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Prevalence and Perceived Effects of Enrichment Elements in Outdoor Areas on the Behavior and Welfare of Group-Housed Horses

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Abstract

Environmental enrichment has the potential to cultivate positive equine welfare through agency-driven opportunities for socialization, foraging, and exploration. Although the beneficial impacts of enrichment are well documented for captive wildlife, there is comparatively little research on the applications and impacts of enrichment for domestic horses. Our aim was to understand the use and perceived impacts of enrichment for group-housed horses through a global survey of barn owners/managers. The survey asked questions on demographics, horses, and facility characteristics, as well as the use and perceived effects of foraging, structural, and sensory enrichment on horse behavior and welfare (e.g., perceived effects on health issues and stereotypies). We received 132 responses from 16 countries. Data were summarized using descriptive statistics and visualizations. Fisher's exact tests were used to explore the significance of reported behavior changes, and a chi-squared test was used to examine the relationship between the size of the turnout area and the number of enrichment elements. Enrichment elements providing horses with foraging opportunities were the most prevalent type of enrichment, while offering structural diversity and sensory stimulation were also much-utilized enrichment strategies. Respondent data suggested a significant, direct relationship between the prevalence of enrichment and positive behavior change ($p < 0.001$). Respondents reported an increase in natural behaviors since the onset of enrichment provision, including increased foraging (66.7%), play (65.2%), and locomotion (78.8%). They also reported their horses to be calmer (forage enrichment 30.5%, structural enrichment 13.8%, sensory enrichment 7.4%), more social (forage enrichment 9.4%, structural enrichment 8.9%, sensory enrichment 2.8%), and more confident when being handled on the ground and under saddle (structural enrichment 8.1%). Most respondents reported that providing enrichment elements improved the health issues their horses were dealing with (hoof problems 88.7%, laminitis 91.7%, EMS 89.6%, lameness 93.5%, equine asthma 88.5%, others 88.9%) and indicated decreased frequencies of stereotypic behaviors (weaving 100%, box/fence walking 100%, crib-biting 66.6%, others 50%). No significant relationship was found between the size of the turnout area and the number of enrichment items ($p = 0.33$). Overall, these findings suggest positive impacts of environmental enrichment on the behavior and welfare of group-housed horses, warranting further research as a potential welfare-enhancing tool.

Keywords

Equine enrichment; equine welfare; environmental enrichment; husbandry; positive welfare

1. Introduction

The environment in which a horse lives has a significant impact on its health and mental state [1]. Horse welfare can be enhanced or compromised by factors in the environment, such as the provision of forage, available space, social interaction, and the potential to fulfill behavioral needs [2]. Captive environments and human-made outdoor areas often offer limited opportunities for natural behaviors [2,3]. Enrichment provides domesticated animals with various

stimuli to promote species-typical behaviors, offering them increased control over their environment [4]. The ability to pursue goals and accomplish a desired outcome is an important component of positive animal welfare [5].

Mellor's Five Domains model provides a useful lens to assess the value of potential welfare-enhancing factors [6]. It consists of four functional domains (environment, nutrition, behavioral interactions, and health) that influence the welfare state directly, as well as indirectly by impacting the fifth domain: mental state. The mental state domain acknowledges that animals are sentient and have their own subjective experiences of life. For animals to experience positive welfare, they not only need access to the physical resources they require, such as a suitable habitat and appropriate food, but they also need to be able to pursue pleasure, have choice, and experience agency [2]. Environmental enrichment can influence several of Mellor's domains. The environment is directly shaped by enrichment provision; in addition, there can be impacts on the nutrition domain in the case of food-based enrichment [7,8]. There may also be impacts on health if elements such as structural enrichment help horses maintain fitness and good physical condition [9]. Importantly, environmental enrichment can impact their mental state by giving domesticated equids opportunities to interact more fully with their environment, choose what to engage with, develop curiosity, and feel motivation [5]. For these reasons, environmental enrichment can significantly influence a horse's welfare state.

While enhancing captive environments with enriching elements has been shown to elicit positive effects in zoo animals [10,11], existing research has yet to fully investigate the impacts of environmental enrichment on group-housed horses. Research has been conducted mainly on horses kept in single stalls, with a focus on foraging opportunities and toys [8,12,13], as well as enrichment aimed at reducing the display of stereotypies [14,15]. Of the few studies available on group-housed horses in outdoor areas, results suggest a positive effect of enrichment, reporting increased activity and social interactions [16,17], as well as greater curiosity and confidence [18]. While existing research has focused mostly on short-term exposure to one or a few enrichment elements, the long-term implications of more extensive enrichment strategies on the behavior and welfare of group-housed horses remain largely unexplored.

Online groups and the lay press indicate that environmental enrichment is used more frequently for group-housed horses than existing research implies [19]. Therefore, barn owners/managers were considered valuable sources of information on current enrichment practices and the perceived results of these practices.

