It's a Sign: From Nocturnal Kiwi to Daytime Heroes - The Power of Design in Shaping Conservation Behaviour

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Abstract

Interpretive signage is widely used in zoos and aquariums to support conservation education, yet evidence of its behavioural effectiveness remains inconsistent. I examined whether a poster designed using Big Hero Visualisation (BHV) principles functioned as an effective antecedent stimulus to increase recall of the five kiwi species. A between-subjects online experiment presented participants with existing National Aquarium exhibition signage, with the BHV kiwi poster included as an additional antecedent stimulus for the experimental condition only. The control condition viewed the same materials without the BHV poster prior to recall assessment. Participants also completed the Value Orientation Scale (VOS) and the New Ecological Paradigm (NEP) scale to explore whether self-reported environmental value orientations predicted recall or interacted with the signage condition. The logistic regression indicated that participants who viewed the BHV poster were more likely to recall the correct number of kiwi species compared to the control condition. None of the VOS or NEP subscales, nor their interactions with condition, were associated with recall accuracy. The study provides applied evidence that antecedent manipulations in visual design may influence immediate recall of conservation information. However, the online format likely increased attending relative to naturalistic settings, and I measured only immediate recall rather than broader behavioural outcomes. Future research should investigate how BHV elements perform amongst real-world competing stimuli and whether specific design components are more effective antecedent features. Overall, the results support continued evaluation of interpretive design as a low-cost behavioural intervention for improving conservation-related learning.

Keywords: antecedent intervention, behaviour change, between-subjects, conservation, interpretive signage, kiwi, recall, visual design

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Allerby, for being my favourite person throughout all of this.

Finally, to me. The horcrux I never expected to create.

Endgame.

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Signs are visual, symbolic stimuli, including symbols, text, and images, that can communicate information. Signs functionally communicate a message to the audience, providing environmental cues for behaviour (Cooper et al., 2020). Based on Skinner's (1987) behavioural learning theory, which centres on observable events, interpretive signage is an antecedent stimulus, an environmental cue that signals the availability of a behavioural response (Driscoll & Burner, 2025), which is shaped and maintained by reinforcement (Cooper et al., 2020).

The Three-Term Contingency (ABCs of Behaviour)

The three-term contingency (Skinner, 1953) states that the relationships among antecedents, behaviours, and consequences can explain observable behaviour. Antecedents set the occasion for behaviour, the observable response is the behaviour, and the consequences determine whether the behaviour will occur in the future (Cooper et al., 2020). For example, a visitor may read an educational sign (antecedent) about kiwi conservation, which may evoke verbal behaviour (talking about kiwi). If the behaviour is followed by a consequence such as social reinforcement (approval or shared discussion), the behaviour is more likely to recur in the presence of similar antecedent stimuli. Through repeated exposure to these contingencies, the visual properties of signs may become discriminative stimuli that reliably evoke attention and recall behaviour (Bitgood, 2016; Cooper et al., 2020; Skinner, 1953). Building on this framework, antecedent manipulations in visual design can alter the environmental conditions that influence when and how behaviour is likely to occur (Cooper et al., 2020; Staddon, 2014). When a sign is visually

salient, it functions to modify the surrounding environment, making reading or observing behaviour more likely. Adjusting antecedent conditions to alter the environmental cues rather than attempting to change internal states (attitudes) is a core principle of behavioural design (Cooper et al., 2020; Geller, 2002). These environmental modifications are, in themselves, behavioural interventions for behaviour change (Moss & Pavitt, 2019b). Whilst antecedent cues do not cause behaviour, they set an occasion for behaviour to occur. In this way, interpretive signage functions as a low-cost antecedent intervention, a non-coercive environmental arrangement that can be tailored to address the needs of a specific conservation issue and can increase the likelihood of learning and recall (Cooper et al., 2020; Schultz, 2001).

Promoting awareness through interpretive educational signage is essential for educating and influencing visitors' behaviour in conservation spaces (Mellish et al., 2021; Roe & McConney, 2015; Ross et al., 2012). Behaviour analysis explains how signage functions as an antecedent stimulus within the environment and how it can actively shape observable behaviour in conservation settings (Cooper et al., 2020; Skinner, 1987).

Signage as a Behavioural Antecedent Intervention

Research on signage as an antecedent intervention predominantly targets problematic behaviours, though results have been inconsistent (Mustapha et al., 2024; Wood et al., 2018), with some studies showing that signage functions as an effective antecedent that decreases the probability of rule-violating responses (Cialdini et al., 2006; Meschke et al., 2020), whereas other research has shown that signage fails to alter behaviour under competing environmental contingencies or high-distraction conditions (Kidd et al., 2015; Roggenbuck, 1992; Winter, 2006). Field-based work further demonstrates that clearly phrased prompts can shift visitor responding under naturalistic conditions.

Lemmen et al. (2020) reported that instructional signage altered the antecedent conditions in the exhibit, resulting in fewer visitor attempts to lure primates. By arranging clearer cues about expected behaviour the signage shifted the environmental context in a way that reduced the likelihood of lure-attempt responses. In addition to reducing problematic behaviour, signage is frequently used to increase the likelihood of pro-environmental actions. Environmental cues, such as signage, arrange conditions that increase the likelihood of responding, by presenting text and imagery that signal the opportunity to engage in pro-environmental behaviour. Educational conservation signage implicitly functions to signal or evoke attention (Coe, 1987), however, empirical evidence demonstrating its efficacy is sparse. Rather than arranging full contingencies, signage primarily operates as an antecedent stimulus by structuring the visual and textual cues in the environment to increase the likelihood of specific visitor responses related to conservation outcomes (Saunders, 2003).

Do Signs Work to Change Conservation-Related Behaviour?

Empirical studies conducted in managed wildlife facilities have explored the influence of interpretive signage on visitor behaviour, although findings remain inconsistent (Clayton et al., 2009; Dierking et al., 2004; Edney et al., 2023; Moss & Pavitt, 2019a). Some studies have shown that signage functions as an effective antecedent that increases visitor engagement with exhibits or conservation information, such as Moss and Pavitt (2019a), who reported longer dwell times at exhibits with well-designed interpretive panels, and Edney et al. (2023), who found that concise, image-driven signs increased the probability of visitors attending to key conservation messages. In contrast, other research has demonstrated limited behavioural impact. Clayton et al. (2009) observed that only a small proportion of visitors altered their behaviour in response to signage, and Dierking et al.

(2004) reported minimal changes in visitor interaction patterns despite the presence of interpretive materials.

Research also indicates that fewer than 35% of visitors stop to read signs in captive facilities, emphasising the need for interpretive design elements that evoke attending behaviour (Clayton et al., 2009; Davis & Thompson, 2011; Holland et al., 2015; Povey & Rios, 2002). Interpretive signage designs that incorporate attention principles, such as visual design features, have increased engagement (Bitgood, 2000; Bitgood, 2016; Mellish et al., 2021; Moss & Pavitt, 2019b). Bitgood's (2000, 2016) attention-value model proposes that visual features such as colour contrast, simplicity, and clear focal points increase the probability that a stimulus captures and holds attention, thereby strengthening the antecedent function of signage. Moss and Pavitt (2019b) found that signage with simplified layouts and high-salience design elements increased dwell time and viewing behaviours of zoo visitors. Similarly, Mellish et al. (2021) reported that interpretive signs incorporating concise text, strong visual hierarchy, and clear imagery produced greater visitor engagement and more accurate recall of conservation information. Collectively, these findings demonstrate that design features grounded in attention principles can enhance the discriminative properties of signage, increasing the likelihood of visitor interaction with conservation messages.

Visual communication enhances remembering and attention, which supports interpretive educational signage as an intervention (Moss & Pavitt, 2019b). Edney et al. (2023) reported that visual design elements such as colour and typography increased the likelihood of visitors orienting toward signage, aligning with prior research showing that such features operate as antecedent variables influencing attending behaviour (Bitgood, 2016; Cooper et al., 2020; Falk & Dierking, 2013; Moss & Pavitt, 2019b). Similarly, Ogbonda

et al. (2023) demonstrated, by experimentally manipulating visual layout, colour contrast, and text load, that design features can function as antecedent stimuli. Their results showed that high-salience layouts increased initial orienting responses and improved short-term recall, indicating that stimulus salience strengthens the attending component of the behaviour chain. However, they also noted that improvements were modest when competing stimuli were dense, suggesting that design features alone may not consistently evoke attending behaviour under high distraction conditions. This aligns with broader evidence showing that, although visually salient signage can enhance attending and recall, these effects are not uniformly reliable across settings or visitor populations. For example, several studies have reported negligible changes in behaviour despite the presence of well-designed interpretive materials, with visitors either not approaching signage or failing to modify their behaviour after viewing it (Clayton et al., 2009; Dierking et al., 2004; Winter, 2006). These findings indicate that the effectiveness of interpretive signage is variable, shaped by competing environmental contingencies, visitor motivation, and the broader context in which the antecedent stimulus is presented.

Signage Effectiveness and Limitations

Researchers have shown that education alone is not very effective at changing behaviour (Clayton et al., 2009; Moss et al., 2017; Schultz, 2001). Although indicators of engagement, such as attendance and attraction, can be observed, Edney et al. (2023) note that these measures do not necessarily reflect knowledge acquisition or behaviour change.

