

An evidence-based behavioural intervention on saiga horn as a traditional medicine in Singapore

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Doctor of Philosophy

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Declaration

I declare that this thesis, *An evidence-based behavioural intervention on saiga horn as a traditional medicine in Singapore*, is my own work. Contributions by other authors to any of the manuscripts discussed are stated in section 1.3.2. None of the work submitted for this thesis has been submitted, in whole or part, for any previous degree application.

Dedication

This thesis is dedicated to Remy and Pepper.

Acknowledgements

It feels surreal to be writing an acknowledgements section for something that I have been working towards for so long. Formally this journey began four years ago, but in truth, it started three decades ago. In a small house on a corner, surrounded by trees and more non-humans than humans. To that end, I acknowledge the many incredible, intelligent, personality-big, and loving non-humans that have so heavily shaped my love of the natural world, and my drive to protect it.

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Abstract

Illegal and/or unsustainable wildlife trade affects wildlife globally. To address this issue, a plethora of demand reduction efforts have been carried out. However, shortcomings in behaviour change interventions targeting wildlife consumers have been widely noted, and these likely compromise conservationists' capacities to assess, and stem, unsustainable use of wildlife. In disciplines, such as public health, which include behavioural approaches, behaviour change interventions have been extensively implemented and offer useful insights for addressing wildlife trade. Thus, for this thesis I aimed to design, implement, and evaluate an evidence-based behaviour change intervention that robustly applies relevant approaches found in behavioural science-informed disciplines to the field of wildlife trade. For this work I targeted saiga horn usage in Singapore. The saiga (*Saiga tatarica*) is a Critically Endangered antelope from Central Asia whose horn is used in traditional Chinese medicine (TCM) to treat fever and heatiness (a TCM state of illness with symptoms like cough). **Chapter 2** shows that not only is saiga horn commonly used in Singapore, but that many Chinese Singaporeans consider saiga horn a product option they use *most often*; and that middle-aged Chinese Singaporean women are among the largest consumers and are the most likely to purchase saiga horn for other people. Perceived efficacy and recommendations from others, are the top stated reasons for using saiga horn. **Chapter 3** highlights that there are many interlinked influences affecting saiga horn usage among middle-aged Chinese Singaporean women, and that some of these influences, particularly related to their societal-level perspectives and health information sources, would be important and feasible to leverage in a behaviour change intervention. **Chapter 4** details the implementation of a carefully disseminated, socially-framed, online intervention targeting saiga horn usage among middle-aged Chinese Singaporean women. This chapter shows how concepts around repeat message exposure, news spread, and social reinforcement were employed to produce positive immediate online audience response to an intervention message. **Chapter 5** reveals how the highly pervasive online intervention resulted in some measurable

behavioural impacts on middle-aged Chinese Singaporean women's usage of saiga horn, as well as impacts on their awareness of saiga antelopes. Though this chapter also discusses heterogeneity in impact, where limitations arose in the intervention, and where relevant future research could improve upon this work. **Chapter 6** looks at how this thesis ties with wider discourse around behaviour change interventions in demand reduction, how conservationists can improve this arena, and some potential directions for future research on this study system. In sum, this thesis helps to fill a key gap in our understanding of effective, evidence-based, large-scale approaches that can be feasibly implemented to induce change among unsustainable wildlife trade consumers.

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List of Acronyms

AIDS = Acquired Immunodeficiency syndrome

ASE News = Asian School of the Environment News

CITES = Convention on International Trade in Endangered Species of Wild Fauna and Flora

COVID-19 = Coronavirus Disease 2019

CPC = cost per click

CTR = click-through rate

EVD = Ebola Virus Disease

GLMs = generalised linear models

IUCN = International Union for Conservation of Nature

NTU = Nanyang Technological University

SARS-CoV = Severe Acute Respiratory Syndrome Coronavirus

SCT = Social Cognitive Theory

TCM = traditional Chinese medicine

TTM = Transtheoretical Model



Singapore at night. Photo Credit: Hunter Doughty.

this lion city

of lights and buildings and manicured grass
juxtaposing wet markets and Michelin eateries,

you span marble-floored plazas and hawker centres

and tenuously weave together your triad of heritage
with interlocking motorways and mass transit,

the intrinsic dichotomy runs deep through your canals
and soaks into the ground with your afternoon showers,

and yet somehow you thrive,

born of an origin spinning with imagination and turmoil,

you have boasted perseverant fight and folklore,
conquering typhoons, disease, and oppression

in order to brazenly smash together acupuncturists
with vitamin shoppes and cutting-edge research,

pitting leather against temples, mosques, and vegan stalls,

you baffle and intrigue me,
the enigma that is

Singapura

H.L. Doughty

Chapter 1 Introduction

1.1 Problem Statement

Trade of wildlife and their parts occurs across the globe, encompassing legal and illegal markets sourced from both sustainable and unsustainable harvests of species (‘t Sas-Rolfes et al. 2019). This trade generates an unknown amount of money with some estimating billions of US dollars in annual revenue (‘t Sas-Rolfes et al. 2019). The species harvested and the consumer needs they meet are similarly vast (Thomas-Walters et al. 2020c). The trade in wildlife provides key sources of subsistence and income for rural populations and contributes to national economies (Robinson et al. 2018; World Bank 2019b). However, illegal and unsustainable wildlife trade are also helping drive the global biological ‘annihilation of species’ (Ceballos et al. 2017). Aside from charismatic species like elephants and tigers, the majority of traded species largely go unnoticed and understudied. Countless amphibians are globally traded for consumption and medicine (Carpenter et al. 2014), parrots are taken from Africa to be pets in the Middle East (Bush et al. 2014), orchid species are harvested for discerning international collectors (Phelps & Webb 2015), unidentified genets are sold for consumption in Central Africa (Doughty et al. 2015), and glass eels are smuggled from Europe to Asia for consumption (Stein et al. 2016).

In addition to causing widespread ecological impact, illegal wildlife trade has been cited as a threat to local livelihoods and safety (Rosen & Smith 2010), and the unregulated consumption or transport of wildlife has been implicated in the spread of globally infectious diseases (Can et al. 2018). This includes diseases like Acquired Immunodeficiency syndrome, AIDS (Sharp & Hahn 2011), Ebola Virus Disease, EVD (Osterholm et al. 2015), and Severe Acute Respiratory Syndrome Coronavirus, SARS-CoV (Guan et al. 2004). Further, such trade is potentially linked to the spread of Coronavirus

Disease 2019, COVID-19: the viral strain causing the current mass pandemic (Liu et al. 2020). There is thus a palpable need for large-scale, effective measures to combat this pervasive and multi-faceted issue.

In an effort to tackle illegal or unsustainable wildlife trade, a number of national and international policies and projects have been implemented. The majority of these have consisted of anti-poaching and trade-regulation efforts. A minimum 2.35 billion USD were spent between 2010 and 2018 on combatting illegal wildlife trade, with an estimated 40% used specifically for protected area management, 19% for sustainable use and alternative livelihoods, and 21% for law enforcement (World Bank 2019a). Though range state or trade-chain efforts are an important component of controlling wildlife trade, it is now acknowledged that consumer-focused efforts are vital for stemming unsustainable demand and allowing for long-term change (Challender & MacMillan 2014; Wallen & Daut 2018). However despite this understanding, only 4% of total funding is estimated to have been used for “communication and awareness raising,” which includes both demand reduction and supply-side efforts (World Bank 2019a).

Among demand reduction efforts that have been carried out, interventions attempting to directly shift individual consumer behaviour (as opposed to legislative interventions for example) are frequent (Veríssimo & Wan 2019). The majority of such interventions have targeted consumers in Asia or the United States. Those working to counter unsustainable or illegal wildlife trade, however, have acknowledged methodological shortcomings in these interventions which likely hamper their effectiveness in reducing consumer demand (Olmedo et al. 2017; Greenfield & Veríssimo 2018). In particular, these interventions often lack a robust evidence base, the employment of human behaviour theory, careful design and implementation processes, or detailed impact evaluations (Olmedo et al. 2017; Greenfield & Veríssimo 2018). As such, we are seeing a push for more detailed consumer research, the incorporation of social and cultural factors, and more transparent and

neutral evaluations (Biggs et al. 2017; Milner-Gulland et al. 2018; Moorhouse et al. 2020; Smith et al. 2020).

Outside of conservation, disciplines or fields such as public health, social marketing, and development, include the use of behavioural approaches (often informed by behavioural sciences like social psychology and behavioural economics), and thus have established practices for implementing extensive behaviour change interventions (Craig et al. 2008; Hopwood 2011). These practices can offer highly useful insights for wildlife trade research (Thomas-Walters et al. 2020d). Common standards in public health, for instance, detail robust stepwise cycles in implementing behaviour change interventions so that these activities have a greater likelihood of achieving intervention aims (Figure 1.1) (MRC & NIHR 2019). The intervention development stage is considered an extensive process whereby researchers collect empirical evidence on a study system, use this data, existing literature, and human behaviour theory, to form a comprehensive understanding of the study system, and formulate and test a subsequent intervention design (Melnyk & Morrison-Beedy 2018; MRC & NIHR 2019). The development process can vary in exact order depending on the research aim and study system; for instance, researchers may start the process with a chosen theory they wish to test and collect empirical data accordingly (Bredemeier et al. 1986), or start with the evidence and select a theory to fit the data. Following the development stage, interventions are then implemented and thoroughly evaluated. This overall cycle is considered iterative, with the lessons learned from one intervention cycle strongly informing and improving the next one (MRC & NIHR 2019).

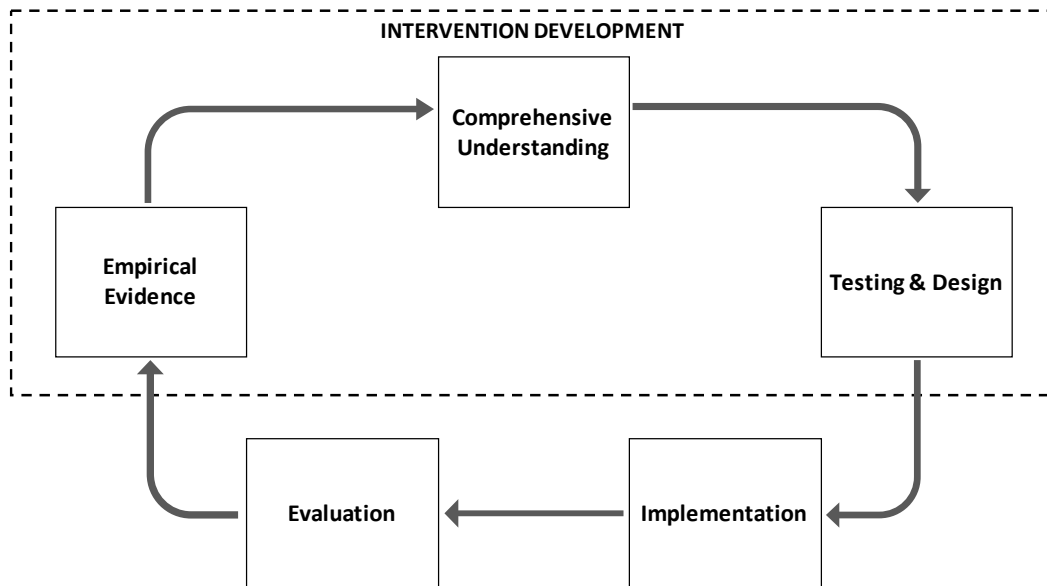


Figure 1.1 An intervention cycle, inspired by processes commonly employed in various public health intervention standards.