In previous research, important enrichment factors for horses were categorized as providing foraging opportunities, adding structural complexity to the horse's environment, and offering sensory stimulation [16]. This categorization was adopted for the present research project to provide a clear and easily applicable structure.

This research project aimed to collect information from barn owners/managers who use environmental enrichment in their turnout areas to gain insights into how enrichment is currently being used and what the perceived impacts of these enrichment elements are on equine behavior and welfare.

2. Materials and Methods

This research was conducted via an online questionnaire, delivered in English, using JISC Online Surveys (V2).

2.1. Sample Selection and Recruitment of Participants

The target group for this global survey was owners/managers of outdoor areas for group-housed horses with one or more enrichment elements. Participants were recruited via social media (international Facebook pages and groups, Instagram posts), as well as through online equine platforms and the researchers' personal contacts and networks. Participants were asked to share the survey, facilitating snowball sampling.

Participants were required to be 18 years or older and voluntarily participate in the survey, giving informed consent and confirming that they understood the purposes of the research and how their responses would be used. All information obtained was anonymous. No personal data were collected or stored. The survey was live from 8 February 2023 to 31 March 2023.

2.2. Questionnaire Design

Questions were primarily multiple-choice or ranking questions, to facilitate anonymity and data analysis, with some optional free-text questions to allow respondents to share additional information if desired. A pre-test was carried out among an international pilot group of barn owners/managers, equine scientists, and equine science students (n = 16), and the questionnaire was revised based on their feedback. These revisions included rephrasing questions for better understanding and providing additional explanations and examples. The finalized survey consisted of 30 main questions, some of which included sub-questions **(Supplementary Materials)**. The approximate timeframe to complete the questionnaire was 15 minutes.

2.2.1. About the Participants

The first section of the survey asked demographic questions, such as country of residence, age, involvement with equines, and experience managing an equine facility.

2.2.2. Information on Horses and Facility

Questions about the equine environment included herd size, turnout area size, and access to enrichment. Respondents were asked to report the perceived prevailing affective states of the horses in their enriched turnout area by selecting terms from a provided list, for example, "interested," "bored," "calm," "frustrated," etc. Participants were provided with an online tutorial on how to measure their turnout area using Google Maps (https://youtu.be/z-mAw1c5stA) and were instructed to select one herd of horses to answer the survey for, if they had more than one herd with access to enrichment.

2.2.3. Enrichment-Specific Questions

Questions on enrichment items were divided into three groups: forage enrichment (e.g., herb garden), structural enrichment (e.g., shelter), and sensory enrichment (e.g., toys).

At the beginning of each section, respondents were asked if their horses had access to the respective type of enrichment, with visual examples. Detailed questions only appeared for those who confirmed they had the respective type of enrichment in their turnout area.

For each type of enrichment, participants were asked to identify the provided enrichment items from an extensive list of elements. Some questions were asked for all enrichment categories. For example, barn owners were asked whether they had observed positive, negative, or no behavior changes in their horses since enrichment was installed, the prevalence of certain behaviors toward the enrichment items, or any injuries caused by enrichment items. All sections allowed respondents to provide additional notes and thoughts in a free-text section at the end of the page.

2.2.4. General Feedback on Enrichment

The last part of the survey collected general information on enrichment, respondents' motivation to provide it (such as health issues or stereotypic behaviors), and the perceived effects of enrichment on these outcomes.

2.3. Data Preparation

Only complete responses were exported and considered for analysis. Data were exported from JISC Online Surveys into Microsoft Excel 2019, where they were cleaned and prepared for further use. Full-sentence questions were replaced with keywords to enable data analysis in statistical software. Extensive multiple-choice answers were coded for easier use; for example, "salt and mineral lick" was shortened to "lick", and "slow feeder net" was shortened to "net". The imported file positioned all selected multiple-choice answers together in one column; these answers were split into separate columns to make them available for analysis. Answers relevant to statistical analysis were summarized into categories; for example, the size of the turnout area was categorized into five size categories, or converted into binary values; for instance, the presence (1) or absence (0) of each selectable enrichment element per participant, to make them suitable for the statistical program, ensuring the accuracy and reliability of the analysis.

2.4. Data Analyses

Microsoft Excel (Office 365, version 2019) was used for descriptive statistics and visualizations. To explore free-text responses, a word cloud generator (www.freewordcloudgenerator.com, accessed March 2024) was used to identify frequently mentioned themes, which were then manually indexed and counted by the first author. Statistical analyses were conducted in RStudio (version 2023.12.1+402). The relationship between enrichment item count and turnout area size category was analyzed using Pearson's chi-squared test. Fisher's exact tests investigated relationships between enrichment categories and behavior change categories (positive, null, negative). ChatGPT (accessed April 2024) was used in a limited capacity, solely to troubleshoot R code. When low frequencies of observations, such as stereotypic behaviors, precluded statistical analyses, descriptive relationships were explored instead.

3. Results

3.1. Demographic Overview

The survey received 132 responses from 16 countries across five continents. Enrichment was more common in owned properties (n = 91, 68.9%) than in rented properties (n = 41, 31.1%). Most respondents (n = 90, 68.2%) had over 20 years of experience with horses, and most (n = 76, 57.6%) had managed their facility for at least six years **(Table 1)**.