Several zoo-based exhibition studies have reported favourable results when visitors view educational messaging incorporating diverse interpretive elements and key messaging (Adelman et al., 2000, Falk & Dierking, 2013; Skibins & Powell, 2013). However, both Dove (2016) and Marshall (2016) found that visitor engagement and understanding reduced when

visitors were presented with information-heavy text or excessive signage. This suggests that in captive settings, designers of conservation education must consider not only the content but also the delivery of the messaging (Moss & Pavitt, 2019b).

Rice et al. (2023) further demonstrated that graphic design elements, particularly typography and colour, can capture attention and influence behaviour, although the researchers did not measure recall, which is a gap addressed in my study.

A broader body of empirical research across captive wildlife facility settings has examined how signage influences observable behaviour, though the types of behaviours measured vary considerably. Some researchers have assessed whether providing conservation or interpretive information increases on-site behaviours such as stopping, reading, and approaching exhibits (e.g., Bitgood, 2000, 2016; Davis & Thompson, 2011; Holland et al., 2015). Bitgood (2000, 2016) reported that signage incorporating salient visual features increased the probability that visitors stopped and visually oriented toward an exhibit. Davis and Thompson (2011) similarly found that clear, well-positioned signs increased reading behaviour and time spent attending to exhibit areas. Holland et al. (2015) observed that adding concise interpretive content increased approach behaviours, with visitors more likely to slow down and engage with exhibit displays when signage was present.

Other researchers have evaluated whether signage alters specific visitor actions, including compliance with rules such as staying on designated paths or not feeding the animals (Clayton et al., 2009), reducing behaviours that disrupt animal-visitor boundaries (Lemmen et al., 2020), increasing recycling and waste disposal responses (Kidd et al., 2015), improving hygiene-related actions such as handwashing (Kroshus et al., 2019), and promoting participation in pro-environmental activities (Mustapha et al., 2024).

Clayton et al. (2009) found that rule-focused signage produced only small changes in compliance, with most visitors maintaining their usual behaviour regardless of the antecedent cue. Recent research shows that the interpretive materials displayed in captive wildlife facilities are highly variable in both content and design quality, resulting in inconsistent antecedent conditions for visitors (Fourage et al., 2023). This variability highlights the need for structured behavioural design approaches, such as Big Hero Visualisation (BHV) framework, that deliberately arrange clear and effective antecedent stimuli.

More recently, Zhang et al. (2021) demonstrated that strategically framed signs in a zoo setting reduced attempts by visitors to lure primates by increasing the salience of the behavioural contingency and emphasising the potential negative outcomes of the action. Their findings support the conclusion that when signage provides a distinct, easily interpreted prompt that presents an unambiguous behavioural expectation, it can arrange environmental conditions that increase or decrease the likelihood of specific visitor behaviours under naturalistic conditions.

Kidd et al. (2015) similarly reported limited effectiveness of signage aimed at discouraging wildlife feeding. In conditions where social and environmental contingencies were strong, the signage did not reliably reduce feeding behaviours. In contrast, Kroshus et al. (2019) demonstrated that hygiene prompts increased handwashing behaviour, indicating that clear, proximal cues can evoke the desired response when the relevant behavioural opportunity is immediate. Mustapha et al. (2024) found that recycling and waste-disposal signage increased correct bin use modestly but inconsistently across locations, suggesting that the antecedent effect of signage depends heavily on contextual variables such as bin placement and competing stimuli.

Studies in museums and aquariums have also reported that clearly structured signage, simplified visual layout, or distinct graphic features increase attraction to exhibits, dwell time, and behavioural engagement (Adelman et al., 2000; Skibins & Powell, 2013; Yalowits & Bronnenkant, 2009). Collectively, these findings show that signage can function as an antecedent arrangement that increases the likelihood of a range of observable behaviours in managed settings.

However, few studies have examined recall as an observable behavioural outcome, and even fewer have evaluated how specific visual design features may contribute to recall accuracy. This gap highlights the need to investigate whether tailored interpretive designs, such as BHV elements, might influence recall of conservation messaging.

Big Hero Visualisation

The BHV framework, proposed by Ogbonda et al. (2023), uses specific design elements to accentuate the salience of visual stimuli, which in turn raises the probability of visitors orienting toward the signage. These elements typically incorporate bold typography, distinctive colour palettes, simplified layout, and clear messaging. Proponents of Attention Theory (AT) posit that human attention is limited and selective, and that certain visual features are more effective at capturing and evoking attending behaviours because they stand out from the surrounding environment (Bitgood, 2016; Mayer, 2005).

While BHV commonly relies on strong contrast and saturated colour, I applied BHV principles in my poster through clarity, segmentation, and discriminability, prioritising the key message: five kiwi species. The use of the numeral “5” aligns with evidence that numerals are more discriminable and recalled more efficiently than words due to their compact visual structure (Bae et al., 2023). Segmenting information into rounded shapes helps separate content into distinct units, reducing competing visual elements and

supporting discrimination of each species (Mayer, 2020). Simple, legible typography further enhanced feature detection (Wolfe, 1994). Soft colour choices minimised visual competition, while the consistent circular framing created predictable visual patterns that supported visual search. Together, these features modified the antecedent stimulus, with the aim of increasing salience and improving the likelihood of accurate recall. The poster also avoided visual clutter, an important consideration, as designs with fewer competing elements reduce attentional demands and increase the probability that viewers detect and respond to the core message (Bitgood, 2016). In addition, the soft colour palette and organic shapes introduced mild novelty compared to typical rectangular signage formats, which can evoke orienting responses (Berlyne, 1960).

Within interpretive design, AT aligns with behavioural principles of stimulus control, proposing that people are more likely to attend to visual information that stands out from the surrounding environment (Cooper et al., 2020). Empirical studies show that when signage contains clear, discriminable, well-designed elements, visitors are more likely to orient toward exhibits, approach them, and engage with their displayed content in captive settings (Derwin & Piper, 1988; Jensen, 2006; Zhu et al., 2021). Some design elements evoke attending behaviour more reliably because they either stand out against the visual background or match both learned reinforcement histories and evolutionary predispositions.

Visitors are more likely to attend to cues that have previously been followed by reinforcing outcomes. For this to occur, the cue must first be perceived. Signs that are visually clear or discriminable are more likely to be detected in the environment, increasing the likelihood that attending behaviour occurs in the first place. When attending to a sign results in accessing information that is meaningful or useful, that attending behaviour is

more likely to be reinforced, strengthening the probability of noticing similar visual features in the future.

Biologically salient cues, such as strong contrast or the colour red, which is often associated with urgency and danger, naturally capture attention due to their evolutionary relevance and function as particularly evocative cues in signage design (Elliot & Maier, 2012; Öhman & Mineka, 2001; Pravossoudovitch et al., 2014). Highly discriminable stimuli, such as bold typography and high-saturation colours, capture attention promptly, increasing salience and likelihood of evoking attending behaviour by sharply contrasting with their surroundings (Bitgood, 2016; Wolfe, 1994). Novel or distinctive features, including unexpected imagery or layout, can elicit orienting responses that sustain attention and exploration because they differ from familiar patterns (Berlyne, 1960; Bitgood, 2016). Collectively, these features explain why the BHV design framework can be effective as an antecedent intervention, manipulating the visual properties of the environment to increase the likelihood of visitors attending and recalling the message (Wood et al., 2018).

Gestalt principles further hypothesise how observers group visual components into coherent units. Features such as closure, continuity, proximity, and similarity organise complex displays into meaningful structures (Wertheimer, 1938). When applied in signage (as a behavioural intervention), Gestalt-based organisation can increase the discriminability of visual elements, guide attending behaviour, and enhance message clarity (Pettersson, 2017). These design principles are essential in ensuring that diverse audiences see conservation messages (Bitgood, 2016; Mayer, 2005), and they have been effectively used in informal learning environments such as zoos and aquariums, where organised and visually salient displays increase the likelihood of visitor engagement and conservation-

related behaviours (Clayton et al., 2009; Mellish et al., 2021; Moss & Pavitt, 2019a; Skibins & Powell, 2013).

Skibins and Powell (2013) further illustrated how interpretive design can influence visitor responses. Their findings showed that even an atypical species, such as jellyfish, considered an unusual choice, became a preferred favourite exhibit when displays employed distinctive interpretive design features. These findings support the functional role of design elements as antecedent stimuli that can increase attendance and recall, aligning with the BHV framework as a behavioural intervention (Skibins & Powell, 2013).

In addition to the effects of design features on attending and recall, individual differences may also influence the extent to which signage functions as an effective antecedent stimulus. People vary in how much they claim to value the environment more than others, and these reported differences may affect the extent to which they attend to conservation cues when they are presented.

Values as a Category Label

Within the behavioural framework, what are often referred to in social psychology as "values" can be understood as verbal summaries of reinforcement histories rather than internal states. In a conservation context, statements or responses to a questionnaire are examples of verbal behaviour that has been shaped and maintained by past reinforcement contingencies. When people respond to questions regarding environmental values, the verbal response is observable behaviour under stimulus control by the questionnaire item.