In public health, a theory-based behaviour change intervention means an intervention in which the implementers use one or more theories, along with additional evidence, to understand the behaviour in question and find appropriate ways to change it (Bartholomew & Mullen 2011). Different theories can also be used at each intervention stage, as theories differ in their aims (Davidoff 2019) and explanatory power (Bearman et al. 2017). An evidence-based behaviour change intervention refers to one that uses empirical evidence to support the assumptions the intervention makes, to justify any theoretical basis of the intervention, and to test hypotheses (Melnyk & Morrison-Beedy 2018). This evidence encompasses newly collected data and existing research. It is generally accepted that interventions which are based in both theory and evidence have a higher likelihood of success (Fernandez et al. 2019).

Despite advances in conservation, there are still scant instances of Figure 1.1's full public health-inspired intervention cycle being robustly actualised in a large-scale evidence-based behaviour change intervention targeting unsustainable wildlife consumption. Thus, there is a clear need for

more research on how to apply this cycle to real-world study-systems so that future demand reduction efforts have a greater likelihood of influencing consumer behaviour.

1.2 Study System

This thesis uses a case study of saiga antelope horn as a traditional Chinese medicine in Singapore.

The following sections thus aim to give relevant information for understanding this study system.

1.2.1 Traditional Chinese Medicine

Chinese medicine is an inherently complex web interlacing physical wellbeing practices with metaphysical outlooks and a culture dating back thousands of years (Kaptchuk 2000). The medicinal practices and texts across China have evolved throughout the centuries and vary in both formality and treatment approach (Pan et al. 2014). In the 1950s, the People's Republic of China standardised Chinese medicine under the umbrella term 'traditional Chinese medicine – TCM' in comparison to 'Western' medicine (henceforth referred to as biomedicine) (Xu & Yang 2009). In the last three decades a massive commercial industry around TCM has further developed, and official Chinese sources use TCM to refer to both Chinese medicine teachings and this pharma-industrial complex (Hsu 2018).

TCM is founded predominantly around the theory of yin and yang (Maciocia 2015). In this theory, everything that exists can only be defined relative to something else, and is an integral, and changing, part of the whole (Kaptchuk 2000). All things have facets of yin-yang. Yin is the shady side of the slope, while yang is the sunny side of the slope (Xu et al. 2018). An additional core concept in TCM is Qi, which is often mistakenly simplified as energy, but is instead more accurately described as what composes and connects all of life and non-life (Kaptchuk 2000). Everything has a unique Qi and it links them with all other things. Further, Qi is the change, and the capacity to

change. Qi allows for, and helps maintain, a body's overall dynamic equilibrium of yin-yang (Jiang et al. 2012).

Since everything inherently changes and evolves in TCM, there is no definitive source of conflict or change in a person's body. As such, a TCM practitioner does not search for the cause of a problem like a biomedical physician would look for a certain pathogenic source (Xu et al. 2018). They instead identify the current relative disharmonious state in the person and work to re-harmonise it (Jiang et al. 2012). Specifically, a TCM practitioner assesses the overall 'landscape' of a patient, noticing how each component of his existence is in relation to the other components, and upon identifying patterns of disharmony in the patient, will prescribe a treatment accordingly (Kaptchuk 2000). This process is why TCM treatments for the same symptoms in different individuals may be different, or why the same TCM treatment can be used for different symptoms (Karchmer 2010). Treatments are prescribed in relation to an individual's overall harmony, and their harmony in relation to the outer world. TCM focuses on the totality of the patient and is often described as a whole-body healing approach, rather than a disease-centred approach (Xu et al. 2018). Additionally, whole-body in TCM means 'whole person': considering both the physical and the mental or metaphysical as contributing to an individual's harmony (Kaptchuk 2000).

One manifestation of the yin-yang philosophy is the dichotomy of heat and cool, which could relate to weather, seasonal changes, and daily or internal factors. This manifestation also ties to TCM's six commonly cited characteristics of disharmonies *within* the body (i.e. excessive wind, cold, heat, damp, dryness, and fire) (Jiang et al. 2012). Note that internal disharmonies are not meteorological or climatic, even though the country of Singapore, for example, is also a landscape that is categorised in TCM as heat and damp (Rittersmith 2009). Therefore, an individual existing in a given moment in Singapore will have their personal landscape of yin-yang existing in relation to this outside landscape of heat and damp. This can have implications for that individual's harmony, and

could lead to them having excessive heat. In Singapore, this is referred to as a person feeling 'heaty' (Ho et al. 2018b). Heatiness can also be caused by the foods you consume. Lychee and fried food, for example, are considered heaty (Ho et al. 2018b). Symptoms of heatiness can be sore throat, nasal congestion, headache, cough, etc. Extreme heatiness can include a measurable increase in body temperature, what biomedicine defines as a fever.

To rebalance excess heat in TCM, one can use a 'cooling' product like chrysanthemum, ginseng, or saiga antelope horn. Saiga horn is often selected when there is a disproportionately high amount of yang, and it acts on the liver and heart meridians (i.e. lines that bisect the body) (Bensky et al. 2004). Saiga horn is denoted as a relatively strong cooling product (Bensky et al. 2004).

The use of natural products is paramount in TCM, and an overall affinity for wild specimens is quite integral to both underlying TCM philosophy and Chinese culture on the whole (Gratwicke et al. 2008; Dutton et al. 2011; Fabinyi 2012). All natural substrates used in TCM, including minerals, plants, and animals, are described in the *Chinese materia medica* (Critchley et al. 2000; Bensky et al. 2004; Xu & Yang 2009). This text lists over 10,000 substrates used presently or historically in TCM, with around a thousand of these, including saiga horn, considered to be common in use (Williamson et al. 2013). In conservation, TCM is mainly known by its negative affiliation with an overexploitation of natural resources, including impacts on charismatic species like rhino (But et al. 1991), tiger (Still 2003), and pangolin (Soewu & Adekanola 2011).

1.2.2 Saiga Antelope

The saiga (*Saiga tatarica*) is a Critically Endangered ungulate from the rangelands of Central Asia (Mallon 2008). It is a migratory species, traversing 80–120 km per day during migration (Sokolov 1974) and foraging on grass, herb, and shrub species in its semi-arid habitat (Bekenov et al. 1998). Saiga antelopes are about 73cm in shoulder height, tan to brown colour depending on the season,

and have a distinct bulbous nose (Bannikov et al. 1961; Frey et al. 2007). They are also sexually dimorphic, with the males being slightly larger in size and boasting amber ridged horns (Bannikov et al. 1961; Kühl et al. 2007).

Saigas live about 3.5 years (though they can live over 5 years), with females reproductive by their first calving season (Bekenov et al. 1998). This rapid replacement rate means saigas can recover from major population declines if given the opportunity. Herd sizes can be in the tens of thousands (Bekenov et al. 1998). Prehistorically, the species ranged as far west as the United Kingdom and as far east as Alaska (Bekenov et al. 1998). At present, however, there is only one population in southwest Russia, three in Kazakhstan, and a subspecies population in western Mongolia (Mallon 2008). Drastic species decline through the centuries was predominately due to habitat loss and hunting (Bekenov et al. 1998). Locally, saiga is used for meat, hide, and sport (Kühl et al. 2009), but saiga is traded primarily for its horn – which is used in TCM (discussed above) (CITES 2018). Saiga horn trade from range states in Eastern Europe to China likely occurred as far back as the 1700s (Milner-Gulland 1991). Within China, the species was hunted to extinction by the 1960s (Cui et al. 2017).

Hunting pressure abated dramatically during Soviet Union rule throughout the 20th century (Milner-Gulland et al. 2001). However, following the collapse of the Soviet Union in 1991, the subsequent loss of law enforcement and management capacity in the saiga's range states, as well as rampant rural poverty, resulted in harsh saiga poaching during the 1990s and early 2000s – plummeting population numbers and causing a reproductive collapse, since males are selectively poached for their horns (Milner-Gulland et al. 2003). The number of saigas in 2003 was less than 5% of the number in 1980 (Milner-Gulland et al. 2003). This causal sequence of events disproves the misconception that poaching increased during the 1990s and early 2000s because of conservationists recommending saiga horn as a replacement for rhino horn.

Widespread poaching continues today along with a number of human-induced threats (CMS 2017). Habitat loss and fragmentation due to human development and agricultural land abandonment has altered the saiga's key habitat and migratory routes (Mallon 2008; Singh et al. 2010; Milner-Gulland 2015). Further, there have been mass population die-offs due to both viral and bacterial diseases (Kock et al. 2018; Pruvot et al. 2020). The largest die-off was in 2015 and killed around 200,000 individuals in just a few weeks – over half of the species population (Kock et al. 2018). The most recent incident, in winter 2016-2017, affected the Mongolian sub-species, and killed an estimated 80% of the sub-species population (Pruvot et al. 2020).

Saigas are currently categorised as Critically Endangered by the International Union for Conservation of Nature (IUCN) (Mallon 2008). International trade in saiga products has been regulated by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) since it was added as an Appendix II listed species in 1995 (CITES 2018). This ruling dictates that all international trade in saiga or saiga products is prohibited unless accompanied by a CITES approved permit. In 2019, its CITES listing was amended to specify 'zero quota', indicating that until further review, no saiga or saiga parts may be commercially traded internationally (CITES 2019). In addition, a memorandum of understanding signed in 2005 by all five saiga range states is still in place, which stipulates each state will implement country-specific conservation measures to mitigate poaching and conserve the saiga (CMS 2017). All saiga range states currently have domestic regulations in place prohibiting hunting, possession, and trade in saigas.

Range-state conservation efforts also include things like education and awareness, anti-poaching actions, some captive breeding, and research on local drivers behind saiga poaching (CMS 2015; Kühl et al. 2009). Past research on international saiga horn consumers, however, has been limited to only a few preliminary or grey literature pieces, often focused on market trends (Meibom et al.

2010; Theng et al. 2017). No specific saiga horn demand reduction work, to my knowledge, had occurred prior to the work presented in this thesis.

1.2.3 The Republic of Singapore

Singapore is the only island city-state in the world, located at the southern tip of the Thai-Malaysian peninsula in Southeast Asia (Leinbach 2020). Singapore has a total population of 5.7 million people (DoS Singapore 2020), and serves as a major tourist and commerce destination. In 2019, 19.1 million people visited Singapore and spent 20 million USD (STAN 2020; STB 2020).

Health products are a ubiquitous component of the consumer marketplace. Singapore's over-the-counter drug market was worth 610 million USD in 2019, and the dominating companies included both biomedical corporations and a TCM corporation (Eu Yan Sang International Ltd.) (MDF 2020). Singapore alone accounts for 1.2% of the total Asia-Pacific over-the-counter drug market (MDF 2020). Thus, Singaporean preferences for medicinal product purchases maintain a thriving local market that simultaneously caters to the international community. As such, Singaporean stances on sustainable consumer products, particularly for health goods, could influence product popularity and availability across the region; especially considering that the nation is already a regional and global leader in many 'green' initiatives (BCA 2014).