Among all participants, 90 barn owners/managers (68.2%) had a turnout area sized between 0.1 and 5 acres, 31 participants (23.5%) had areas between 5.1 and 20 acres, 10 participants (7.6%) stated a size of 20.1–100 acres, and one participant (0.8%) did not enter a size. The median area size was 1.9 acres, and the average size was 3.9 acres.

3.2. Prevalence of enrichment items and motivation to install enrichment

Respondents reported having between one and 28 enrichment items in their turnout areas, with a median of 13 items. No significant relationship was found between the categorized size of turnout areas and the number of enrichment items, $X^2(120, N = 132) = 126.4$, $p = 0.33$).

The most frequently reported type of enrichment was forage enrichment, used by 128 participants (97%), followed by structural enrichment, used by 123 participants (93.2%), and sensory enrichment, used by 109 participants (82.6%).

Most survey respondents (n = 101, 76.5%) reported provision of all three enrichment categories, 26 respondents (19.7%) used a combination of items from two categories, and six respondents (4.5%) reported having items from only one enrichment category.

Among forage enrichment items, salt or mineral licks (n = 109), trees (n = 102), branches (n = 96), slow feeder nets (n = 94), and hedges (n = 57) were the most frequently used elements. The five most popular structural enrichment elements were tree shelters (n = 78), wooden shelters (n = 76), logs (n = 71), gravel surfaces (n = 67), and sandpits (n = 60). For sensory enrichment elements, counts were highest for scratching poles (n = 66), balls (n = 56), treat balls (n = 34), scratching mats (n = 33), and cones (n = 30).

Motivations of respondents to use enrichment were diverse. The most frequently expressed motivational factors were horse welfare (n = 125), increasing movement (n = 121), and reducing passive behaviors (n = 116). A detailed list of motivations is shown in **Figure 1**.

3.3. Environmental Enrichment and Horse Behavior

Most respondents (n = 119, 90.2%) assigned only positive affective states to their horses with access to enrichment. Twelve respondents (9.1%) reported both positive and negative affective states, and only one respondent (0.8%) assigned only negative affective states. **Table 2** shows the distribution of all affective states.

Table 1: Demographics of survey respondents.

Factor	Level	Number of respondents	Percent of respondents (%)
Country of residence	United States	31	23.5
	United Kingdom	25	18.9
	Germany	24	18.1
	Austria	15	11.4
	Canada	11	8.3
	Australia	7	5.3
	Other *e.g., New Zealand, Norway, South Africa, France*	19	14.5
Experience with horses	3–5 years	4	3
	6–10 years	12	9.1
	11–20 years	26	19.7
	20+ years	90	68.2
Time managing this facility	Less than 1 year	18	13.6
	1–2 years	14	10.6
	3–5 years	24	18.2
	6–10 years	31	23.5
	10+ years	45	34.1

Table 2: Affective states assigned to horses in enriched turnout areas.

Affective state	Number of respondents	Percentage of respondents (%)
Interested (*Positive affective state*)	104	78.8
Engaged (*Positive affective state*)	70	53.0
Confident (*Positive affective state*)	90	68.2
Social (*Positive affective state*)	95	72.0
Spooky (*Negative affective state*)	8	6.1
Bored (*Negative affective state*)	6	4.5
Curious (*Positive affective state*)	78	59.1
Aggressive (*Negative affective state*)	0	0.0
Friendly (*Positive affective state*)	99	69.7
Frustrated (*Negative affective state*)	1	0.8

Of all survey participants who used forage enrichment, 71.1% (n = 91) reported a positive behavior change after introducing it, 28.9% (n = 37) observed no behavior change, and no participant noticed a negative change in horse behavior. A significant association was found between forage enrichment and positive behavior change ($p < 0.001$). An increase in foraging time due to the provided enrichment was observed by 68.8% (n = 88) of those who had forage enrichment elements. The respondents' open-text explanations of observed behavior change are summarized in **Table 3**. **Figure 2** shows quote examples. The most reported observations of behavior changes for forage enrichment were horses being calmer and more relaxed. They were observed to spend more time foraging and moving around, to be more interested in their environment, and to be more social. Other focal points for behavior change due to forage enrichment were horses being perceived as easier to handle and showing less resource-guarding behavior since this type of enrichment was used.

Of all participants with structural enrichment, 63.4% (n = 78) observed a positive behavior change, 36.6% (n = 45) observed no change, and no participant reported having observed a negative change. A significant relationship was found between the presence of structural enrichment and positive behavior change ($p < 0.001$). Answers from the open-text question for structural enrichment suggested that horses were observed to be calmer and more relaxed, more social, and more interested. Increased movement was reported, as well as more playing behavior. Unique feedback for structural enrichment included horses being more confident when handled and ridden, an increase in observed time spent lying down/sleeping, and horses being perceived to be more relaxed during extreme weather situations **(Table 3)**.