Importantly, the term "value" refers to a category label that summarises a pattern of learned behaviour; it does not describe an internal entity that causes behaviour. Reporting an altruistic, biospheric, egoistic, or hedonic value orientation is therefore a form of verbal behaviour shaped by a person's learning history.

In this context, interpretive signage functions as an antecedent stimulus that can increase the likelihood of conservation-related responding by making relevant information more noticeable in the moment. For individuals who report strong biospheric values, the sign may be particularly effective because their learning histories likely include reinforcement for engaging in pro-environmental behaviours (PEBs). In this sense, the sign acts as a reminder that frames the conservation contingency as relevant, making PEB-consistent responses more probable for people who already have those behaviours in their repertoire. For example, a sign highlighting the vulnerability of kiwi species may increase the probability of conservation-related verbal behaviour (such as recalling or discussing the information), particularly for people who report holding strong biospheric values, because the relevant cues have been made more salient and align with behaviours that have previously been reinforced.

In this way, the sign increases access to conservation information and supports recall, particularly among those who report higher biospheric concern, as this self-reported value orientation likely reflects a reinforcement history in which engaging in similar pro-environmental actions has been selected and maintained over time (Skinner, 1974). This interpretation aligns with the behavioural position that “values” operate as verbal behaviour summarising patterns of interaction with the environment, rather than internal casual entities, and is consistent with Rachlin’s (2012; 2014) teleological behaviourism, which argues that hypothetical constructs, such as “values”, can function as useful category labels that describe extended patterns of observable behaviour over time, rather than mental entities that exert causal influence (Rachlin, 2014).

This interpretation is also compatible with Skibins and Powell’s (2013) conservation caring construct, which suggests that people who report higher biospheric concern are more

likely to recall conservation information presented in exhibitions. Although this mechanism is hypothetical, it remains consistent with the behavioural perspective that past reinforcement histories shape attending and verbal responding in conservation contexts.

When signs are memorable, the message may influence behaviour beyond the captive facility environment (Clayton et al., 2009; Dierking et al., 2004; Moss & Pavitt, 2019a; Roe & McConney, 2015). Therefore, interpretive signage with design elements that draw attention to biospheric issues has the potential to support behaviour change (Schultz, 2001; Skibins & Powell, 2013). If individuals who report higher biospheric values are generally more responsive to conservation cues, then effective visual design may support their recall of key information. In this way, both variables, the antecedent stimulus (the sign) and a person's reinforcement history (reported biospheric values) may contribute to the likelihood of responding.

Individual Differences

Visitor characteristics also influence the extent to which signage functions as an effective antecedent. This nuance, namely, that individuals differ in how strongly they respond to the same conservation cues, highlights how subtle differences among visitors can alter the extent to which signage elicits conservation behaviour (Skibins & Powell, 2013). Previous studies have shown that self-reported altruistic and biospheric values are associated with higher probability of attending to conservation messaging (De Groot & Steg, 2010; Stern & Dietz, 1994). Contrarily, egoistic and hedonic orientations tend to weaken pro-environmental behavioural responses (Bouman et al., 2018; Marshall et al., 2019). Cross-national findings from Sargisson et al. (2020) demonstrate that reported value orientations vary across populations, which can be interpreted behaviourally as reflecting

different reinforcement histories rather than differences in responsiveness to conservation information.

Biospheric Values and Environmental Concern

Researchers have observed that zoo visitors who engage in conservation-oriented behaviours tend to report stronger biospheric values and environmental concern, as measured by Schultz's (2001) Biospheric Value Scale (BVS) and the New Ecological Paradigm (NEP) scale (Dunlap et al, 2000; Skibins & Powell, 2013). The BVS was adapted from Schwartz's (1992) Value Orientation Scale (VOS), and described and defined altruistic, biospheric, and egoistic domains related to conservation behaviour (Corner et al., 2014; De Groot & Steg, 2007; Schultz, 2001; Schultz et al., 2005).

Individual concern for conservation often reflects underlying environmental value orientations (EVOs) – altruistic, biospheric, egoistic, and hedonic (De Groot & Steg, 2008; Schwartz, 1992; Stern & Dietz, 1994; Stern et al., 1993). Altruistic values reflect a verbal endorsement of fairness and social justice and are often associated with behaviour that benefits others. For example, Item 3 "*Equality (equal opportunity for all)",* illustrates how altruistic values emphasise equitable outcomes and concern for others' welfare. Biospheric values represent the verbally reported importance placed on the conservation and protection of nature and are correlated with behaviours of ecological preservation. For example, Item 6 "*Preventing pollution (protecting natural resources)",* reflects a biospheric value that prioritises safeguarding the natural environment and reducing ecological harm. Egoistic values reflect a preference for personal resources, achievements, and status and are associated with behaviours that emphasise self-interest and personal gain. For example, Item 10 "*Authority (the right to lead or command)",* represents an egoistic value that prioritises control, influence, and the maintenance of one's own status. Hedonic values

capture the reported importance of comfort and pleasure for individuals, linked to behaviour that maximises positive affect or minimises effort. For example, Item 12 "*Pleasure (gratification of desires*)", reflects a hedonic orientation that emphasises immediate enjoyment and the pursuit of pleasurable experiences.

Items within the NEP scale represent five facets of environmental worldview (Dunlap et al., 2000). Anti-anthropocentrism rejects the belief that humans are superior to or separate from nature (e.g., Item 12 "*Humans were meant to rule over the rest of nature*"). The fragility of nature's balance relates to the belief that natural systems are delicate and easily disrupted (e.g., Item 4 "*The balance of nature is very delicate and easily upset*"). Limits to growth represents the belief that human development is constrained by ecological limits (e.g., Item 11 "*The Earth is like a spaceship with very limited room and resources*"). Rejection of human exceptionalism rejects the notion that humans are exempt from natural laws and limits (e.g., Item 5 "*Humans are subject to laws of nature*"). The possibility of an eco-crisis reflects concern that environmental degradation may lead to severe and imminent consequences (e.g., Item 15 "*If things continue on their present course, we will soon experience a major ecological catastrophe*"). Although the NEP includes five conceptual facets, a broad literature review shows that subscales do not replicate consistently across cultures (Amburgey & Thoman, 2012) and indicate weak internal consistency (Hawcroft & Milfont, 2010). Therefore, the NEP is treated as a unidimensional environmental worldview (Dunlap et al., 2000). Reported individual differences, such as values or environmental concern, can shape patterns of engagement with conservation information by reflecting past reinforcement histories, which in turn influence the conditions under which environmental stimuli function as antecedents for pro-environmental behaviour (Geiger et al., 2025; Steg et al., 2011).

Captive Facilities and Kiwi Advocacy

Captive facilities provide animal exhibitions accompanied by educational signage designed to inform visitors and communicate key conservation messages (Clayton et al., 2009). Particular attention is given to endangered species, such as the kiwi, to promote awareness and engagement in conservation advocacy initiatives. A handful of facilities house kiwi (~ 5 in New Zealand) and require specialised nocturnal accommodations. Educational initiatives promoting awareness and fostering behaviour change are essential for biodiversity conservation outcomes (Sithole et al., 2024). Educational signage, exhibitions, multimedia displays, interactive technology, and conservation campaigns are commonly used in captive facilities (Dove, 2016; Zimmermann et al., 2007).

The national bird in New Zealand (NZ) is the flightless and endangered kiwi (*Apteryx* spp.*).* The Department of Conservation (DOC) estimated that approximately 70,000 remain, with five variants recorded: North Island Brown Kiwi (*Apteryx mantelli)*, Roroa / *Great Spotted Kiwi (Apteryx hastii)*, Kiwi Pukupuku / *Little Spotted Kiwi (Apteryx owenii)*, Rowi (*Apteryx rowi)*, and Tokoeka (*Apteryx australis)*; with fewer than 600 each; these last two are the most susceptible to extinction (Department of Conservation, 2025; Save the Kiwi, 2024). Advocating for kiwi is a primary objective for DOC to counter the decline of the species driven by predation and anthropogenic factors (McLennan et al., 1996; Sales, 2005). The Kiwi Advocacy Project emerged as a collaborative initiative among ZAA partners, iwi representatives, and key government and conservation stakeholders.

Captive facilities present an opportunity to apply design principles to observe how signage interventions function within conservation environments and how they may shape behaviour. The ZAA supports conservation efforts in captive facilities, specifically addressing public engagement and advocacy. Conservation outcomes are largely anthropogenic,

resulting from decision-making that threatens habitats, creates pollution, and influences biodiversity. Although interpretive signage can alter the environmental conditions under which behaviour occurs, limited research has systematically analysed whether specific interpretive design features serve to improve recall and consequently advocacy outcomes (Edney et al., 2023).

To investigate whether exposure to a sign can increase recall of conservation facts about an endangered species, I developed an exhibition poster (Figure 1) featuring BHV design elements, in collaboration with the Zoo and Aquarium Association (ZAA) and the National Aquarium of New Zealand (NANZ).

Figure 1

Kiwi Exhibition Poster With Bold Number Five Element of the BHV Design

Research gap

Although design features have been shown to influence behaviour in conservation settings (Edney et al., 2023; Geiger et al., 2025), and self-reported value orientations predict how individuals respond to environmental issues (De Groot & Steg, 2010; Sauer & Rüttinger, 2004; Steg et al., 2011), it remains unclear how these two factors operate together.

