.671[a]
10	The distribution of B10: Ears F (F) is the same across categories of Stimuli Type .	Independent-Samples Mann-Whitney U Test	.000[a]
11	The distribution of B11: Ears B (F) is the same across categories of Stimuli Type .	Independent-Samples Mann-Whitney U Test	.000[a]
12	The distribution of B12: Yawn (F) is the same across categories of Stimuli Type .	Independent-Samples Mann-Whitney U Test	1.000[a]

Table III. Prior-abuse horses (negative vs. positive stimuli) statistical results summary on all behavioural responses using the Mann-Whitney U Test

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.
1	The distribution of B1: Binocular Look (LD) is the same across categories of Stimuli Type.	Independent-Samples Mann-Whitney U Test	.076[a]
2	The distribution of B2: Monocular Look (LD) is the same across categories of Stimuli Type.	Independent-Samples Mann-Whitney U Test	.047[a]
3	The distribution of B3: Approach (F) is the same across categories of Stimuli Type.	Independent-Samples Mann-Whitney U Test	.001[a]
4	The distribution of B4: Avoid (F) is the same across categories of Stimuli Type.	Independent-Samples Mann-Whitney U Test	.001[a]
5	The distribution of B5: Nostril Dilation (F) is the same across categories of Stimuli Type.	Independent-Samples Mann-Whitney U Test	.101[a]
6	The distribution of B6: Tail Swish (F) is the same across categories of Stimuli Type.	Independent-Samples Mann-Whitney U Test	.699[a]
7	The distribution of B7: Head Bob (F) is the same across categories of Stimuli Type.	Independent-Samples Mann-Whitney U Test	.332[a]
8	The distribution of B8: Lick and Chew (F) is the same across categories of Stimuli Type.	Independent-Samples Mann-Whitney U Test	.949[a]
9	The distribution of B9: Increased eye whites (F) is the same across categories of Stimuli Type.	Independent-Samples Mann-Whitney U Test	.002[a]
10	The distribution of B10: Ears F (F) is the same across categories of Stimuli Type.	Independent-Samples Mann-Whitney U Test	.000[a]
11	The distribution of B11: Ears B (F) is the same across categories of Stimuli Type.	Independent-Samples Mann-Whitney U Test	.000[a]
12	The distribution of B12: Yawn (F) is the same across categories of Stimuli Type.	Independent-Samples Mann-Whitney U Test	.797[a]