A statistical test revealed an association between sensory enrichment and positive behavior change ($p < 0.001$). Among participants with sensory enrichment, 53.2% (n = 58) observed a positive behavior change, 45% (n = 49) observed no change in horse behavior, and 1.8% (n = 2) observed a negative change in behavior. A total of 81.7% (n = 89) of all participants using sensory enrichment reported an increase in exploration time. Prevalent themes from open-text answers included an observed increase in playing behavior and activity, interest and engagement with the environment, and horses being calmer and more relaxed. Unique for sensory enrichment was an increased observation of scratching behavior on enrichment objects. While some respondents perceived their horses to be more social (n = 3, 2.8%), increased resource-guarding behavior was reported for enrichment elements using treats (n = 2, 1.8%).

Respondents were asked to rate the prevalence, or change thereof, of certain behaviors since starting to use enrichment elements. A perceived decrease was reported for passive behavior by 68.2% (n = 90) of participants and for antagonistic behavior by 50% (n = 66) of participants. An increase was observed for allogrooming behavior (43.2%, n = 57), locomotion (78.8%, n = 104), and playing behavior (65.2%, n = 86). Self-grooming behavior was also observed to have increased (73.5%, n = 97) for participants' horses since enrichment was first provided **(Figure 3)**.

Table 3: Themes regarding observed behavior change since introducing enrichment elements of each category, summarized from open-text answers.

Type of enrichment	Observed change in behavior/attitude	Number of respondents	Percent of respondents using this type of enrichment (%)
Forage enrichment	More calm/relaxed	39	30.5
	Moving more	21	16.4
	More interested/engaged	17	13.3
	Foraging more	14	11.0
	More social	12	9.4
	Less resource-guarding	10	7.8
	Easier to handle	10	7.8
	Healthier/fitter	10	7.8
	Happier	10	7.8
	More confident	4	3.0
	Less destructive	3	2.3
Structural enrichment	More calm/relaxed	17	13.8
	More confident when ridden/handled	10	8.1
	More social	11	8.9
	More interested/engaged	8	6.5
	Healthier/fitter	8	6.5
	More playful/active	8	6.5
	More confident	6	4.9
	Moving more	6	4.9
	Happier	6	4.9
	Calmer during weather events	6	4.9
	Lying down/sleeping more	4	3.3
Sensory enrichment	More playful/active	13	11.9
	More interested/engaged	9	8.3
	More calm/relaxed	8	7.4
	More scratching on enrichment items	7	6.4
	More confident	6	5.5
	Less destructive	4	3.7
	Happier	4	3.7
	More social	3	2.8
	More aggressive	2	1.8

3.4. Reported Effects on Equine Welfare

Risk of injury in relation to enrichment items was reportedly low throughout all three categories of enrichment elements. Responses for no or rare injuries ranged from 97.2% (n = 106; sensory enrichment) to 96.9% (n = 124; forage enrichment) and 96.8% (n = 119; structural enrichment). A very small proportion of respondents (2.8%–3.2%) reported occasional injuries, and no respondents selected "often" or "very often" for enrichment-related injuries.

Those who selected health issues as a motivation for enrichment (n = 104, 78.8%) reported hoof problems to be most prevalent, with a quota of 23.7% (n = 53) of total answers; equine metabolic syndrome (EMS) and laminitis each made up 21.4% (n = 48). Musculoskeletal lameness was reported

with a 13.8% (n = 31) prevalence, equine asthma with 11.6% (n = 26), and other health issues (e.g., colic, ulcers, PPIM) collectively made up 8% (n = 18). All health issues were reportedly improved, and no health issue was perceived to deteriorate with the use of enrichment. **Table 4** shows the relationship between health issues and improvement in more detail.

The participants (n = 17, 12.9%) with stereotypic horses in their care observed no change in pawing behavior (n = 1) through access to enrichment. Crib-biting frequency was perceived to have decreased by eight (66.6%) of the 12 participants dealing with this condition. Weaving and box/fence walking were observed less frequently by 100% of the two and three participants who had reported these stereotypies, respectively. One case of crib-biting was observed to increase in frequency since installing enrichment **(Table 5)**. Respondents who reported stereotypies used elements from all three enrichment categories, apart from one respondent, who managed a crib-biting horse and used only forage and structural enrichment.

4. Discussion

These preliminary results indicate that barn managers/owners perceive environmental enrichment for group-housed horses to have an overall positive impact on horse behavior, health, and welfare. A variety of different enrichment elements were reported to be used in turnout areas, with most respondents using a combination of items from all three enrichment categories (forage, structural, and sensory). The reported impacts of enrichment on horse behavior included a reduction in observed passive and antagonistic behaviors and an increase in positive behaviors, including foraging, playing, allogrooming, and locomotion. Together with a perceived improvement in health issues and a reduction of stereotypic behavior, reported to be associated with the onset of enrichment provision, this indicates a positive influence on equine welfare.