As evidenced by the over-the-counter medicine market, Singapore is home to biomedicine as well as complementary and alternative medicine (CAM; which includes TCM), and Singaporeans frequently make use of both medical systems (Lim et al. 2005). TCM has been used in Singapore since Chinese migrants first came from mainland China in the early 1800s (Singapore CPA 2011). Modern increases in standardization, regulation, and industrialisation, however, have changed the face of TCM in the country (Tan & Freathy 2011). In particular, the TCM Practitioners Act of 2000 required that all TCM practitioners be certified and adhere to professional guidelines set forth by

the Singapore Ministry of Health (SSO 2001). The legislation increased public confidence in TCM (Shen 2005) but hampered family-owned apothecaries that couldn't meet these standards (Tan & Freathy 2011). This change was accompanied by a subsequent boom in TCM chain stores throughout the last two decades. These contemporary stores look like biomedical pharmacies, sell products in manufactured packaging like capsules or sealed bottles, and can meet consumers' demand for affordable and quality products (Tan & Freathy 2011).

Among these sold TCM products is saiga antelope horn. Singapore is recognised as one of the largest consumer countries of saiga horn (CITES 2018), and because saiga horn is legal to sell within Singapore, its purchase is non-sensitive to consumers. A 2016 preliminary survey suggested that saiga horn is widely sold (Theng et al. 2018). A scoping trip in 2017 confirmed the frequent availability of saiga products in TCM shops, provision shops, and even grocery stores throughout the country. For though saiga horn can be prescribed by a certified TCM practitioner, it does not have to be.

The outer sheath of the horn, just beneath the ridges, is the desirable portion for medicinal use (Figure 1.2). Traditionally, glass is used to shave off the desirable parts of the horn. These shavings are then boiled, sometimes for many hours, with other TCM herbs, and then served to ailing individuals. Saiga horn is most commonly sold in four forms (Figure 1.2) corresponding to this preparation process:

- 1) intact horns that the consumer then shaves and boils at home,
- 2) horn shavings (often accompanied by the proper herbs) that are then boiled at home,
- 3) pre-boiled broth ready to consume (considered a type of 'cooling water' or 'cooling drink'; often sold chilled), and
- 4) dehydrated broth compacted into capsules or pills ready to consume.

These products are usually marketed as líng yáng, 羚羊, or antelope horn. Sometimes 'Cornu Saigae Tataricae', or a variation thereof, is written as an ingredient.



Figure 1.2 Saiga horn products for sale in Singapore: whole horns (top left), packaged horn shavings (top right), refrigerated broth (bottom left), and broth dehydrated into capsules (bottom right). Photo credit: Hunter Doughty.

Most discourse regarding Singapore and wildlife trade tends to focus on Singapore as an international transshipment hub for maritime and air trade (Low 2014; Ong et al. 2016). Singapore

has a long-standing reputation as a trade and business friendly port, which it has upheld by maintaining minimal taxes on businesses, ensuring efficient customs processing times, and boasting Free Trade Zones which allow for product storage and trading that is exempt from customs and taxes (EDB Singapore 2020; Singapore Customs 2020). These commercial benefits, however, make it difficult for pro-conservation efforts to push for changes that might strengthen enforcement operations in Singapore regarding the searching and seizing of illegal wildlife trade products. But in addition to being a foreign trade hub, Singapore itself is a wildlife product consuming country (Hinsley & Roberts 2018; Wainwright et al. 2018; Aloysius et al. 2020); and as evidenced by saiga horn, some of those products are likely unsustainable and/or have conflicting international legalities. Other items for medicinal use that have opaque and controversial trade can be seen in TCM shops, such as cordyceps, shark fins, and bird nests. Similar to most countries, these medicinal items are predominately not of high government priority, and given Singapore's pro-business tendencies, it is unlikely that they would be regulated in Singapore solely on a conservation basis. So long as these products are legal/have proper permits upon import into Singapore, then the government has little incentive to further regulate their import or consumption.

Compared to other countries in Southeast Asia like Vietnam or Indonesia, Singapore also seems to have had fewer concerted efforts by conservation agencies to reduce in-country consumption of threatened wildlife products. Those efforts that have been carried out primarily focus on live pets, with some focused on seafood and TCM (WCS Singapore 2019; ACRES 2020; WRS 2020). One particularly noteworthy TCM-related effort was implemented in 2007 by the Singapore-based non-profit, Animal Concerns Research & Education Society (ACRES 2020). This organisation worked with the Singapore TCM Organisations Committee to encourage TCM shops to display a sticker indicating their pledge to not sell tiger, bear, and rhino products. This campaign was implemented

to coincide with increased government enforcement on these products, and the stickers can still be seen in some shops throughout the country.

1.3 Thesis Overview

1.3.1 Aims and Objectives

Research Aims: Through this research I draw on behavioural science approaches in order to design, implement, and evaluate a large-scale behaviour change intervention targeting the usage of an unsustainable wildlife product: saiga horn in Singapore. My aim is for this intervention is to be informed and evaluated by a strong evidence-base on the drivers behind saiga horn consumption, as garnered through robust data collection and relevant literature and theory. Through this research I also aim to highlight methods and findings that can be used to improve future demand reduction efforts for wildlife trade, particularly for species that are used as traditional medicines, or those with strong social influences around their usage.

The main research objectives are to:

1. Assess Singaporean population-wide trends in saiga horn usage and consumer preferences,
2. Use theory and empirical evidence about saiga horn consumers to develop a detailed understanding capable of directly informing an intervention,
3. Implement a subsequent tailored behaviour change intervention on a target audience's usage of saiga horn,
4. Evaluate whether the intervention impacted the target audience's perception and usage of saiga horn.
5. Draw out key general lessons for future research and conservation practice.

1.3.2 Outline

This thesis contains four main research chapters (Figure 1.3), along with this introduction and a concluding general discussion. The research chapters include: **Chapter 2.** Saiga horn usage across Singapore; **Chapter 3.** A conceptual and actionable understanding; **Chapter 4.** Intervening on saiga horn usage; **Chapter 5.** A multi-pronged evaluation.

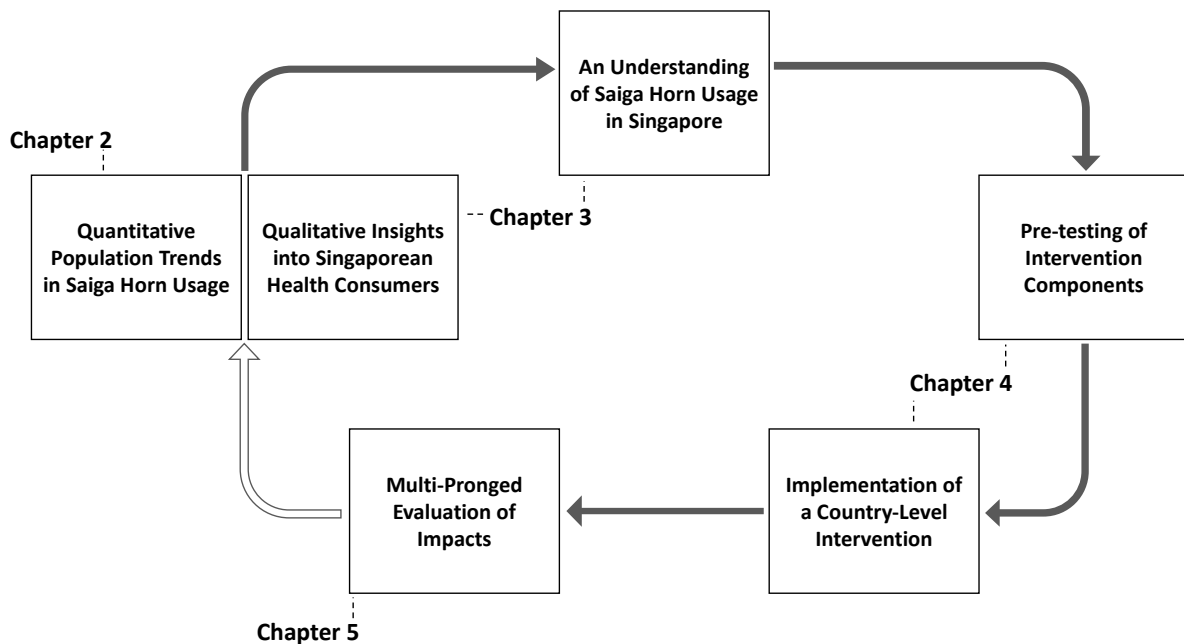


Figure 1.3 Mapping the four research chapters of this thesis as a behaviour change intervention targeting saiga horn usage in Singapore.

Chapter 2. Saiga horn usage across Singapore

In order to assess Singaporean population-wide trends in saiga horn usage and consumer preferences (e.g. prevalence of use, consumer demographics, purchase locations, and reasons for use), we conducted over 2,200 in-person surveys on saiga horn use with Chinese Singaporeans, employing neutral questioning approaches. We found that 19% of Chinese Singaporeans were ‘high-fidelity’ saiga users, meaning that they considered saiga horn to be a product they use *most often* when treating fever and heatiness. Other key findings were that saiga horn users were most likely to be middle-aged (35-59 years old) Buddhists or Taoists, and that middle-aged women were

the most likely to buy saiga horn for both themselves and other people. Saiga horn users were also significantly more likely to mistake the saiga for being common in the wild. Lastly, we found that “it works” and “someone recommended it to me” were the top two cited reasons for using saiga horn, and that TCM shopkeepers and family were the top two recommenders of saiga horn. These findings, along with others, were the foundation for the rest of the project – helping to define the target audience, highlight influences on saiga horn usage, and suggest potential directions for the intervention design and message. These surveys are the most extensive study to date on a saiga horn consumer population. This chapter has been published as:

H Doughty, D Veríssimo, R Tan, JSH Lee, LR Carrasco, K Oliver, EJ Milner-Gulland (2019). Saiga horn user characteristics, motivations, and purchasing behaviour in Singapore. PLOS ONE.

DOI: 10.1371/journal.pone.0222038.

HD led the methods design and data collection with input from JSHL, LRC, and EJMG. RT carried out the data collection. HD led the data analyses with input from DV, EJMG, and KO. HD wrote the initial manuscript with input from DV. All authors contributed critically to subsequent manuscript drafts and gave final approval for publication.

[Chapter 3. A conceptual and actionable understanding](#)

In this chapter we detail the underpinning process we used to integrate relevant human behaviour theories, past literature on Singapore, and new empirical evidence, to gain the specific insight used to inform an intervention design. Empirical evidence included the quantitative consumer surveys from Chapter 2 and qualitative insights from 10 in-depth focus groups with Chinese Singaporeans. The main concepts employed were Social Cognitive Theory, medical pluralism, and health information seeking behaviour. In this chapter we identify a target audience of middle-aged Chinese Singaporean women, and elucidate the many influences on this audience’s usage of saiga horn. We highlight a subset of influences that would be impactful and practical to leverage in an intervention: namely related to societal-level perspectives of saiga horn as being a socially accepted

product, and the target audience gaining health information from both their interpersonal network and impersonal channels like the internet. As such, this chapter was vital in identifying and selecting the target audience and the influences we would use for the intervention. This work fills a gap in wildlife trade research by providing a stepwise exemplification for how to integrate theory and evidence in support of a behaviour change intervention. Additionally, it demonstrates the often overlooked complex intricacies of socially-influenced behaviour and why a methodical understanding of these intricacies is invaluable when attempting to shift human behaviour. This chapter has been submitted for publication as:

H Doughty, K Oliver, D Veríssimo, JSH Lee, EJ Milner-Gulland (*in press*). Using theory and evidence to design behaviour change interventions for reducing unsustainable wildlife consumption. *People and Nature*.