Building on Edney et al.'s (2023) call for observable and measurable learning responses, I analysed recall as a behavioural outcome of interpretive signage design. Despite evidence that interpretive signage can influence observable behaviour, few studies have explored how visual design elements interact with individual differences noted in earlier conservation research, including self-reported EVOs. Whilst Edney et al. (2023) did not measure value orientations, their work highlights the broader need to consider how individual characteristics may influence the effectiveness of visual design based interventions. The present study addressed this gap by examining recall alongside self-reported environmental orientations, exploring whether visual design elements might interact with these factors to predict the probability of correct recall (Ballantyne & Hughes, 2006; Falk & Adelman, 2003; Falk & Storksdieck, 2005).

Previous studies focused on broad learning outcomes or general visitor experiences and did not examine recall as a discrete behavioural measure. For example, Ballantyne and Hughes (2006) examined visitors' reported learning and emotional engagement during tourism experiences, relying on reflective survey responses rather than direct behavioural measures such as recall accuracy. Similarly, Falk and Adelman (2003) showed that prior knowledge and self-reported personal motivations influence what visitors report learning, based on retrospective accounts, not behavioural indicators or outcomes. Falk and Storksdieck (2005) further identified a wide range of contextual factors such as personal,

social, and physical factors that contribute to free-choice learning, yet they did not analyse the functional role of visual design elements or how these may interact with individual characteristics. Together, these studies (Ballantyne & Hughes, 2006; Falk & Adelman, 2003; Falk & Storksdieck, 2005) demonstrate that multiple factors influence learning, but the behavioural processes through which visual design functions as an antecedent stimulus for accurate recall remain insufficiently understood.

In an online questionnaire, all participants viewed the existing National Aquarium of New Zealand (NANZ) exhibition materials, with only the experimental condition also viewing the BHV kiwi posters. Participants were provided two self-report environmental orientation scales, and recall of the number of kiwi species was measured as an observable behavioural response.

I hypothesised that participants who viewed an array of educational signs, including a sign with tailored visual design elements (BHV poster) displaying the number of kiwi species, would recall the number of kiwi species more accurately than those who viewed the same signs except for the kiwi-species sign (control condition). Secondly, I predicted a positive association between self-reported environmental value orientations (EVOs) and recall accuracy. Higher altruistic and biospheric orientations were expected to correspond with higher recall accuracy, consistent with evidence that these orientations are associated with a greater probability of engaging in pro-environmental actions (De Groot & Steg, 2012; Kis et al., 2020; Stern & Dietz, 1994). In contrast, egoistic and hedonic value orientations were not expected to show this positive association, given evidence that these values are typically unrelated or negatively related to pro-environmental responding (Bouman et al., 2018; Marshall et al., 2019; Steg et al., 2011). Because self-reported value orientations tend to be independent of sociodemographic factors (Sargisson et al., 2020), they may reflect

individual differences shaped by reinforcement histories rather than demographic characteristics.

The final hypothesis was that self-reported value orientation scores would modify the antecedent effect of the BHV sign on recall. Higher reported altruistic and biospheric scores were expected to strengthen the sign–recall relation, whereas higher egoistic and hedonic scores were expected to reduce or inhibit the recall advantage associated with the sign. Thus, I expected to find significant interactions between value orientation scores and recall accuracy. Specifically, the improvement in recall expected for participants in the experimental condition was anticipated to be enhanced for those who reported holding strong biospheric and altruistic values. Conversely, for those who reported holding strong egoistic or hedonic values, the improvement in recall in the experimental condition was predicted to be less pronounced than for those who did not strongly endorse those values.

Method

Participants

Participants were psychology students of the University of Waikato who participated for course credits. Of the initial 285 participants who completed the first questionnaire, 202 remained after exclusions. Data from participants who did not complete the questionnaire were excluded. The final sample was 160 women, 35 men, four non-binary individuals, and three who did not disclose their gender. Participant ages ranged from 17 to 54 years (M = 22.20, SD = 7.02). The ethnic composition was 63% New Zealand European, 12% Māori, 11% Asian, 8% Other, 3% Pacific, and 3% did not disclose ethnicity. Participants were asked to indicate whether they had any colour vision deficiency, with one denoting a red-green deficiency. Participants reported holding mostly centre-left to centre-right political views,

representing 63% of the sample; with 16% for each of liberal, moderate liberal, moderate left, and 15% for moderate conservative.

Materials

Poster Design

I developed the 5-species kiwi poster in collaboration with the National Aquarium of New Zealand (NANZ) and ZAA. Following the Big Hero Visualisation approach of Ogbonda et al. (2023), the design featured bold visual elements and a large number to inform participants of the 5 species of kiwi (see Figure 1). This design simplified the messaging and aligned with the existing NANZ posters (Appendix A) and branding colours to maintain standardised imaging across the two conditions.

Value Orientation Scale

I measured environmental values using an extended 17-item version of the Value Orientation Scale (VOS), which combines the original value domains developed by De Groot and Steg (2007, 2008) with additional Schwartz (1992) value items, encompassing four key subscales (see Appendix B): *Altruistic* (welfare of others, Items 3, 4, & 5), *Biospheric* (environment and nature, Items 1, 2, 6, & 7), *Egoistic* (personal resources and achievement, Items 8, 9, 10, & 11), and *Hedonic* (pleasure and comfort, Items 12 & 13). Participants rated the importance of 17 guiding principles as life values on a 9-point Likert scale (–1 = opposed to my values, 0 = not important, 7 = extremely important). The remaining four items (Items 14 – 17: *A comfortable life*, *A varied life*, *Ambitious*, *Capable*) represent broader Schwartz value domains such as stimulation, achievement, and competence; these do not form part of the VOS structure and were therefore excluded from value-orientation scoring.

The VOS scale has demonstrated good reliability and construct validity, with previous studies reporting Cronbach's alpha values ranging from α = 0.75 - 0.81 (Bouman et al., 2018)

and from 0.65 - 0.79 (De Groot & Steg, 2007), with biospheric values consistently linked to stronger pro-environmental intentions and behaviours (Dong et al., 2023; Wang et al., 2021). I calculated the total score as the mean of the items in each subscale. Internal consistency ranged between 0.70 – 0.91, across the four VOS value domains. Biospheric values showed excellent reliability, α = .91, with a mean of 4.74 (*SD* = 1.44). The remaining values demonstrated acceptable internal consistency, altruistic α = .70 (*M* = 5.08, *SD* = 1.17), egoistic α = .70 (*M* = 2.72, *SD* = 1.43), and hedonic α = .73 (*M* = 4.93, *SD* = 1.51). The comparatively low egoistic mean is not unusual, as previous studies have shown that self-reported egoistic value items are typically lower relative to other VOS values in comparable student and young adult populations (Bouman et al., 2018; Steg et al., 2011). This pattern reflects established trends in the VOS literature rather than a measurement inconsistency.

New Ecological Paradigm Scale

I measured environmental worldview using the revised New Ecological Paradigm (NEP) scale (Dunlap et al., 2000). This 15-item unidimensional measure (see Appendix C) assesses participants' self-reported environmental concern and endorsement of an ecological worldview, evaluating participants' self-reported attitudes and beliefs which represent five facets: *Anti-anthropocentrism* (Items 2, 3, & 12), *Fragility of nature's balance* (Items 4, 9, & 14) , *Limits to growth* (Items 1, 6, & 11), *Rejection of human exceptionalism* (Items 5 & 10), and *Possibility of an eco-crisis* (Items 7, 8, 13, & 15). The scale was a traditional 5-point Likert scale (1 = Strongly Disagree; 5 = Strongly Agree). I reverse-coded the anti-ecological items (2, 6, 8, 9, 10, 12, 13) before calculating the total score as mean values. The NEP scale has demonstrated strong internal validity and consistency in prior validation studies, α = 0.70 to .85 (Dunlap et al., 2000; Hawcroft & Milfont, 2010).

The initial internal consistency for the full 15-item scale was low (Cronbach's α = .50). This level of reliability is not unusual for the NEP, as several studies have reported modest and variable alpha values across adult and student samples (Amburgey & Thoman, 2012; Hawcroft & Milfont, 2010). Because the overall reliability was poor, item-level diagnostics were reviewed to determine whether any items were functioning inconsistently with the scale.

Item 2, "*Humans have the right to modify the environment to suit their needs",* showed a negative corrected item-total correlation (-.006), indicating that responses to this item did not align with the direction of the remaining NEP items. This pattern is consistent with previous research showing that several anthropocentric, reverse-worded NEP items, particularly Item 2, which is often reported to function inconsistently (Amburgey & Thoman, 2012; Hawcroft & Milfont, 2010), tend to reduce reliability or display weak factor loadings across age ranges and cultural groups (Cordano et al., 2003; Hawcroft & Milfont, 2010; Jonson et al., 2004; Milfont & Duckitt, 2004). Based on both the statistical criteria and prior psychometric findings (DeVellis, 2017), this item was removed from the final scale. Removing this item improved internal consistency (α = 0.53). Analysis therefore used the mean score of the remaining 14 items. Environmental worldview scores remained consistent with reports from similar student populations, with a mean of 3.37 (*SD* = 0.39), reflecting generally pro-environmental responding (Amburgey & Thoman, 2012; Hawcroft & Milfont, 2010; Rideout et al., 2005).