4.1. Demographics of Survey Respondents

The demographics of survey respondents showed that environmental enrichment for horses has been applied in many countries across different continents. Respondents' demographic data indicate that enrichment is primarily utilized by a highly experienced group of barn owners/managers. Many years of horse experience and prolonged time managing their facility could have offered opportunities to monitor the horses in their care and to find measures to improve equine welfare and behavior within their scope of knowledge and resources, as suggested by Noble **[20]**.

The reported size of turnout areas was commonly small. This could imply that respondents might see enrichment elements as a mitigation for the constraints in available space, due to common management practices **[21]**. A statistically significant relationship between the size of the turnout area and the number of enrichment items used could not be detected in the results of this survey. This suggests that while enrichment was used more frequently in smaller turnout areas, the number of enrichment items used was not statistically dependent on the available space.

4.2. Prevalence of Enrichment Items

Previous research has primarily focused on a single kind of enrichment **[17,22]** or one enrichment object at a time **[12,23]**. In contrast, survey respondents reported using a median of 13 enrichment items, from two or three different categories, in their turnout areas. This indicates that it is less common for horses to be exposed to only one enrichment item or to items of just one enrichment category at a time. The choice of different objects could amplify the benefits of enrichment, as providing choices has been highlighted as an important aspect for achieving positive mental states in animals **[24]**.

4.3. Environmental Enrichment and Horse Behavior

The respondents' observations of the effect that environmental enrichment had on their horses' behavior suggest an overall positive influence. Since enrichment was provided, natural and positive behaviors were reported to have increased, while aggressive, passive, and destructive behaviors were frequently observed to have been reduced. Additional benefits, such as horses being easier to handle and more confident when ridden, were mentioned by multiple respondents and could indicate that enrichment might be a valuable tool to reduce the risk of injury for humans riding and handling horses.

Table 4: Reported health conditions and their perceived changes since the use of enrichment.

Health condition	Number of participants				
	Condition improved	No change	Condition got worse	Not sure	Total count
Equine asthma	23	1	0	2	26
Hoof problems	47	4	0	2	53
EMS	43	3	0	2	48
Laminitis	44	3	0	1	48
Lameness (musculoskeletal)	29	1	0	1	31
Other	16	1	0	1	18

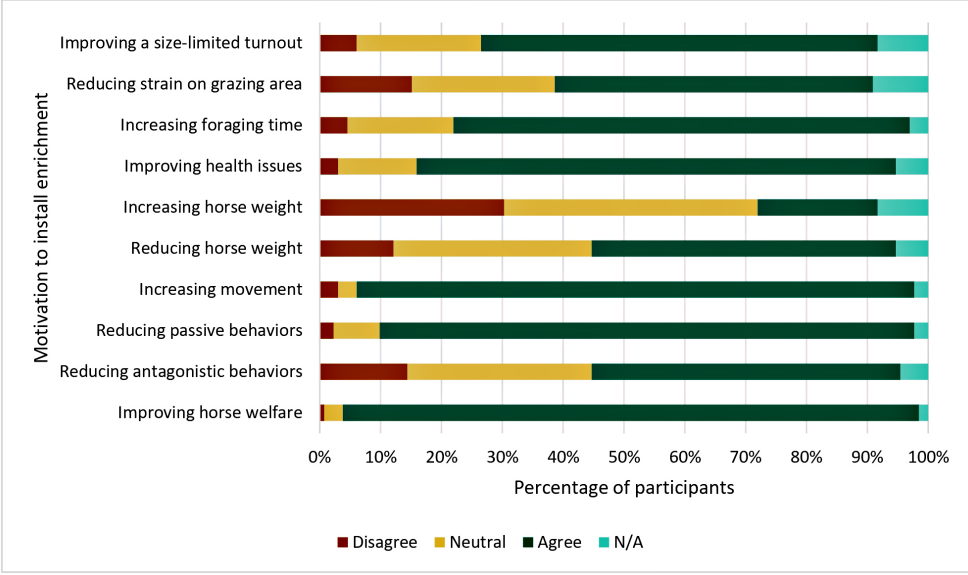

Figure 1: Reported importance of motivation to install enrichment.

"Stopped scarfing his food down as fast as he could"

""Balanced mentally, less fearful on new surfaces"

"No fear of water or water crossing when riding"

"They no longer scratch destructively on fence"

"Horses seem happy and relaxed"

"Happier, less colic episodes"

"More engaged and playful"

"Less food aggressive"

"More active, move more"

"They spend more time foraging and wander more often between the foraging stations"

"They can get quite aggressive around treat balls"

"Calmer attitude when out for walks"

"One of the horses did a lot of weaving when he came to us, now there is no weaving"

The horses seem more confident when we do different activities or haul them places"

"Reduced excitable behaviour when ridden"

"More time foraging, calmer"

"Much calmer and relaxed, hardly any resource guarding"

"Horses are calmer in new situations"

"The horses move regularly between the different areas of enrichment, therefore appear to increase general movement around their enclosure"

"More relaxed while feeding"

"Less bullying of other horses"

"Some sleep more"

"Calmer - will come into the shelter when it's raining instead of getting grumpy in the rain/wind"

"They are easier to handle and more polite"

"Horse less reactive in arena - not so spooky"

"The horses got more confident in different surfaces, even on trail rides"

"Happier and more content overall"

"Less stress, less illness, less aggressive behaviour between barn mates"

"So much calmer, less stall vices"

"More confident, more walking around, more calm while riding and in dark"

"Calmer herd, more movement"

Figure 2: Example quotes from open-text answers on behavior change after installing enrichment.