HD led the methods design, data collection, and data analyses for the empirical evidence, with input from KO, DV, JSHL, and EJMG. HD and KO conceptualised the design process of integrating theory and evidence. HD conducted the relevant exploratory literature searches and wrote the initial manuscript. All authors contributed critically to subsequent manuscript drafts and gave final approval for publication.

[Chapter 4. Intervening on saiga horn usage](#)

To shift middle-aged Chinese Singaporean women from using saiga horn to using more sustainable alternatives, we designed and implemented an online behaviour change intervention. This work used insights from Chapter 3 along with three additional detailed focus groups with the target audience to test and refine design components. For the intervention delivery, we employed concepts around repeat message exposure and social reinforcement, and tools of online news coverage and targeted online adverts. Specifically, we used online adverts through Facebook, Google, and Outbrain, to promote news articles discussing the use of saiga horn as TCM in Singapore. The intervention message framed saiga horn products as being no longer socially

endorsed. Through advert performance and in-depth analyses of Facebook user engagement, we assessed message spread and immediate audience response. The intervention message pervaded Singapore's online media (e.g. our adverts were shown almost five million times), and resulted in widespread desirable immediate audience responses (e.g. 63% of user engagements included identifiably positive responses to the intervention message, while only 13% included identifiably negative responses). This chapter details our innovative implementation process and analyses the audience's initial response to the chosen message and delivery. This work shows that targeted dissemination of online news articles can have promising initial results, and may have wide applicability to conservation. This chapter has been accepted for publication as:

H Doughty, J Wright, D Veríssimo, JSH Lee, EJ Milner-Gulland (2020). Strategic advertising of online news articles as an intervention to influence wildlife product consumers. *Conservation Science and Practice*. DOI: 10.1111/csp2.272.

HD conceptualised the intervention design, and led the intervention implementation, advert performance data collection, and overall data analyses, with input from JW, DV, JSHL, and EJMG. JW coded and carried out the Facebook web-scraping. HD wrote the initial manuscript. All authors contributed critically to subsequent manuscript drafts and gave final approval for publication.

[Chapter 5. A multi-pronged evaluation](#)

To robustly evaluate possible intervention impacts on target audience perceptions and behaviour, we carried out more than 2,100 in-person consumer surveys post-intervention (as a comparison to the pre-intervention Chapter 2 surveys), and 93 in-person surveys with TCM shopkeepers post-intervention. The proportion of high-fidelity saiga horn consumers in the target audience did not change from pre- to post-intervention. However, within the post-intervention dataset, when compared to the non-target audience, the target audience was more likely to accurately recall the intervention message and to decrease their saiga horn usage. Within the target audience, high-

fidelity consumers were more likely than lower-fidelity consumers to recall the message and to report a behaviour change. Additionally, across all respondents, mistaking saigas for being common in the wild decreased from pre- to post-intervention. Further, respondents who decreased saiga horn usage cited the intervention message as a specific reason for their behaviour change. This chapter shows the intervention did influence some consumers, and explores the reasons why greater effects were not observed, including competing consumer influences, intervention characteristics, and evaluation timing. The work suggests our online intervention approach has potential for conservation, and is a rare example of a mixed-methods pre-post evaluation of a wildlife trade consumer intervention. This chapter has been submitted for publication as:

H Doughty, EJ Milner-Gulland, JSH Lee, K Oliver, LR Carrasco, D Veríssimo (*in press*). Evaluating a Large-Scale Online Behaviour Change Intervention on Wildlife Consumers in Singapore. PLOS ONE

HD led the methods design, data collection, and data analyses with input from EJM, JSH, KO, LRC, and particularly DV. HD wrote the initial manuscript. All authors contributed critically to subsequent manuscript drafts and gave final approval for publication.

1.3.3 Additional Research

During the course of my DPhil I also contributed to the following research outputs:

H Cheung, **H Doughty**, A Hinsley, E Hsu, TM Lee, EJ Milner-Gulland, H Possingham, D Biggs (*in press*). Understanding Traditional Chinese Medicine to facilitate conservation. *People and Nature*.

L Thomas-Walters, A Hinsley, D Bergin, G Burgess, **H Doughty**, S Eppel, D Macfarlane, W Meijer, TM Lee, J Phelps, RJ Smith, A Wan, D Veríssimo (2020). Motivations for the use and consumption of wildlife products. *Conservation Biology*. DOI: 10.1111/cobi.13578.

D Verissimo, T Pienkowski, M Arias, L Cugnière, **H Doughty**, M Hazenbosch, E de Lange, A Moskeland,
M Grace (2020). Ethical publishing in biodiversity conservation science. *Conservation and Society*.
18:220-5. DOI: 10.4103/cs.cs_19_56

Chapter 2 Saiga horn usage across Singapore

2.1 Abstract

Consumer research provides crucial knowledge for designing and evaluating targeted behaviour change interventions. We implemented a rigorous consumer survey on saiga horn use in Singapore, where usage is legal and widely sold. This work is the most extensive consumer research to date specifically characterising saiga horn consumers and usage. We conducted 2294 in-person surveys on saiga horn use with Chinese Singaporeans, employing neutral questioning approaches. We found 19% of individuals reported saiga horn as a product they choose *most often* for themselves or others, when treating fever and heatiness (a TCM state of illness), indicating a minimum estimate of high-fidelity usage, not including possible lower-fidelity users. Overall saiga horn users were most characterised as middle-aged Buddhists and Taoists. However, saiga users were found in a range of demographic groups. Women preferred saiga shavings (the more traditional form), while men preferred saiga cooling water (the more modern form). About 53% of individuals who used saiga horn themselves also bought it for someone else. Buyers for others were most likely to be female middle-aged Buddhists or Taoists. Key motivating reasons for usage were “it works” and “someone recommended it to me.” The top two reported recommenders were family and TCM shopkeepers. Saiga users were more likely than non-saiga users to mistakenly perceive saiga as a common species in the wild. This research holds significance for interventions targeting saiga horn consumption within Singapore and throughout Asia, by identifying potential target audiences, product types, non-desirable alternatives, and motivations for use.

2.2 Introduction

Implementing a behaviour change intervention requires a detailed understanding of the consumers the intervention is targeting. In disciplines like public health and social marketing this implies rigorously collected datasets, that are defensibly illustrative of the consumer landscape (Craig et al. 2008; Hopwood 2011). Those working in wildlife trade have drawn criticism around the validity of behaviour change intervention data collection methods and the findings extrapolated from these datasets (Robertson 2014; Greenfield & Verissimo 2018; Verissimo & Wan 2019). Similar points have been made across conservation when assessing the social studies that are often used to inform or evaluate human behaviour interventions (St. John et al. 2014) These shortcomings likely compromise researchers' ability to accurately assess the use of critically endangered species under trade impact.

One species greatly affected by human demand is the saiga antelope (*Saiga tatarica*). Singapore is recognised as one of the largest saiga horn consumer countries, and sales of saiga horn and its derivatives within Singapore are permitted if they are pre-Convention stock or have been legally imported with CITES permits (CITES 2018). Therefore, saiga products are widely available in shops and their purchase is non-sensitive. A 2016 small-scale survey of saiga product usage in Singapore found 13% of their sample of 230 Chinese Singaporeans were current users of saiga products (Theng et al. 2017). Without a large-scale study though, a robust estimate of usage has not been known. To address the timely need for detailed research on saiga horn consumers, this work aims to understand consumption patterns of medicines containing saiga horn in Singapore, through the most extensive and robust study of a saiga horn consumer population to date. By assessing:

- prevalence of use,
- socio-demographic characteristics of saiga horn users,
- purchase trends (i.e. who buys for others and additional treatment types consumers use),
- stated reasons for use,

- and conservation awareness,

we provide insight into potential target audiences, product types, and intervention angles for a behaviour change intervention design to reduce the use of saiga products in Singapore. We thus hope this research will prove a sound foundation for any future demand reduction efforts with these consumers. We furthermore aimed to implement a robust approach to consumer survey design and implementation, that may be useful for other researchers.

2.3. Methods

2.3.1 Survey Overview

The survey focused on asking participants about their preferred treatment for fever and heatiness in themselves and others (see Appendix 2.1 for the full survey). The first section assessed heatiness preferences for themselves and then others (if they indicated they buy treatments for others), followed by fever preferences, a single question assessing their perception of the abundance of wild populations of a set of species used in TCM, and finally the demographic questions. The format and questions were a result of iterative drafts and scrutiny by the authors, informed by discussions with the relevant government agencies (the Agri-Food & Veterinary Authority of Singapore – now under the National Parks Board of Singapore – and the Health Science Authority of Singapore), as well as Wildlife Reserves Singapore. The survey was piloted for two days (~75 surveys) with members of the public at the National University of Singapore and in a Planning Area not used in our study (Singapore is divided into 56 Planning Areas as demarcated in the Urban Redevelopment Authority's Master Plan 2014 (URA 2014). Feedback from the pilots helped to refine question phrasing and formatting. For example, we found that the heatiness section had a higher cognitive burden than the fever section (i.e. it required more thought on the part of the respondent), and thus we placed the heatiness section first so that respondents could answer it while they were freshly engaged.

The following sections about survey questions and sampling highlight our efforts to employ neutral questioning approaches. Each of these components was used to mitigate the probability of potential biases, including social desirability bias (i.e. that we would inadvertently prompt our respondents to inflate or deflate their saiga horn consumption depending on what they thought we wanted to hear), thereby increasing the probability of obtaining accurate figures for saiga product usage.

2.3.2 Question Format

Questions were organised into a decision-tree style format, allowing respondents to answer general questions first, and only be asked further questions as they were applicable to them. The top-level question for fever, for instance, simply asked which treatment types (western, traditional herbal, traditional animal, or other) that they used most often. We used the term western medicine in our survey to refer to biomedical medicine, as this was the phrase determined to be the most commonly understood by our target audience based on our scoping trip and discussions with relevant in-country stakeholders. If a respondent stated that they use western and other treatments in the survey, then they would be asked about types of western and other treatments, but they would not answer any questions on traditional treatments. This approach to questioning allowed us to not ask about saiga product usage directly, but rather have it as an option for those who selected traditional animal products in these top-level questions. Those who selected saiga horn at this point could then answer further questions regarding their usage, such as product form and purchase location.

2.3.3 Question Phrasing

Questions were framed as neutrally as possible so as not to prompt respondents into choosing one answer over another. If for example, a respondent had stated in a previous question that they purchased traditional animal products when treating a teenager with heatiness, then the next question was “When treating a teenager's heatiness with traditional animal products: which type of animal products do you use most often? [Select all that apply],” followed by other questions such as “What form of treatment do you use most often?”. We specifically asked which health treatments respondents use *most often* in the given circumstance as that would give us a robust minimum estimate of the prevalence of use. However, it does not necessarily capture all users who may not consider saiga horn a product they use most often, but whom do consume it at times. A respondent's ability to select multiple choices as their most used health treatments aimed to mitigate this limitation.