Other Questionnaire Items

Participants were asked "*How many species of kiwi are there in New Zealand?"*, using a 1-8 numerical dropdown option. Participants were required to answer this question before continuing (see Appendix D). The question was followed by several demographic

questions, including age, ethnicity, domestic or international status, colour-blindness, and gender. Political orientation was measured using a 10-point scale in response to *"What is your political orientation?",* (1 = Far left wing (e.g., Green Party), 3 = Liberal, 5 = Moderate Left (e.g., Labour), 8 = Conservative (e.g., National), and 10 = Far Right Wing (e.g., ACT)).

Procedure

The University of Waikato Arts, Law, Psychology, and Social Sciences (ALPSS) Human Research Ethics Committee, under delegated authority of the University of Waikato Human Research Ethics Committee, granted ethical approval for the research before the study commenced, under Reference number FS2025-12 (see Appendix E).

Participants were recruited through the University of Waikato's Introduction to Psychological Research Programme (IPRP) and they provided consent before receiving a brief study overview (see Appendix F). All responses were collected and anonymised via a Qualtrics (https://www.qualtrics.com) questionnaire. All participants completed the questionnaire in a fixed sequence: exhibition posters from the National Aquarium of New Zealand were presented first, followed by the VOS and NEP scales, kiwi species question, and lastly the demographic items. Participants were randomly assigned to one of two conditions (control and experimental) through a randomised block within the Qualtrics software. The experimental condition included exposure to the BHV poster, while the control condition did not. Participants in the control condition viewed seven exhibition posters (see Appendix A), excluding the 5-species kiwi poster. The experimental condition viewed the same seven posters and additionally viewed the 5-species kiwi poster (Figure 1). I designed the questionnaire to simulate walking through a wildlife conservation facility environment with various educational animal exhibits. All items within each of the first three blocks (posters, VOS, and NEP) were randomised within each scale, and a time limit

was applied. A minimum response time was applied as a quality control measure to prevent speeding through the poster content and to increase the likelihood that participants had sufficient time to view materials.

Data Analysis

I collected the data using Qualtrics software from 21 July to 08 September 2025 and analysed it with IBM's SPSS Statistics (Version 29, https://www.ibm.com/products/spss-statstics). The primary dependent variable (DV) was recoded as a binary outcome: correct recall = 1, incorrect recall = 0 (e.g., 1, 2, 3, 4, 6, 7, & 8 were incorrect answers, 5 was correct). In line with standard VOS scoring procedures, item responses were recoded from the Qualtrics output format (1–9) into the original –1 to 7 metric to reflect the conceptual structure of the VOS, consistent with recommendations from De Groot and Steg (2007, 2008) and subsequent applications by Bouman et al. (2020) and Marshall et al. (2019).

I used a binary stepwise logistic regression to examine whether condition (control v. experimental) and environmental values predicted recall accuracy. The analysis followed the same structure as Geiger et al.'s (2025) Study 2, with a two-step logistic regression. Step 1 included the main effects of experimental condition (control v. experimental) and the environmental VOS value orientations: mean scores of altruistic, biospheric, egoistic, and hedonic, plus the NEP worldview score. The Step 2 interaction model added interactions between condition and each value variable (entered individually to avoid multicollinearity).

Results

Analysis Data and Diagnostics

Of the 202 participants, 108 correctly recalled that there are five species (53.5%) and 94 participants provided an incorrect response (46.5%) across the sample. Recall performance differed across the two conditions. In the control condition, 44 of 101

participants correctly recalled the number of kiwi species (43.6%). In contrast, the experimental condition, 64 of 101 participants answered correctly (63.4%).

I conducted a binary two-step logistic regression to examine whether exposure to the BHV sign, EVOs, and NEP scores predicted correct recall of the number of kiwi species (0 = incorrect, 1 = correct). The Step 1 model was not statistically significant overall, χ^2 (6) = 4.91, p = .427, and accounted for a small portion of variance (Nagelkerke R^2 = 10.3%). Although the goodness-of-fit test indicated adequate fit to the observed data, χ^2 (8) = 14.41, p = .072, the overall Step 1 model did not significantly improve prediction of recall (see Table 1).

Table 1

Results of Stepwise Logistic Regression

Step	Predictor	*B*	*OR*	*SE*	*Wald* χ^2	*p*	R^2	χ^2	*p*
1	Condition (BHV = 1)	.87	2.37	.29	8.67	.003	.10	4.91	.427
	Altruistic	.18	1.20	.17	0.34	.292			
	Biospheric	-.08	0.92	.14	1.11	.560			
	Egoistic	-.02	0.99	.11	0.04	.847			
	Hedonic	.09	1.09	.11	0.64	.424			
	NEP (14 items)	.16	1.17	.40	0.15	.694			
2	Condition × Altruistic	-.36	0.88	.36	1.00	.727	.08	0.87	.352
	Condition × Biospheric	-.21	0.81	.29	0.53	.468	.08	1.27	.260
	Condition × Egoistic	-.18	0.83	.22	0.69	.405	.08	0.58	.447
	Condition × Hedonic	.15	1.16	.23	0.40	.528	.07	0.01	.932

Note. R^2 = Nagelkerke, Degrees of freedom are 6 for Step 1 and 5 for Step 2.

Condition was the strongest and only significant predictor of correct recall of the number of kiwi species. Participants in the experimental condition were significantly more likely to respond correctly (64%) than those in control condition (44%), p = .003. Exposure to the BHV sign increased the odds of a correct response by approximately 2.3 times.

None of the environmental values (altruistic, biospheric, egoistic, hedonic, and NEP) significantly predicted recall accuracy. All coefficients were small and did not significantly predict recall accuracy.

In the Step 2 model, none of the interaction terms reached significance, indicating that the effect of viewing the BHV sign on recall did not vary as a function of participants' self-reported value orientations or NEP scores. The inclusion of interaction terms produced only a small increase in explained variance (R^2 = 13.4%), demonstrating limited additional predictive value.

Overall, the logistic regression models indicated that exposure to the BHV sign was the only meaningful predictor of recall accuracy in the main-effects model, and that individual differences in value orientations did not contribute to or moderate recall performance.

Discussion

Overview of Findings

I explored the effects of visual-design interpretive signage on the recall of the five species of kiwi in Aotearoa New Zealand, specifically examining whether a sign using Big Hero Visualisation (BHV) elements functioned as an antecedent stimulus that may increase the likelihood of correct recall. Consistent with my primary hypothesis, participants who viewed the BHV sign demonstrated significantly higher recall accuracy than those in the control condition. Exposure to the BHV design increased the odds of correct recall by approximately 2.3 times, indicating that viewing a sign, compared to no sign, may increase the probability of producing an accurate recall response.

My second hypothesis that environmental value orientations (EVOs) would predict recall accuracy, was not supported. Across the VOS and NEP scores, none emerged as significant predictors, indicating that reported value orientations did not meaningfully differentiate between participants who did and did not recall the correct number of kiwi

species. All coefficients were small and non-significant, and no reported value orientation showed a meaningful association with recall. Given that subscales demonstrated acceptable internal consistency, the non-significant findings suggest that, within this study, self-reported value orientations did not reliably influence how participants responded to the recall task.

This pattern contrasts with earlier research demonstrating associations between value orientations and pro-environmental engagement (Bolderdijk et al., 2013; De Groot & Steg, 2010; Stern & Dietz, 1994), but aligns with studies showing that immediate antecedent cues may influence behaviour independently of reported environmental values. For example, Geiger et al. (2025) demonstrated that contextual prompts, in the form of packaging design, influenced recycling behaviour regardless of individuals' self-reported environmental orientations. Similarly, Bolderdijk et al. (2021) found that biospheric values did not reliably predict pro-environmental behaviour when contextual variables were more salient, and Dragoni et al. (2019) reported main effects of values but no interactions with contextual prompts. Linder et al. (2021) likewise found that environmental values did not predict recycling behaviour; instead, the strongest determinant was the physical position of the recycling bin, illustrating that contextual antecedents were more influential in shaping responding behaviours than self-reported values. Zhang et al. (2021) demonstrated that contextual cues altered the probability of pro-environmental responding more than reported biospheric value orientations, with value-context interactions generally non-significant.

These findings collectively support the conclusion that when a clear antecedent cue is present, moment-to-moment responding may be influenced more strongly by the cue itself than by underlying value orientations.

To date, no published New Zealand research has applied the full 17-item Value Orientation Scale (VOS) with university student samples. However, the mean VOS scores in the present study were broadly consistent with international student-based research (Bouman et al., 2018; De Groot & Steg, 2007), suggesting that the absence of value-based effects was unlikely to reflect atypical responding among New Zealand participants. Instead, the results support the interpretation that the BHV sign's antecedent properties may have exerted a more immediate influence on recall than individual differences in reported environmental values.

My third hypothesis that EVOs would interact with the sign condition, was also not supported. None of the interaction terms were significant, indicating that the BHV poster's effect on recall remained relatively stable across participants regardless of their reported value orientations. In behavioural terms, the antecedent properties of the BHV design appeared sufficient to evoke higher recall without being moderated by differences in reinforcement histories reflected in VOS or NEP scores.