Table 5: Reported equine stereotypies and observed change in their frequency since the installation of enrichment.

Stereotypies	Number of respondents			
	Less frequent	No change	More frequent	Total count
Crib-biting	8	3	1	12
Weaving	2	0	0	2
Box/fence walking	3	0	0	3
Pawing	0	1	0	1
Other	1	1	0	2

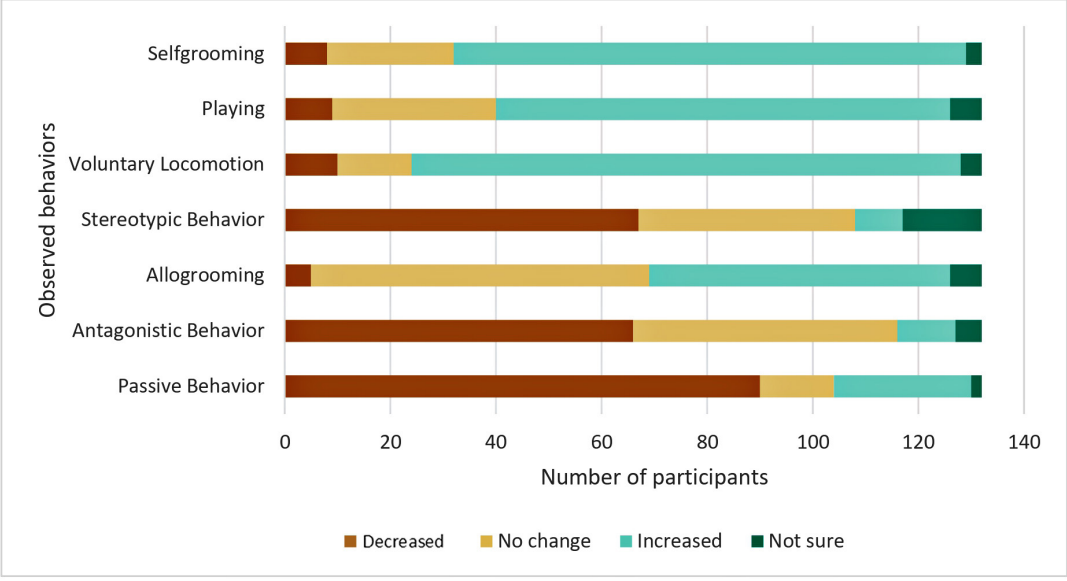

Figure 3: Overview of the observed changes in certain equine behaviors since respondents started to use enrichment.

While trends in behavior and attitude cannot be measured as easily as parameters such as health status or body condition **[25]**, they are still valuable for assessing animal welfare. The importance of subjective animal feelings was highlighted when looking at animal welfare, and it was suggested that a focus on psychological welfare metrics could help achieve optimal welfare in a captive environment **[26]**. In accordance, Mellor *et al.* **[6]** introduced domain five of their welfare framework, Mental State, in order to better understand the subjective experiences of each individual animal, emphasizing that the totality of opportunities and experiences through all functional domains will influence this domain and manifest through behavior, which can be evaluated. The high prevalence of horses described with only positive affective states within this study indicates a favorable effect of environmental enrichment on the horses' mental state, subsequently indicating positive impacts on welfare. However, it is acknowledged that the survey participants likely were invested in the idea of enrichment and might have been biased toward reporting a positive effect on their horses **[27]**. Future studies that empirically investigate the welfare impacts of enriched versus non-enriched environments would add rigor to our preliminary results.

4.3.1. Forage Enrichment

Among those who used forage enrichment items, a majority (71.1%) reported a positive change in behavior, including increased time spent foraging, horses being calmer and more relaxed, showing more locomotion and interest in their environment, and less resource-guarding behavior toward other horses in their herd. Prolonged foraging time and low stress levels are connected to reduced occurrence of ulcers **[28]** and reduced frequency of oral stereotypies **[29]**, and can therefore be considered welfare-enhancing. Enrichment elements often provide forage in more variety, different forms, and multiple places. An enriched turnout area might give horses opportunities to make choices between different kinds of forage and move between forage stations, dispersing the herd rather than focusing all horses in one place where forage is provided, supporting the findings of a study examining the effects of feeding management on antagonistic behavior **[30]**. This might account for the observed increased locomotion and reduced antagonistic behavior, in accordance with findings from a study on foraging opportunities **[31]**. Additionally, the presence of agency and choice has been highlighted as important for cultivating positive welfare **[32]**.