2.3.4 Target Audience, Location, and Timing

Using 13% as an estimate of the percentage of saiga product users among Chinese Singaporeans (based on a prior small-scale study) (Theng et al. 2017) we assessed the sample size we would need to have statistical power when running analyses with the user sub-samples. Using nested analyses as an initial gauge, we conducted a power calculation for performing a three-tiered nested proportion statistical test with three of our main questions (Appendix 2.2). This calculation estimated that we would need a minimum of ~1500 respondents. We then based our sampling plan on the co-authors' experiences of past survey recruitment rates along with rates from the pilot days. However, the actual recruitment rate during our survey was higher than anticipated, and thus we were able to collect more surveys.

Many ethnicities in Singapore have been cited as being TCM users, but Chinese Singaporeans make-up the largest ethnic group (84%) of complementary and alternative medicine users (inclusive of

TCM) (Lim et al. 2005). We therefore chose to focus on them. Consumer surveys were conducted in the Planning Areas with the top five largest populations of Chinese Singaporeans (Appendix 2.3). Within each Planning Area, we identified four locations that attracted people of varying socio-economic levels including malls with high-end or lower-end stores, hawker food centres with affordable open-air food stalls, and generally popular areas with restaurants and shops (Appendix 2.3). Survey numbers across Planning Areas were distributed proportionally to Planning Area Chinese Singaporean population. Surveys were also stratified across day of the week and time of day (weekday/weekend and morning-afternoon/afternoon-evening shifts) to capture as many different types of people with varying schedules as we could. To sample evenly across gender and age groups (18 - 35 years, 36 - 59 years, ≥ 60 years), we checked the demographic characteristics of the respondent sample weekly. Distributions were naturally at most 3% different for age, and under 8% for gender, but to gain more gender balance, in the last day we only sampled women, with all other collection protocols remaining the same.

2.3.5 Sampling Method

There are a number of sampling methods that could be employed to conduct consumer surveys. For example, they could have been conducted online through the use of a third-party survey platform (Moorhouse et al. 2019), or via snowball sampling using contacts to build-up a respondent pool (Brooks et al. 2010). We chose intercept surveys in which researchers intercepted individuals in-person in public places outside of our chosen locations. These allowed us to engage independently with different members of the general population from a diverse range of backgrounds, who were not incentivised by compensation for participation, had no affiliations with our networks, and were not required to have internet access.

All four survey researchers were in their early twenties, female, and Chinese Singaporean. Surveys were designed and managed using Open Data Kit, and administered using tablets. Respondents

who did not wish to use the tablet themselves had the choice to have the researcher ask them questions orally. The survey was available in both English and Mandarin, and the researchers were fluent in both languages.

Researchers wore identifiable Nanyang Technological University (NTU) logo shirts so as to not be mistaken for saleswomen. Surveys were described to potential participants as assessing heatiness and fever treatment preferences, with no mention of saiga, TCM, or wildlife. This was in order not to prime participants into pre-emptively thinking about these topics, or into thinking that we were especially interested in these topics (which could lead to social desirability bias). Every third person who passed a researcher (while the researcher was not with another respondent) was asked to participate. If a group of people approached, the researcher asked the person on the right (for a group of two) or the third person to the right (for groups larger than two). It is possible that there is some bias in certain types of people always being on one side of a group, however, we hope that through our balanced collection of gender and age types we have mitigated for this. Only the chosen person in a group was allowed to take the survey.

2.3.6 Data Analysis

The data were first assessed through descriptive and visual analyses, followed by a statistical analysis using R 3.5.2 GUI 1.70 (7612 El Capitan build). We preferred parametric tests over non-parametric tests because of their greater statistical power, and because parametric tests can be used even when groups have different levels of variability (as was the case with our data) (Frost 2017). We first evaluated whether the datasets met the assumptions of parametric tests using visual and frequency-based analyses. Demographic data analysis for various user sub-groups (Figure 2.1) began with a summary of each demographic variable (Table 2.1). Data were not weighted because we were interested in identifying potential target demographic groups for future interventions, rather than producing a population-wide estimate of product consumption levels.

At this stage though, sub-levels of some variables with low (<10) or no counts were combined, for example uncommon religious affiliations were all combined into “Other religion”. Then, generalised linear models (GLMs) were used to explore associations between those belonging to a saiga horn user sub-group, and other dependent variables (Table 2.1). The initial GLM outputs led us to choose model averaging, in order to minimise researcher bias in model selection as there were no clear top models. We used the package MuMim (Bartón 2016), included all seven demographic variables, and averaged models with an Akaike information criterion (AIC) < 4.

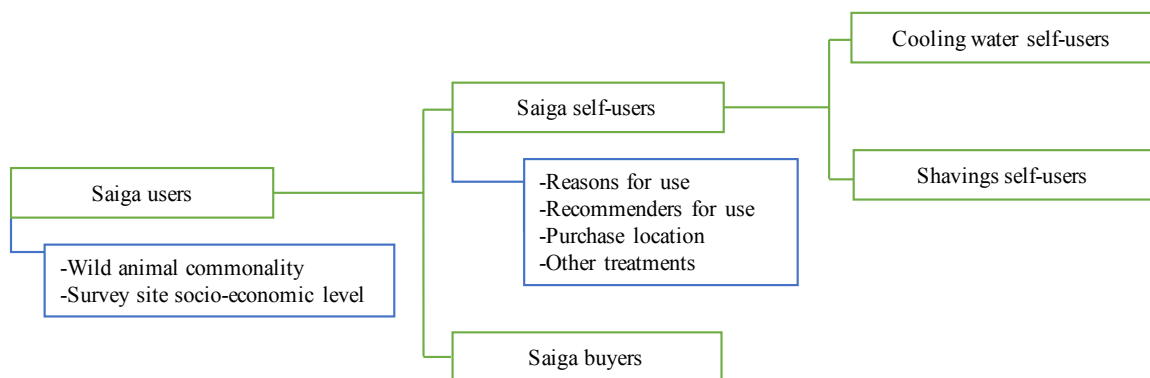


Figure 2.1 Data analysis breakdown showing saiga horn sub-user groups, assessed using averaged GLMs with contrasts, along with the additional questions that are asked of two groups of particular interest. All respondents who use or buy saiga horn for themselves or others are considered "saiga users". Respondents who use it themselves are considered "saiga self-users", and those who buy for others are "saiga buyers" (self-users and buyers are not mutually exclusive, and both are subsets of users). Within saiga self-users, we also characterised respondents who stated that the saiga products they purchase most often are cooling water or shavings.

Table 2.1 Demographic variables used in regression analyses, along with their *a priori* hypothesised effects in each consumer sub-group.

Variable	Type	Consumer Group	Hypothesis [^]	
			Variable Effect	Direction of Effect
Age	Ordinal	Total saiga users, self-users, & buyers		Older age more likely to use or buy ^{(Tan & Freathy 2011), a, b}
		Cooling water self-users	Yes	Younger age more likely to use ^{(Tan & Freathy 2011), a, b}
		Shavings self-users		Older age more likely to use ^{(Tan & Freathy 2011), a, b}
Dialect	Categorical	All consumer sub-groups	No	No difference between dialects ^{(Loh 2009), a, b}
Education	Ordinal	All consumer sub-groups	Yes	Lower education more likely to use or buy ^{(Tan & Freathy 2011), a, b}
Sex	Binary	Total saiga users, & self-users	No	No difference between sexes ^{a, b}
		Saiga buyers		Women more likely to buy ^{(Xia et al. 2006), a}
		Cooling water self-users	Yes	Males more likely to use ^{(Tan & Freathy 2011), a}
		Shavings self-users		Females more likely to use ^a
Generation Singaporean ^{^^}	Ordinal	Total saiga users, self-users, & buyers		Less time family has lived in Singapore, more likely to use ^{(Rittersmith 2009), a}
		Cooling water self-users	Yes	More time family has lived in Singapore, more likely to use ^{(Rittersmith 2009), a}
		Shavings self-users		Less time family has lived in Singapore, more likely to use ^{(Rittersmith 2009), a}
Income	Ordinal	All consumer sub-groups	Yes	Lower income more likely to use ^{(Lim et al. 2005; Tan & Freathy 2011), a}
Religion	Categorical	All consumer sub-groups	Yes	Buddhists and Taoists more likely to use ^{(Kaptchuk 2000; Rittersmith 2009), a}

[^] Hypotheses were based on: general readings of TCM trends in Singapore, as well as discussions within the research team and colleagues in Singapore (denoted with symbol “a”), and a scoping trip in February 2017 (denoted with symbol “b”).

^{^^} Generation Singaporean is the number of generations a respondent’s family has lived in Singapore.

In conjunction with this process, we applied sum contrasts. Sum contrasts allow for a comparison of the mean of one variable level to the mean of all means for all the levels within that variable (Fox 2002). This is different from the default GLM output which compares each level to a single reference level within that variable.

The *a priori* hypothesised direction of effect for each demographic variable on the consumer sub-groups were based on insights from previous studies and from our own scoping research (Table 2.1). This included discussions within our team (a group of Singaporean and international researchers from varying disciplines) and with external colleagues in Singapore, along with visits to TCM shops and discussions with relevant stakeholders such as shopkeepers and government officials. Literature on TCM use in Singapore also informed our choice of variables to test. For instance, findings on spousal influence on family purchase behaviour suggested women were more likely to purchase these treatments for others (Xia et al. 2006), and a study on TCM shop patronage augmented general perceptions in Singapore that older individuals might be more likely to purchase minor ailment treatments like saiga horn in a TCM shop (Tan & Freathy 2011). That same study found that gender, education, and income were also correlated with visiting TCM shops for minor ailment treatments. An anthropological study on TCM cooling treatments in Singapore (Rittersmith 2009), and a broader text on TCM foundations (Kaptchuk 2000), led us to hypothesize that Buddhists and Taoists, along with those who have more recent family ties to mainland China, would be more likely to be saiga horn users given the cultural overlaps with TCM.

To understand saiga product consumption, we analysed preferences specifically of those who use saiga products to treat themselves (saiga self-users), as these individuals are likely to present the strongest preferences. These individuals may or may not also be buyers (those who buy saiga products for others). In a preliminary analysis, preferences for the buyer group resembled the self-user group, so a second analysis of that group was not performed. Potential other treatment types

preferred by saiga self-users were assessed via a GLM, while reasons for using saiga products, who recommended saiga product use, and purchase locations of saiga products, were all analysed using 2-sample z-tests for equality of proportions with a continuity correction (which was chosen because the respondent's answers on these questions were not mutually exclusive).

Insight into the perceptions of those who purchase saiga products either for themselves or others (saiga users), was also of interest. In particular, we wondered whether being a saiga user meant that the individual was more likely to think saiga was a common species, as an indicator for conservation awareness regarding saiga. To answer this query, respondents were given a list of species that are found in TCM and asked to select the ones that they think are common in the wild. We chose to not ask about rarity as we did not want to prompt respondents into thinking that some of the given species must be rare. Results were analysed for each species via Pearson's chi-squared test for independence, and overall propensity for perceiving commonness of species was analysed via a GLM. Lastly, we used the locations in which saiga users were surveyed as a second means of assessing whether socio-demographic level was associated with saiga product use. Results were similarly analysed using Pearson's chi-squared test for independence.