Taken together, the findings indicate that the BHV poster may have functioned as an effective antecedent stimulus for recall, and that value orientations did not meaningfully differentiate recall behaviour in this study.

Comparison With Previous Literature

My findings extend earlier research showing inconsistent visitor engagement with interpretive materials (Clayton et al., 2009; Dierking et al., 2004) by demonstrating that when signage incorporates clear, discriminable design features, recall may become more likely. While prior studies report weak engagement with typical signage formats, the present results provide behavioural evidence that structured visual design may increase the probability of accessing and recalling conservation information.

Much of the interpretive signage literature relies on self-reported learning or engagement rather than direct behavioural indicators such as recall. By assessing recall as an observable behavioural response (Skinner, 1987), my findings address this gap and provide clearer evidence for how interpretive signage, in this case, BHV may influence learning.

Consistent with Edney et al.'s (2023) and Moss and Pavitt's (2019b) findings, my results show that well-designed visual features, particularly clarity, discriminability, and visual structure, may enhance attending behaviour. Unlike dense or text-heavy signage (Dove, 2016; Marshall, 2016), the BHV poster used simplified segmentation, a large numeral, rounded shapes, and minimal visual clutter, all of which may have reduced competing stimuli and increased the accessibility of the key message.

Additional zoo-based research reinforces the influence of antecedent cues on visitor behaviour. Lemmen et al. (2020) found that a brief, clearly phrased instruction reduced attempts to lure primates, demonstrating that simple, discriminable prompts may alter observable behaviour under naturalistic conditions. Their findings strengthen the interpretation that immediate environmental cues may influence behaviour independently of purported internal states, consistent with the present study's observation that a clear antecedent stimulus (the BHV sign) may have increased recall even in the absence of value-based effects.

Although recall was higher in the BHV condition (64%) than in the control condition (44%), a substantial proportion of participants in the experimental condition still responded incorrectly. This suggests that while the BHV poster may increase the probability of correct recall, the magnitude of the effect was modest. Given that participants viewed the stimuli under controlled conditions and likely anticipated a follow-up question, the results highlight

that visually structured design may support recall but may have limited impact when competing with task expectations, limited exposure time, or low prior knowledge.

Behavioural Theory Interpretation

From a behaviour-analytic perspective, the BHV poster functioned as a salient antecedent stimulus that may set the occasion for increased attending and recall behaviours. Behaviour is more likely when the environment provides clear discriminative stimuli signalling the availability of relevant information (Cooper et al., 2020; Skinner, 1987). Participants who viewed the BHV sign had access to information that was not available in the control condition, appearing to increase the probability of a correct recall response.

Related field-based work provides additional examples of how antecedent cues may shift visitor responding. Lemmen et al. (2020) demonstrated that instructional signage reduced attempts to lure primates, illustrating how clear prompts may alter responding under real environmental contingencies. Similarly, contextual cues and informational prompts have been shown to facilitate pro-environmental behaviour when they function as salient antecedent conditions (Geiger et al., 2025). These findings counter claims that signage is often ineffective (Bitgood, 2000; Falk & Dierking, 2013; Moss & Pavitt, 2019), instead demonstrating that when the environment is arranged with clear and discriminable visual cues, visitors are more likely to access and recall the intended information (Ballantyne & Hughes, 2006; Mellish et al., 2021; Roe & McConney, 2015; Skibins & Powell, 2013).

The BHV poster incorporated several design elements identified in the literature as supporting attending behaviour, including high discriminability, simplified segmentation, predictable visual arrangement, and numerical clarity. These features may have reduced visual competition and increased contact with the target information. Importantly, the absence of significant interactions with self-reported value orientations suggests that these

antecedent properties operated consistently across participants with differing reinforcement histories.

Implications for Conservation Messaging

The results have several practical implications for zoos, aquariums, conservation organisations, and advocacy groups. The experimental condition produced significantly higher recall than the control condition, indicating that visually salient, behaviourally informed signage may support learning when designed to maximise discriminability and attention. Arranging environmental conditions so that key information is more likely to be contacted and remembered aligns with behaviour-analytic principles of antecedent control. For conservation messaging, this indicates that simplifying visual design and emphasising key information may support rapid, low-effort learning even for visitors who report that they do not value the environment or nature.

Limitations

Several limitations should be acknowledged. The study was conducted online rather than in a captive facility, meaning participants were not exposed to the typical competing stimuli or naturalistic reinforcement conditions present in zoos and aquariums. Participants also knew they were taking part in a study and may have anticipated a follow-up question, which likely increased attending to the materials. This heightened attending would advantage the experimental condition, who had access to the BHV sign, and may have produced higher recall accuracy than would be expected under naturalistic conditions. In a real exhibit environment, where visitors do not expect to be questioned and encounter competing stimuli, the effect size of the signage may be smaller, although the control condition in this study provides a useful baseline of existing knowledge about the number of kiwi species. Finally, participants engaged with the signage without the natural social,

contextual, and reinforcing contingencies of a conservation facility, which likely influence attending and the conditions under which conservation-related responses occur in real-world settings.

Recall was the only behavioural outcome measured. Although it provided a clear observable response, it reflects only immediate retrieval and does not capture delayed recall or comprehension. Other behaviours commonly shaped by signage, such as stopping, reading, dwell time, gaze patterns, and verbal behaviour, were not recorded, limiting analysis of the full behavioural chain.

The BHV poster incorporated several design elements simultaneously, meaning the study cannot isolate which specific components functioned as the most effective antecedent stimuli. This limitation concerns the interpretation of BHV features rather than differences between the BHV poster and the aquarium's existing signage; the design package was tested as a whole, not component by component. In addition, exposure time was standardised in the online study, ensuring consistent viewing across participants but reducing ecological validity. In naturalistic settings, visitors self-select how long they attend to signage, and this variability could influence the extent to which the BHV elements exert stimulus control.

Although the VOS subscales demonstrated acceptable internal consistency in the present study, these measures function as verbal self-reports that summarise an individual's reinforcement history rather than directly measure behaviour in context. As such, self-reported value orientations may not be sensitive to the immediate antecedent conditions arranged in the recall task, which limits their usefulness in predicting moment-to-moment behavioural responding.

The sample consisted primarily of university students, who may differ from typical zoo visitors in age, learning histories, and environmental worldviews. Limited variability in EVOs may also have contributed to the non-significant interaction effects.

Future Research

Future researchers should examine whether BHV signage produces similar effects under naturalistic conditions. Field-based studies would allow researchers to observe behaviour in the presence of competing stimuli, varied exposure durations, and naturally occurring social interactions (e.g., Lemmen et al., 2020).

Researchers should also analyse the full behavioural sequence, including orienting responses, stopping, reading behaviour, gaze patterns, verbal behaviour, and downstream actions such as advocacy behaviours. Eye-tracking or attention-mapping methods could help identify which BHV components evoke attending behaviour under complex visual conditions.

Experimental studies should isolate specific design elements, such as numerals versus words, segmentation shapes, colour palettes, typography, and layout, to determine which components function most effectively as discriminative stimuli. Given that recall remained modest even in the BHV condition, future researchers could examine the effectiveness of gamification (Karmakar et al., 20204), and other interactive or engagement-based features commonly used in museum displays (Adams et al., 2020; Bitgood, 2014; Hornecker & Stifter, 2006) to strengthen attending and retention.

Longitudinal designs are needed to evaluate delayed recall and determine whether BHV design supports more persistent recall than standard signage. Researchers could also measure more complex conservation behaviours, such as signing petitions as observable behaviour.

Cross-cultural investigations would help determine whether BHV's effectiveness generalises across populations with differing environmental orientations, consistent with cross-national variation in reported value orientations values identified by Sargisson et al. (2020).

Conclusion

I examined whether a visually distinctive interpretive sign using Big Hero Visualisation (BHV) elements may increase correct recall of the number of kiwi species in New Zealand. Consistent with the primary hypothesis, participants who viewed the BHV sign (experimental condition) were more than twice as likely to recall the correct answer as those in the control condition. These findings demonstrate that behaviourally informed visual design may function as an effective antecedent intervention, arranging the environment in ways that increase attending behaviour and support measurable learning.

EVOs showed no influence on recall, indicating that BHV design operated consistently across individuals with differing value profiles. This supports the suggestion that clear antecedent cues could influence behaviour independently of underlying value orientations.

Overall, I provided clear evidence that visual design may influence observable learning outcomes in conservation contexts. These findings support the potential application of behaviourally grounded design strategies within captive facilities and conservation campaigns to enhance recall, engagement, and potentially downstream conservation-related behaviour.