Horses were also reportedly more social and easier to handle by humans since they had access to forage enrichment. Many forage enrichment elements require the horse to spend more time and energy to obtain the food, which might satisfy fundamental needs and lead to improved amenability when being handled by humans **[33]**. An experimental

study using slow feeders and hay bags also found decreased aggression toward other horses and humans [34]. However, it was also noticed that horses were easily frustrated by some of their slow-feeding devices, specifically hay bags, which were related to an increase in frustration behaviors, e.g., yawning and pawing. The type of slow-feeding device and how it provides access to forage might therefore have an impact on how it is accepted by the horse and related to favorable or aversive effects.

A study investigating individual horses might decipher this complex relationship better than the observations on a herd level, which participants were asked to provide in this survey. Based on the results of this study, forage enrichment should be considered a beneficial tool to enhance natural and desirable behaviors in horses.

4.3.2. Structural Enrichment

For structural enrichment, most respondents (63.4%) observed a positive change in horse behavior. Respondents reported increased playing behavior for their horses in enriched turnout areas. More variety in their surroundings might inspire the horses' curiosity, and barn owners/managers might see them interacting with elements and exploring different locations, making a choice where they feel most comfortable at the time. This agrees with research suggesting that the availability of choices supports natural behaviors in animals [24], with subsequent positive impacts on welfare [6]. Horses were described as calmer, more relaxed, more interested, social, and playful since they had access to structural enrichment.

In addition, horses were perceived to be more relaxed during extreme weather events and were observed to be lying down more since they had access to structural enrichment. Several forms of shelters were part of the most prominent structural enrichment elements, which indicates that having the option of protection from the elements had a recognizable impact on horse behavior [35]. This observation also suggests that structural enrichment might have a beneficial impact on equine sleep, supporting the importance of environmental factors for sleep quality in horses [36].

Horses were also reported to be more confident and relaxed when handled and ridden since they had access to structural enrichment. This aligns with a study detecting a more positive perception of the environment, less fearfulness, and more curiosity and learning success in young horses subjected to environmental enrichment, compared to a control group [18]. Such findings suggest not only a positive effect of a structurally enriched environment on the horse's mental state and behavior but also imply a beneficial aspect for rider safety. No studies were found that opposed these findings on structural enrichment.

4.3.3. Sensory Enrichment

A slightly smaller group of respondents (53.2%) observed a positive behavior change since providing sensory enrichment in their turnout areas. While a significant association was found between sensory enrichment and reported behavior change, a nuanced pattern was detected upon examining the distribution of observed behavior change results. Sensory enrichment received a substantial proportion of responses indicating no change in behavior, and it was the only enrichment category with a reported negative behavior change. It can be inferred that, while there is a significant overall association, the practical impact of sensory enrichment on behavior change may vary.

Many respondents using sensory enrichment reported an increase in self-grooming and allogrooming behavior since using scratching poles and mats. A study on the use of automatic brushes provided a similar observation, finding a rise in both self-grooming and allogrooming behavior due to the offered scratching device, indicating that offering such scratching opportunities has a positive effect on social interactions [17]. Increased playing behavior and activity were reported in open-text answers for this enrichment category as well, as was increased interest and engagement with the environment, suggesting that all types of enrichment potentially encourage positive mental states [1].

The few reported cases of aggressive behavior specifically included enrichment using treats as incentives. These findings could indicate that some forms of sensory enrichment might motivate resource-guarding behavior in horses. However, a research project providing group-housed horses with a ball filled with concentrated feed did not find increased displacements compared to other enrichment items, such as poles or branches [16]. Further exploration of the possible reasons for aggression around certain types of sensory enrichment would be commendable for future research in this area.

4.4. Environmental Enrichment and Equine Welfare

4.4.1. Health Issues

A commonly reported motivation for adding enrichment items was the intention to improve existing health issues. The interconnected health challenges of equine metabolic syndrome and laminitis were given a high improvement rate, which might be related to slower forage intake and increased activity and movement due to enrichment, previously identified as important risk mitigation strategies for these conditions [37]. Opportunities for self-directed exercise, such as some forms of enrichment can provide, were suggested as a promising strategy to manage obesity in horses and its attending ills, such as laminitis [38].

The perceived improvement of musculoskeletal lameness could be related to the benefits of increased movement incentives. Moderate exercise can be beneficial for conditions like osteoarthritis, which is a common cause of lameness, especially in older horses [39]. However, possible observer bias needs to be taken into consideration, as lameness can be challenging to identify by horse owners and non-professionals [40]. Equine Asthma was reported to be improved through enrichment by most respondents who had horses with this condition in their care. Management measures, such as increased exposure to fresh air and reduced contamination with dust, are considered beneficial for affected horses [41]. Owner compliance has been determined to be a key factor for the improvement of affected horses' symptoms. Barn owners/managers who were willing to invest in environmental enrichment, and hence were within the target group of this survey, might be more compliant in incorporating these management changes in addition to providing enrichment. Factors facilitating improvements in

equine asthma might therefore be more complex and outside of the scope of this survey.