2.3.7 Ethics

This research was approved by the Institutional Review Board of NTU (IRB-2017-04-018) and the Central University Research Ethics Committee of the University of Oxford (R50787/RE001). Informed consent was obtained orally and recorded by the surveyors via the tablet when initiating the survey; this process was approved by the preceding review boards.

2.4 Results

In total, 2294 surveys were conducted over a six-week period (June-July 2017) (see Appendix 2.4 for raw data). The sample was fairly balanced across age (young 34%, mid-age 34%, older 31%) and sex (male 49%, females 51%). Of these respondents, 438 (19%) were saiga users – defined as those stating saiga horn was a product they use *most often* to treat heatiness or fever in themselves or others. We found that 53% of individuals who buy saiga products for themselves also buy it for someone else. Among buyers, 84% also use it themselves.

2.4.1 Consumer Groups

Of the seven demographic variables assessed, age and religion had the greatest relative importance for almost all of the averaged GLM models (Table 2.2). Sex was also an important determinant of use for the buyer, cooling water, and shavings sub-groups.

Saiga users were significantly more likely to identify as Buddhist ($p < 0.001$) or Taoist ($p < 0.01$), and to be middle-aged ($p < 0.01$). They were significantly less likely to be under 36 years old ($p < 0.05$) (Table 2.3). The demographic characteristics of saiga users were quite variable, especially when comparing between age groups. For example, the most common education levels for younger users was pre-university or university (81%), for mid-aged users it was secondary school or the equivalent (34%), and for older users it was primary school or under (51%).

Table 2.2 Combined model selection table for all consumer sub-groups, showing dredge models with a delta <4, and the Relative Importance (RI) of the variables in each averaged-model.

	Religion	Age	Gender	Education	Income	Generation Singaporean	Dialect	Delta	Weight
Total users	RI	1.0	1.0	0.33	0.69	0.22			
		+	+		+			0	0.319
		+	+					0.91	0.202
		+	+	+	+			1.52	0.149
		+	+		+	+		1.58	0.145
		+	+	+				2.15	0.109
	+	+	+	+	+		2.89	0.075	
Self-users	RI	1.0	0.95	0.22	0.74	0.07	0.08		
		+	+		+			0	0.384
		+	+					1.38	0.192
		+	+	+	+			1.9	0.149
		+	+		+		+	3.07	0.083
		+	+	+				3.37	0.071
		+	+		+	+		3.49	0.067
	+			+			3.9	0.055	
Buyers	RI	1.0	1.0	1.0	0.82	0.1			
		+	+	+	+			0	0.725
		+	+	+				2.84	0.175
	+	+	+		+	+	3.97	0.1	
Cooling water self-users	RI	1.0	0.65	1.0		0.23			
		+	+	+				0	0.498
		+		+				1.19	0.275
		+	+	+			+	2.34	0.154
	+		+			+	3.83	0.073	
Shavings self-users	RI	1.0	1.0	1.0	0.65				
		+	+	+	+			0	0.651
	+	+	+					1.24	0.349

Table 2.3 The full averaged-model coefficients of variables with significant p-values, shown for each consumer sub-group

		β	Std. Error	Z-value	P-value [^]
Total users	(Intercept)	-1.708	0.151	11.357	***
	Young age	-0.238	0.106	2.248	*
	Mid-age	0.230	0.076	3.015	**
	Old	0.007	0.113	0.063	
	Buddhist	0.547	0.145	3.761	***
	Taoist	0.613	0.219	2.792	**
	Catholic	-0.512	0.280	1.827	.
	Christian	-0.031	0.185	0.167	
	No religion	0.083	0.161	0.514	
	Other religion	-0.866	0.635	1.362	
Self-users	(Intercept)	-1.830	0.140	13.103	***
	Young age	-0.193	0.118	1.636	
	Mid-age	0.194	0.090	2.162	*
	Old	-0.001	0.115	0.004	
	Buddhist	0.603	0.148	4.061	***
	Taoist	0.458	0.232	1.969	*
	Catholic	-0.652	0.310	2.104	*
	Christian	-0.039	0.193	0.200	
	No religion	0.108	0.166	0.653	
	Other religion	-0.751	0.636	1.179	
Buyers	(Intercept)	-2.802	0.233	12.034	***
	Young age	-0.644	0.127	5.080	***
	Mid-age	0.533	0.099	5.381	***
	Old	0.111	0.115	0.963	
	Buddhist	0.432	0.202	2.140	*
	Taoist	1.037	0.275	3.773	***
	Catholic	-0.387	0.362	1.069	
	Christian	0.201	0.240	0.840	
	No religion	0.161	0.226	0.712	
	Other religion	-0.706	0.888	0.795	
	Female	0.621	0.153	4.062	***
Cooling water self-users	(Intercept)	-2.764	0.196	14.115	***
	Buddhist	0.615	0.194	3.168	**
	Taoist	0.468	0.298	1.569	
	Catholic	-0.282	0.355	0.794	
	Christian	0.043	0.245	0.175	
	No religion	0.188	0.216	0.873	
	Other religion	-0.776	0.879	0.882	
	Male	0.460	0.143	3.22	**

Shavings self-users	(Intercept)	-5.623	75.730	0.074	
	Young age	-0.595	0.207	2.875	**
	Mid-age	0.390	0.130	3.008	**
	Old	0.206	0.191	1.077	
	Female	0.867	0.198	4.371	***

^ Significance codes: '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1

We saw similar demographic characteristics between the self-user (403 respondents – 18%), and buyer (223 respondents – 10%) groups. Females were more likely than males to buy saiga products for others, as were Buddhists and Taoists, and middle-aged individuals; young people were less likely to buy saiga products for others (all $p < 0.001$). Those who buy saiga products for others were similar to those who buy any treatment type for others in terms of sex and age, but buyers of any treatment type for others were more likely to have a higher educational level than non-buyers, and religion did not affect their buying decisions (Appendix 2.5).

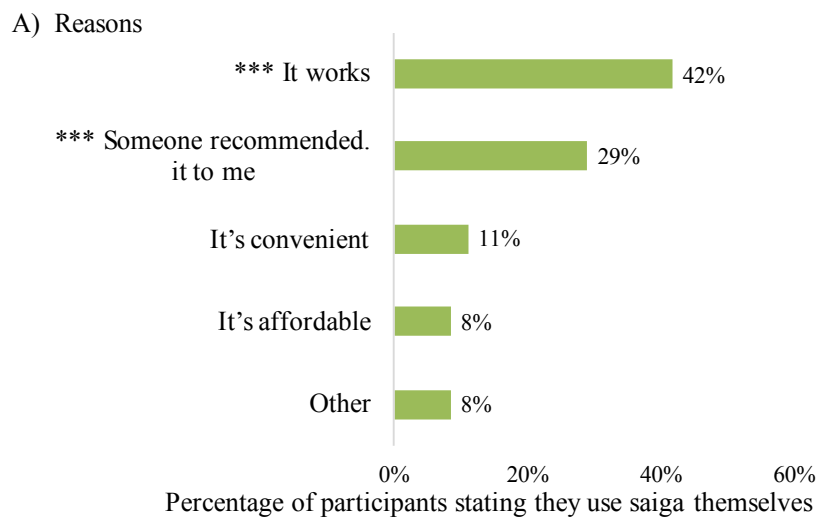
There were product-specific differences in self-usage when assessing the two most cited forms of saiga product: cooling water (54% of self-users) and shavings (33%). Cooling water self-users totalled 231 respondents (10%), and were more likely to be male ($p < 0.01$). Shavings self-users totalled 138 respondents (6%), and were most likely middle-aged ($p < 0.01$), and female ($p < 0.001$). Cooling water was preferred by 66% of young self-users, 59% of middle-aged, and 49% of older self-users. An almost opposite trend was seen for shavings: 19% of young self-users preferred shavings, 39% of middle-aged, and 39% of older self-users.

2.4.2 Self-User Preferences

Motivations and preferences of self-users provide important insights into product use. When self-users were asked why they preferred saiga products to treat heatiness or fever, they reported "It works" (42%)

and "Someone recommended it to me" (29%) more often than other reasons ($\chi^2(1, N = 403) = 33.09, p < 0.001$; $\chi^2(1, N = 403) = 74.24, p < 0.001$ respectively; Figure 2.2A). For self-users who stated that saiga was recommended to them, "Family" (56%) and "TCM shopkeeper" (23%) were reported more often than other options ($\chi^2(1, N = 186) = 97.51, p < 0.001$; $\chi^2(1, N = 186) = 8.97, p < 0.001$ respectively; Figure 2.2B).

Self-users purchased saiga products far more often in TCM family-owned stores (46%) and TCM chain stores (43%) than in other locations ($\chi^2(1, N = 403) = 2.90, p < 0.04$; $\chi^2(1, N = 403) = 353.73, p < 0.001$ respectively; Figure 2.2C). No respondents purchased saiga products online, and in fact, there were only 12 reports of online purchases for any treatment type purchased for oneself or others. When asked what other treatment types they used, self-users were significantly less likely than non-users to also use western medicine or "Other" medicines ($\beta = -1.330, z = -8.879, p < 0.001$; $\beta = -1.513, z = -9.138, p < 0.001$ respectively).



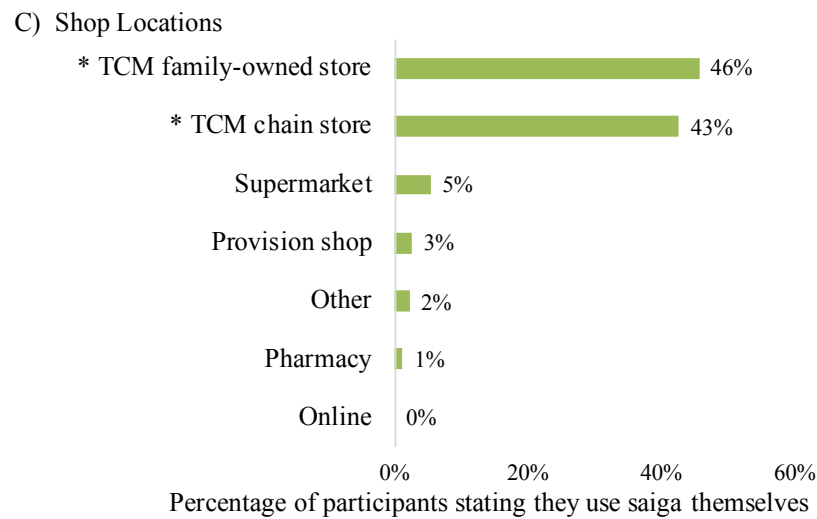
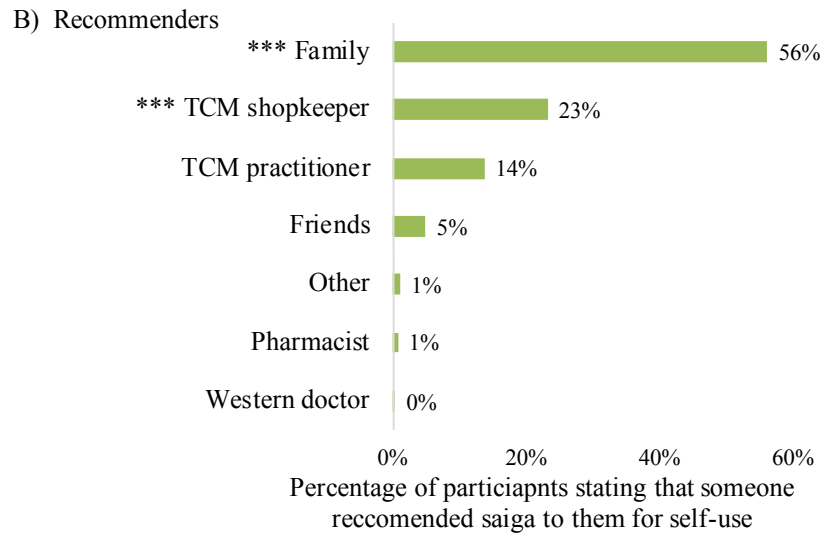


Figure 2.2 Self-user motivations and preferences. Asterisks indicate a statistically significant difference between this answer and all others within a panel (2-sample Z-tests, p-value < ‘***’ 0.001 or ‘*’ 0.05). **A)** Reasons for using saiga products on oneself to treat heatiness and fever, as reported by participants. Percentage out of 403 participants. **B)** Recommenders for using saiga products on oneself to treat heatiness and fever, as reported by participants. Percentage out of 186 participants. **C)** Shop locations for purchasing saiga products to treat heatiness and fever on oneself, as reported by participants. Percentage out of 403 participants.