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Appendix A

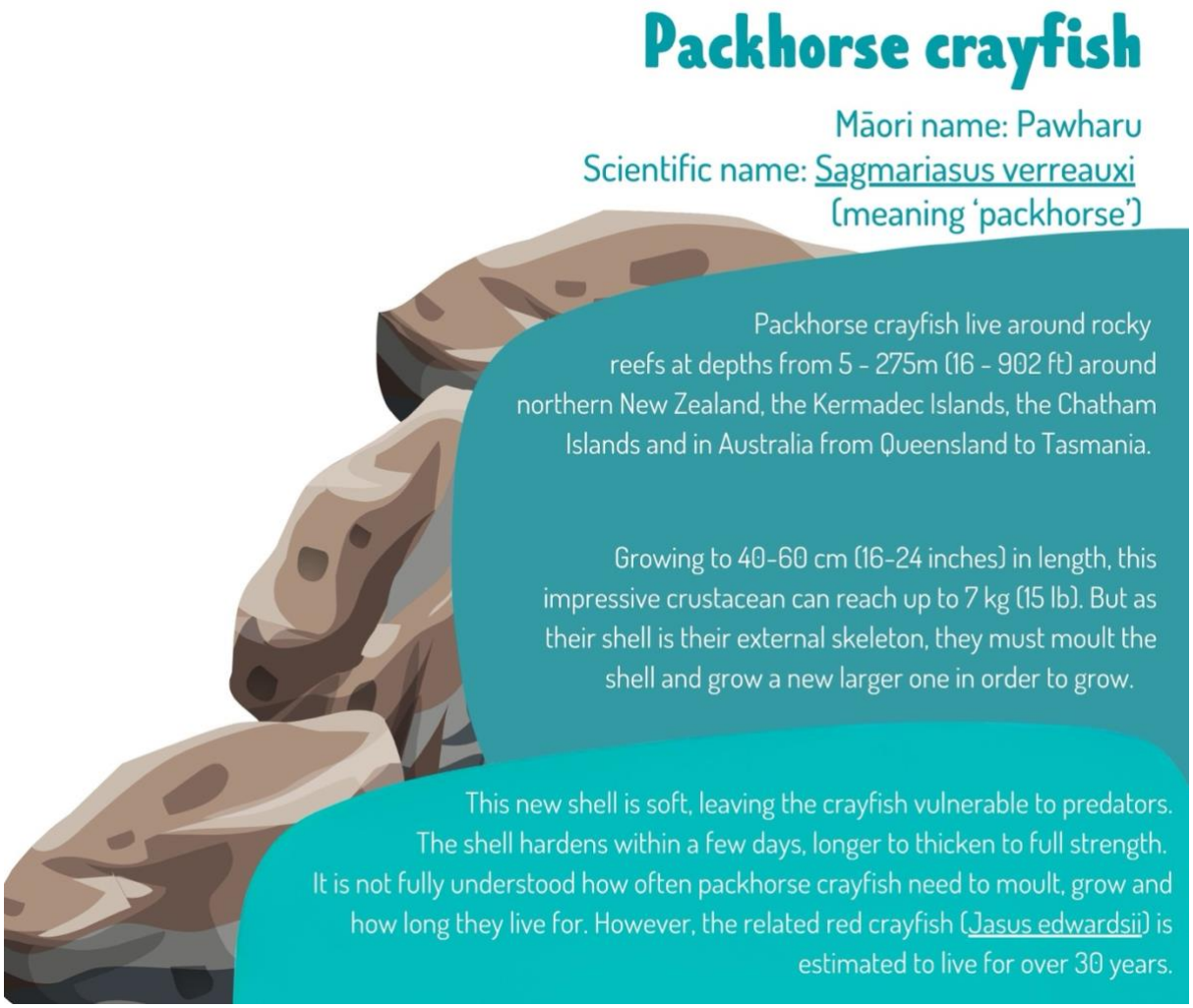
Existing Poster From NANZ's Educational Exhibitions (One)

Appendix A

Existing Poster From NANZ's Educational Exhibitions (Two)

Appendix A

Existing Poster From NANZ's Educational Exhibitions (Three)

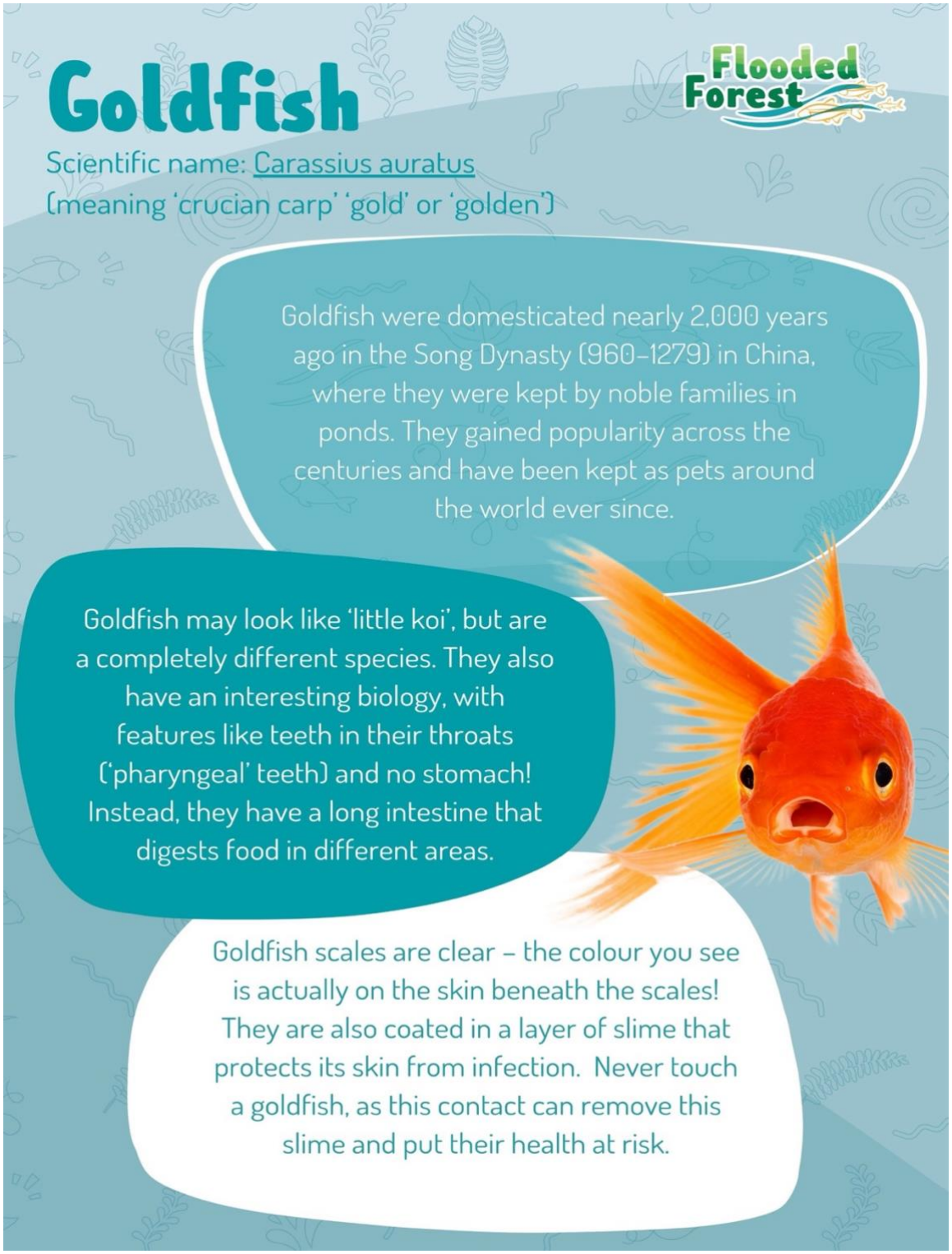


Appendix A

Existing Poster From NANZ's Educational Exhibitions (Four)

Appendix A

Existing Poster From NANZ's Educational Exhibitions (Five)