A previous study connected opportunities to explore and interact with elements in their turnout area with an increased risk of injuries for horses [42]. The results of this project could not confirm this apprehension, as most survey respondents reported injuries related to enrichment items as very unlikely. This suggests that enrichment elements do not pose a significant risk of injury to group-housed horses in outdoor areas.

4.4.2. Stereotypic Behaviors

The group of barn owners/managers reporting horses with stereotypic behaviors in this survey was rather small. Most participants stated the frequency of displayed stereotypies was less frequent than before using enrichment, a few found no change, and only one participant reported crib biting to be displayed more often since enrichment was installed. Since this research project included only group-housed horses with access to turnout, some of the main provocations of stereotypies, such as isolation and restricted movement, would have been avoided [43]. This could potentially have led to the reported low frequency of stereotypic behavior. Furthermore, it has been suggested that aligning the type of enrichment with the underlying cause of the horse's frustration could increase the chance of effectively mitigating stereotypic behaviors [29]. For example, enrichment that promotes foraging, such as a hay toy, may be more effective in reducing oral stereotypies than providing a scratching post. A connection between the type of enrichment and perceived change in frequency of stereotypic behavior could not be distinguished in this research project, since all respondents who reported stereotypic behavior were using enrichment elements of all three categories, except for one participant. While environmental enrichment was perceived to have a reducing effect on stereotypic behavior, in accordance with existing research [44], stereotypies have also been proven to be highly habitual and relatively permanent [15]. A permanent modification of dopamine pathways in the equine brain was discussed as a significant cause for the expression of stereotypies, which can be amplified by stress, but is resistant to dissolution, even in an optimal environment [45]. The presence or frequency of stereotypies might therefore be more an indication of the individual's welfare in the past than a factor of the current conditions, and likely not a suitable indicator of equine welfare. However, future research investigating environmental enrichment and stereotypies would be indicated to gain more insight into related factors.

4.5. Limitations

Previous research has shown that most domestic horses are kept in simplistic grass fields with minimal or no environmental enrichment [38]. Consequently, by requiring the use of environmental enrichment as part of the participant eligibility criteria, this survey targeted a small subset of equine carers. As a result, this research project was unable to contrast perceptions of barn owners/managers using enrichment and those who do not. A confirmation bias toward a positive effect of enrichment on horses is likely [27].

There may have been an overrepresentation of participants from Austria, Germany, and the United States, as well as from the United Kingdom, due to the involvement of the University of Edinburgh. The survey was composed in English, which largely prevented the participation of non-Anglophones.

Statistical analysis proved to be challenging due to unbalanced and often small sample sizes. For example, almost all respondents used elements of all three enrichment categories, which made a comparison between the type of enrichment used and improvement of health issues or stereotypies impossible.

Furthermore, perceptions of horse welfare are not necessarily accurate. Further studies on the effects of enrichment on behavior and welfare should ideally collect primary data from the horses themselves through qualitative behavior assessment [46].

5. Conclusion

This research project aimed to gather insights into which types of environmental enrichment are currently used across many countries and how barn owners/managers perceive their effects on horse behavior and welfare. The findings from the conducted international survey were able to fulfill these initial objectives.

Survey respondents perceived elements of all three enrichment categories (forage enrichment, structural enrichment, and sensory enrichment) to have an overall positive effect on horse behavior. Most respondents linked enrichment to increased species-typical behaviors, such as foraging, explorative, social, and playing behaviors. They also reported an observed tendency for horses to be calmer, more relaxed, interested, and confident, even when handled and ridden. Passive and aggressive behaviors were perceivably decreased since enrichment was installed.

Effects of environmental enrichment on health issues and equine stereotypies were reported to be mostly positive in this research project, but due to small sample sizes, these results are less robust. The reported increase in time spent foraging and moving does imply a health benefit of enrichment, and together with other aspects, such as the popularity of providing protection from the elements as a form of enrichment, warrants further investigation into environmental enrichment as a welfare-enhancing tool.

Overall, the findings of this research project imply that environmental enrichment provides a variety of beneficial aspects influencing horse behavior and welfare and should potentially be considered by more keepers of group-housed horses. The findings will complement and enhance the existing knowledge base regarding the use of enrichment as a welfare-enhancing tool and provide suggestions for future research.

Supplementary Materials

The survey consisted of 30 main questions is available as **Supplementary Materials**.

Authors' Contribution

NM: conceptualization, data collection, data analysis, and paper writing. CJN: conceptualization, supervision, paper writing, and paper review. BEL: conceptualization, supervision, and paper review.

Data Availability

The data supporting the findings of this study are available upon request from the corresponding author.

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Conflict of interest

The authors declare that there are no conflicts of interest.

Ethical Approval

Ethical approval was granted by the Human Ethical Review Committee at the Royal (Dick) School of Veterinary Studies at the University of Edinburgh (reference number HERC_2022_108).

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