2.4.3 Overall User Trends

Overall saiga users (i.e. all self-users and buyers) were significantly more likely to be surveyed in lower socio-economic locations than in other locations (Pearson's Chi-squared test, $\chi^2(1, N = 438) = 12.918, p < 0.001$). Finally, we assessed respondents' perceptions of species used in TCM. We found that saiga users had a greater overall propensity than non-users for perceiving animals as common in the wild ($\beta = 0.023, z = 3.665, p < 0.001$). When looking specifically at each animal though, the difference between saiga and non-saiga user perception was significant only for saiga (Pearson's Chi-squared test, $\chi^2(1, N = 438) = 38.56, p < 0.001$) (Figure 2.3).

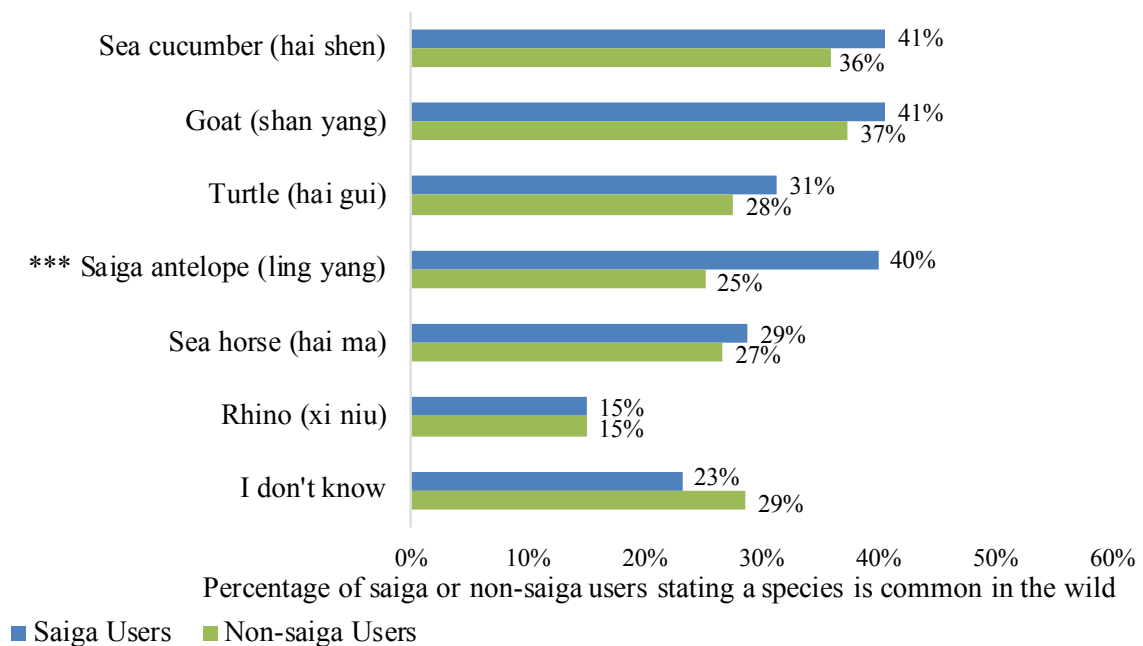


Figure 2.3 Perceived commonness of species in the wild. *** indicates a statistically significant association between saiga users and perceiving that animal as common (p -value < 0.001 , Pearson's Chi-squared test).

Percentages out of 438 participants for saiga users and 1,856 for non-users.

2.5 Discussion

The main saiga users in our sample are middle-aged Chinese Singaporeans who identify as Buddhist or Taoist. The relatively high prevalence of usage (19%) is evidence that saiga is a commonly used TCM product. This level of consumption has been seen for other TCM products derived from wildlife, such as bear bile consumers in China (Dutton et al. 2011), and saiga horn specifically has been previously observed as a common product in TCM markets in countries like China (Lam 2012). However, the usage level we found in Singapore was unexpected given the low level of legal trade into Singapore reported to CITES over the last few years (CITES 2018). This may suggest that the stockpile of horns which was reported as being in Singapore at the time of the species being listed on CITES may be decreasing. The strong influence of family and TCM shopkeepers on a consumer's choice to use saiga horn is also particularly noteworthy for tailoring future demand reduction efforts that may want to employ social or professional influencers (Taher et al. 2012; Kim et al. 2015).

2.5.1 Consumer Groups

When comparing results with our *a priori* hypotheses, we found expected associations between saiga products and age and religion across consumer sub-groups. In contrast to the preliminary findings of (Theng et al. 2017), we hypothesised that saiga product use would increase with age, as general perceptions in Singapore are that TCM use is more popular with older generations. A relationship with age was supported by the significant negative association between younger respondents and saiga product use, contrasting to the significant positive association between middle-aged (though not elderly) respondents and saiga product use.

The strong associations of saiga product use with Buddhism and Taoism were expected given the cultural overlaps between TCM and these religions (Xia et al. 2006). This trend was highlighted when comparing buyers of saiga products to buyers of any treatment (including western treatments), who were not more likely to be associated with any religion. The strong negative association between Christianity, particularly Catholicism, and saiga self-use was unexpected. The robust positive correlations between saiga horn consumption and Buddhism and Taoism have important implications for future intervention approaches. Researchers can thus consider faith-based strategies that are culturally relevant and respectful, as well as have a greater potential for successful uptake. Buddhism is one of the most environmentally benevolent religions (Kabilsingh 2004), and Buddhist monasteries have had active roles in past conservation programs (Li et al. 2014). As such, behaviour change interventions that work in collaboration with Buddhist temples, for example, to highlight how the use of saiga products links to wildlife damage, could potentially be effective in our study population. Utilising a faith-based approach to addressing wildlife trade was innovatively implemented among Muslim communities in Indonesia through the issuing of a Fatwa (Islamic law) against wildlife trafficking (Christy 2014).

Buyers of any treatment, including saiga products, were most likely to be middle-aged women. Women's role in making health decisions for others within their interpersonal network is well documented (Chang et al. 2014) and as such, our findings confirmed our hypothesis on gender for buyers. A 2006 study found Singaporean wives, more than husbands, were the ones to purchase over-the-counter medicine for their family unit (Xia et al. 2006). Additionally in our survey, for those purchasing any treatment, respondents with higher education were more likely to purchase products for others, but this trend was not observed for saiga buyers specifically.

We hypothesized that education level may impact saiga product consumption. Education appeared in the top models for the users and self-users, however the associations were not significant and the variable's importance was <0.8 . We also hypothesised that the number of generations a respondent's family had been living in Singapore might be negatively correlated with saiga product usage, on the assumption that people more recently arrived from China may have a stronger attachment to TCM, but this was not supported by the data. Similarly, we anticipated that TCM would be used more often by lower income people, since some forms have been referenced as cheaper than biomedical alternatives (Lim et al. 2005), but this was not fully supported by our results. A 2005 study also did not find income to influence complementary medicine usage in Singapore (the most common of which is TCM) (Lim et al. 2005). Despite having no significant coefficient though, income did appear strongly in the top model for buyers, with a variable importance of 0.82, suggesting that it may be associated with this behaviour. A large percentage (39%) of respondents chose to not state their income level, so it is possible that correlations with income do exist. Further supporting our original hypothesis, we found that the proportion of saiga users in our sample was highest in lower socio-economic survey locations. More research is thus needed on this point to better understand possible trends.

Descriptive results highlighted to us that even though particular demographic characteristics, like identifying as Buddhist, may make an individual significantly more likely to be a saiga user, there is a lot of demographic variation within the saiga user group. In fact, for the young age group, "No religion" was the second most common religious affiliation of saiga users. Saiga product use was seen across a range of demographic groups, be it religious, educational, or dialect group; suggesting that saiga use is prevalent across the sample.

2.5.2 Preferences and Motivations

There were interesting product-specific differences seen in the data. Saiga horn shavings, which were significantly more popular among middle-aged women, are a relatively traditional form of the product (one step beyond purchasing the whole horn and shaving it yourself). Shavings require an individual to boil them at home, coupled with a prescribed set of herbs. Some shopkeepers in our study area recommended boiling for two to four hours before consumption. Saiga horn cooling water products, however, can be immediately consumed upon purchase. They are therefore a more modern form of the product, that has been pre-boiled for a consumer, and do not require any effort. They are also often sold chilled, which likely adds to their desirability to a consumer who is feeling heaty or feverish. Cooling water self-users were significantly more likely to be male. Strong gender differences in the consumption of wildlife products has been seen for other species as well. For instance, in Vietnam, it has been suggested that women may be the main purchasers of rhino horn, but wealthy middle-aged men may be the main end-users of the product (Truong et al. 2016). Thus, our results suggest that demand reduction efforts might consider tailoring by gender if focusing on one of these product forms.

We were surprised to see the lack of online purchases for any treatment type, given the high prevalence of online shopping in Singapore, and the rise of online sales in over-the-counter medicine in Singapore (Statista 2020). Clearly more research is needed on online purchase behaviour of over-the-counter medicines in Singapore that may contain sensitive species, in order to better monitor and regulate potentially unsustainable usage patterns.

Regarding motivations for consumption, the highly reported "Someone recommended it to me" answer echoes the well-documented influence of interpersonal communication on human behaviour, including health choices (Glanz et al. 2008). Specifically within Singapore, Chang et al. found that Chinese

Singaporean women cited their spouses, parents, and peers as key ongoing influences in their health decisions (Chang et al. 2014). The particular impact of familial influence was seen in "Family" being the most reported recommender for saiga product self-usage among our respondents. In addition to recent direct recommendation of a given health product to a respondent, 'recommendation' could well have occurred in a broad sense many years prior, particularly during a respondent's childhood. The effect of caregiver health decisions and opinions has been shown repeatedly to impact child health choices in areas like vaccination records (Trim et al. 2012), and cold medication use (Lokker et al. 2009), with many of these influences stretching through adulthood, as exemplified in food pallet conditioning (Cooke 2007; Singh et al. 2008), and alcohol use (Ryan et al. 2010). The second most-reported recommender, a "TCM shopkeeper", is likely to be due to saiga products being most often purchased in TCM shops, where consumers frequently seek the advice of the shopkeeper (Tan & Freathy 2011), similar to a biomedical pharmacist (Taher et al. 2012). The use of pharmacies for delivering public health interventions is well documented and could provide good insights into possible saiga interventions utilising TCM shopkeepers' influence (Brown et al. 2016).