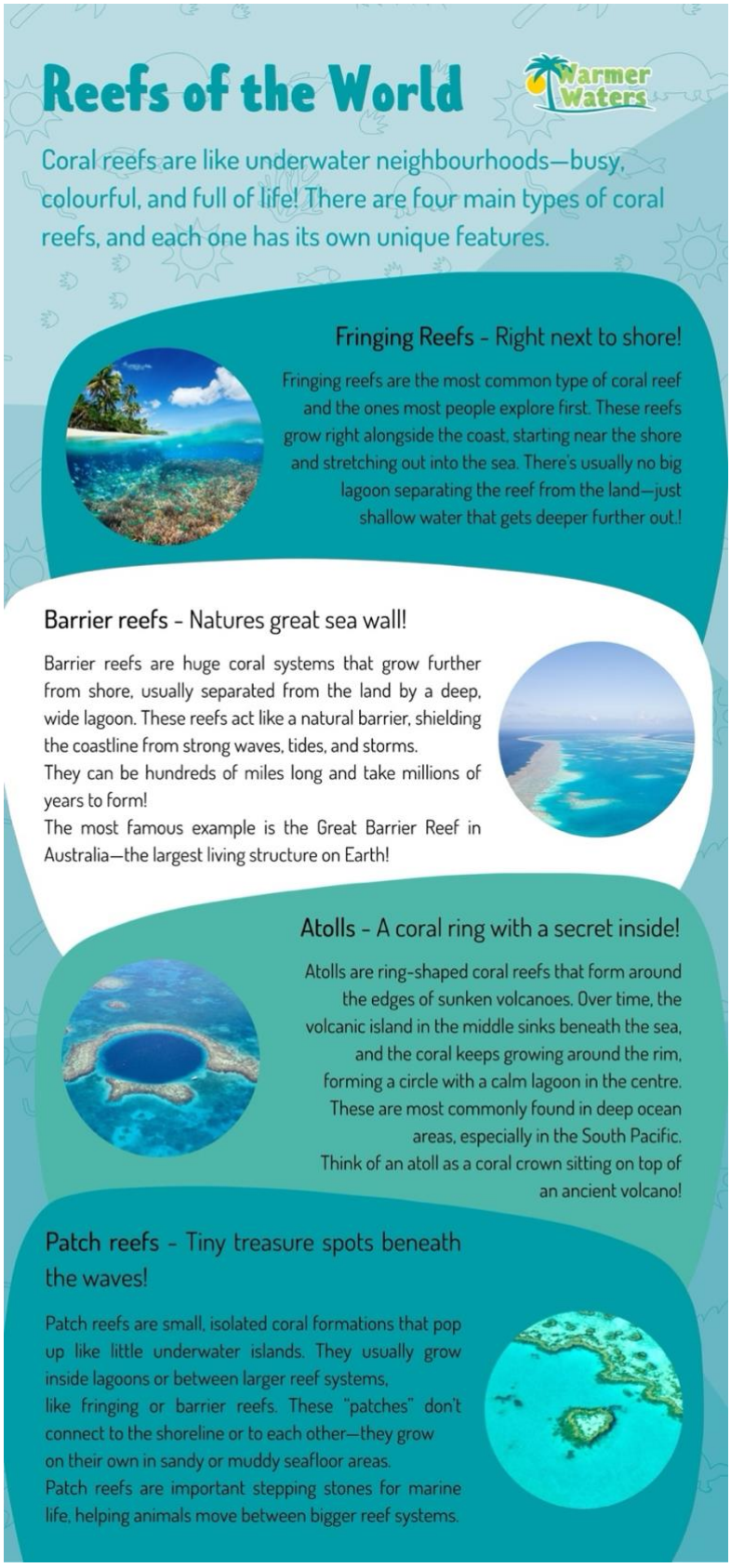


Appendix A

Existing Poster From NANZ's Educational Exhibitions (Six)

Appendix A

Existing Poster From NANZ's Educational Exhibitions (Seven)



Appendix B

Value Orientation Scale (VOS)

Could you please indicate how important each value is as a guiding principle in your own life? You can indicate the importance of each value on a scale ranging from -1 to 7. The higher the number you choose, the more important the value is as a guiding principle in your life.

The meaning of the numbers is as follows:

-1 is for rating any values that are opposed to

0 means the value is not at all important

3 means the value is important

6 means the value is very important

7 is for rating a value of supreme importance

Generally, there are no more than two such values.

Try to distinguish as much as possible between the values by using different numbers.

Use the scale below to mark your answer for each item:

Item	Question									
1	Protecting the environment (preserving nature)	-1	0	1	2	3	4	5	6	7
2	Unity with nature (fitting into nature)	-1	0	1	2	3	4	5	6	7
3	Equality (equal opportunity for all)	-1	0	1	2	3	4	5	6	7
4	A world at peace (free of war and conflict)	-1	0	1	2	3	4	5	6	7
5	Social justice (correcting injustice, care for the weak)	-1	0	1	2	3	4	5	6	7
6	Preventing pollution (protecting natural resources)	-1	0	1	2	3	4	5	6	7
7	Respecting the Earth (harmony with other species)	-1	0	1	2	3	4	5	6	7
8	Social power (control over others, dominance)	-1	0	1	2	3	4	5	6	7
9	Wealth (material possessions, money)	-1	0	1	2	3	4	5	6	7
10	Authority (the right to lead or command)	-1	0	1	2	3	4	5	6	7
11	Influential (having an impact on people and events)	-1	0	1	2	3	4	5	6	7
12	Pleasure (gratification of desires)	-1	0	1	2	3	4	5	6	7
13	Enjoying life (enjoyment, pleasure)	-1	0	1	2	3	4	5	6	7
14	A comfortable life (a prosperous life)	-1	0	1	2	3	4	5	6	7
15	A varied life (adventurous, exciting)	-1	0	1	2	3	4	5	6	7
16	Ambitious (hard-working, aspiring)	-1	0	1	2	3	4	5	6	7
17	Capable (competent, effective)	-1	0	1	2	3	4	5	6	7

Appendix C

New Ecological *Paradigm (NEP) Scale*

Item	Question	Not Important (Strongly Disagree)	Slightly Important (Disagree)	Moderately Important (Neutral)	Very Important (Agree)	Extremely Important (Strongly Agree)
1	We are approaching the limit of the number of people the Earth can support.	1	2	3	4	5
2	Humans have the right to modify the natural environment to suit their needs.	1	2	3	4	5
3	Humans are severely abusing the environment.	1	2	3	4	5
4	The balance of nature is very delicate and easily upset.	1	2	3	4	5
5	Humans are subject to the laws of nature.	1	2	3	4	5
6	The Earth has plenty of natural resources if we just learn how to develop them.	1	2	3	4	5
7	When humans interfere with nature it often produces disastrous consequences.	1	2	3	4	5
8	Humans are not destroying the planet as badly as some people think.	1	2	3	4	5
9	The balance of nature is strong enough to cope with the impacts of modern industrial nations.	1	2	3	4	5
10	Humans will eventually learn enough about how nature works to be able to control it.	1	2	3	4	5
11	The Earth is like a spaceship with very limited room and resources.	1	2	3	4	5
12	Humans were meant to rule over the rest of nature.	1	2	3	4	5
13	The so-called "ecological crisis" facing humankind has been greatly exaggerated.	1	2	3	4	5
14	The balance of nature is very delicate and easily upset.	1	2	3	4	5
15	If things continue on their present course, we will soon experience a major ecological catastrophe.	1	2	3	4	5

Appendix D

Other Qualtrics Questions

How many species of kiwi are there in New Zealand?

1 2 3 4 5 6 7 8

What is your age (in years)?

Drop down box (16 – 85)

What is your gender?

Female Male Prefer not to say Other

What is your ethnicity?

Māori Pacific Asian NZ European Other European Other

Do you live in New Zealand?

Yes No

Are you colourblind?

Yes No

If yes, what form of colour blindness do you have?

Red-Green Blue-Yellow Total

What is your political orientation?

1 = Far Left Wing (eg. Green Party)
2 = Left-Liberal
3 = Liberal
4 = Moderate Left (eg. Labour)
5 = Moderate Left
6. = Moderate Right
7 = Moderate Conservative
8 = Conservative (eg. National)
9 = Right-Wing
10 = Far Right Wing (eg. ACT)

Appendix E

Ethical Approval University of Waikato FS2025-12

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THE UNIVERSITY OF WAIKATO
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18 July 2025

Dear Skye

Re: **FS2025-12: Kiwi Advocacy Project – Investigating the effects of signage on behavioural outcomes**

Thank you for submitting an amendment to your approved application to the ALPSS Human Research Ethics Committee. Specifically, you have requested to also examine the effects of signage, this time with an IPRP population. We have reviewed the amendment and the Committee is now pleased to offer formal approval for your research activities.

We encourage you to contact the committee should issues arise during your data collection, or should you wish to add further research activities or make changes to your project as it unfolds. We wish you all the best with your research. Thank-you for engaging with the process of Ethical Review.

Kind regards

Dr Amy Bird, Convenor
Division of Arts, Law, Psychology & Social Sciences Human Research Ethics

Appendix F

IPRP Information Sheet Provided to Participants

Project title: Kiwi Advocacy Project

You have been invited to participate in this research study investigating Kiwi Advocacy in collaboration with The National Aquarium of New Zealand and The Zoo and Aquarium Association (ZAA).

This research project is being supervised by Dr Rebecca Sargisson, Senior Lecturer in Psychology at the University of Waikato, New Zealand and carried out by Skye Fick-Swann. The findings will be published in peer-reviewed journals and a master's thesis.

For further information If you have any questions related to the research project, please email the researcher: ss810@students.waikato.ac.nz.

Participants' role
You will be shown a series of exhibitions regarding captive animals and then asked to complete a series of questionnaires and related questions. The total time for completing is estimated to be 20-30 minutes.

This is not a test, so there are no right or wrong answers and there are no risks involved in taking part in this research. Please be as honest as you can.

Confidentiality and participants' rights
All data are anonymised meaning no personal information can be linked between yourself and the data that have been given. You can withdraw from the study at any time and without giving a reason by simply closing your browser window.

Storage of data
Data will be stored for a minimum of 5 years after completion of this research project. The data will be stored securely by Dr Rebecca Sargisson and the research investigators of this project will have access to this data. If required for paper publication, anonymised data may be shared in public repositories.

Funding
There is no external funding for this project.

Ethics approval
This research project has been approved by the Human Research Ethics Committee of the Division of Arts, Law, Psychology and Social Sciences at the University of Waikato.

Any questions about the ethical conduct of this research may be sent to the Secretary of the Committee, email alpss-ethics@waikato.ac.nz, postal address, Division of Arts, Law, Psychology and Social Sciences, University of Waikato, Te Whare Wananga o Waikato, Private Bag 3105, Hamilton 3240.

Consent
By proceeding with the online survey, you are agreeing that:
(1) you have read and understood this information
(2) questions about your participation in this study have been answered satisfactorily
(3) you are aware of the potential risks
(4) you are taking part in this research study voluntarily
(5) anonymised data may be shared in public research repositories.