"It works" was the most common reason for using saiga products among our respondents. This perception of efficacy could be due to many factors, such as an individual's personal past experience of using saiga products, a restatement of effects communicated to them by others, the observation of others using it with positive results, or possibly some combination of these factors. It is therefore likely that the top two answers given by respondents as to why they use saiga are highly intertwined, and disentangling them will require further research.

It was interesting to note the difference between saiga users and non-users in their perception of wildlife commonness. Whether perception leads to usage, or usage is justified by perception, or an entirely

different cause affects both variables, is unknown. For instance, it is possible TCM consumers are used to seeing these products in stores and therefore are more likely to perceive the animals as common. Additional work to elucidate perceptions of commonness is important in order to develop effective messaging for reduction of demand for species perceived as common but which are actually threatened.

2.5.3 Future Research Implications

Our survey was conservative in that it asked respondents about their most commonly used products, so we feel confident that *high-fidelity saiga users* compose 19% of the sample, and that overall saiga product use (including lower fidelity users) is higher. Given our findings, it may be possible that a similar proportion of the 2.9 million Chinese Singaporean residents buy or use saiga products frequently for themselves or others (DoS Singapore 2017). There are likely also saiga product users among the many non-resident Chinese living in Singapore, and among non-Chinese Singaporeans. This figure cannot be easily translated into a number of horns (or animals used) per year, however, because the amount of horn per dose is not known. This amount is likely to be relatively small, but varies between product types and even between stores which prepare their own products. Some products marketed as saiga/antelope do not contain any saiga horn, though the degree to which this occurs is also not verified. Saiga horn use in Singapore is nonetheless extensive, and non-negligible. This study paves the way for a grounded behavioural change intervention with a clear target audience and focus. We further hope that this work gives useful guidance on research approaches for understanding the use of saiga products in other countries, as well as for other unsustainably traded species that are perceived as commonplace by consumers

2.6 Acknowledgements

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2.7 Supplementary Materials

[Appendix 2.1](#) Consumer Survey (*separate file*)

[Appendix 2.2](#) Survey Size Power Calculation

[Appendix 2.3](#) Survey Locations

[Appendix 2.4](#) Raw Data (*separate file*)

[Appendix 2.5](#) Buyers of Any Treatment

Chapter 3 A conceptual and actionable understanding

3.1 Abstract

Efforts to shift unsustainable human behaviour are at the crux of many conservation interventions, particularly when addressing illegal or unsustainable wildlife trade. These efforts, often in the form of behaviour change interventions, have yet to counteract this pervasive issue, however, leading to calls for more robust intervention designs. In behavioural science fields like public health, design processes that integrate human behaviour theory and evidence from data collection are often developed to ground behaviour change interventions within a strong understanding of the context, thus supporting interventions that are efficient and have a higher likelihood of success. Here, we detail the foundational process of designing an intervention on Singaporean consumers of saiga horn. We employ both qualitative and quantitative data, along with human behaviour theories and past literature on the study system, to develop a comprehensive understanding of the many influences driving this target audience to purchase saiga horn products. We use this insight to identify the key influences to leverage in a behaviour change intervention: those that are both the most powerful and the most amenable to change. This work highlights the often complex intricacies of socially-influenced behaviour, and demonstrates why a methodical understanding of these intricacies is invaluable when attempting to shift human behaviour for conservation goals.

3.2 Introduction

When shifting demand for unsustainable wildlife products, individual consumers are an important group to address because successful behaviour change often requires not just regulatory change, but a public mindset supporting the desired behaviour (Heberlein 2012). This could be particularly true for reducing purchases of high value items or those with ingrained usage among a population (e.g. those associated with longstanding traditions), which includes some wildlife products. Consumer behaviour can be shifted via interventions at the level of individual consumers, industry actors, or policy itself (whether national or international), and some argue that using behavioural science directly to inform policy is more effective than using it to ‘nudge’ individuals (Ewert 2019). However, attempting to implement regulatory change, or influence an industry or supply-chain, may not be realistic in a wildlife trade landscape, especially given the time-sensitive nature of threats to some species. It is therefore important to be able to directly shift consumer behaviour regardless of other factors, recognizing that any attempt to shift individuals’ behaviour risks both accusations of exerting paternalism over others’ lives (Leggett 2014) and unintended consequences – especially when consumer research and behavioural theory are lacking. Thus, behaviour change efforts should be implemented cautiously, with careful thought about their potential negative impacts on target groups (Häußermann 2020).

Wildlife trade demand reduction interventions have historically had shortcomings in their design and assessment (Veríssimo & Wan 2019), and often make limited use of the extensive literature around human behaviour and behaviour change (Greenfield & Veríssimo 2018). In public health, where behaviour change interventions have been extensively implemented, it is argued that for interventions to be effective, they must be based on: an understanding of the intervention’s context, a theory of change delineating assumptions and their supporting evidence, and pilot testing for feasibility and acceptability (Melnyk & Morrison-Beedy 2018). These elements of effective interventions can be achieved through

reviewing relevant published literature, collecting meticulous data, and applying health behaviour-related theory (MRC & NIHR 2019). Interventions which are based on both theory and evidence are generally recognized as having a higher likelihood of success (Fernandez et al. 2019).

The intervention design process serves to pull together varying theoretical and evidence-based pieces in a coherent way. This gives a more complete insight into the target behaviour and audience, allowing implementers to discern which factors are the most effective and feasible for them to trial in an intervention (Melnyk & Morrison-Beedy 2018).

Here we lay out the foundational process underpinning the design of a country-level intervention to influence the behaviour of saiga horn consumers in Singapore. Stepping through this process, we highlight various theory, literature, and evidence inputs that were used, and tie together these components to identify the influences on the target audience that could be leveraged in an intervention. Finally, we reflect on the process of designing a wildlife trade behaviour change intervention, and the broader applicability of our approach to conservation.

3.3 Design Process Overview

Upon selecting the study system of saiga horn in Singapore, we conducted detailed consumer research to gather new data on this system (process outlined in Figure 3.1). This data was used to determine whether targeting individuals' saiga horn consumption through a behaviour change intervention was feasible and well-placed. We then used this empirical evidence, along with existing evidence from the literature, to select a target audience. With the target audience in mind, we compared broader human behaviour theories for their ability to explain the influences affecting our target audience. Next, we looked for health

behaviour concepts that would be directly relevant to our target audience’s cultural context. Using all this new data, existing evidence, and selected theories, we identified and collated the influences on our target audience’s saiga horn usage. To underpin our understanding of these influences, we explored in detail how they related to the chosen broader theoretical model and its related concepts. With this newfound insight, we identified which of these influences were feasible to employ in a tailored behaviour change intervention, and how we might leverage them.

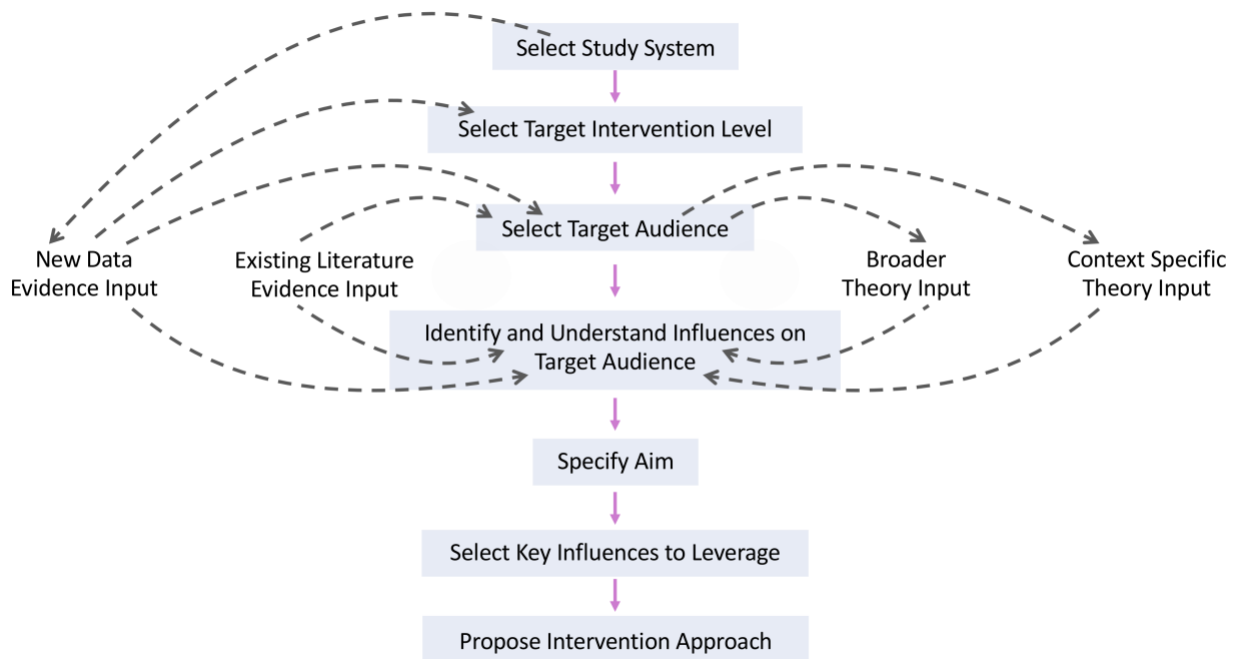


Figure 3.1 Foundational design process used to underpin a behaviour change intervention approach. The diagram includes the steps taken once the study system has been selected (grey boxes with purple arrows), and where evidence and theory inputs were used (unshaded text with dashed arrows).

Inputs

The new data used to determine the intervention level and target audience was in-person consumer surveys with Chinese Singaporean members of the public conducted by Chinese Singaporean researchers and presented in Chapter 2. The new data used for identifying and understanding the influences on the

target audience's behaviour included both these quantitative surveys and 10 in-depth qualitative consumer focus groups also conducted by a Chinese Singaporean (Appendix 3.1). Forty-three individuals participated in our focus groups, though in order to analyse women's preferences and behaviours (which ended up being our focus), we excluded the results for the four male participants. The remaining 39 participants were all Chinese Singaporean women aged 18-70+ years old; 26 of whom had either used saiga horn before or currently used it. The original gender imbalance of the groups was not intentional. For Appendix 3.1 for more focus group methods and findings.

The broader human behaviour theories assessed for this work were identified via a methodical search of the literature relevant to health and pro-environmental behaviours. We also searched literature on the specific context and behaviours of our target audience in order to find directly useful theoretical concepts and applicable existing evidence.

3.4 Overarching Conceptual Components

3.4.1 Target Intervention Level

We felt it was not feasible for our intervention to involve policy change. This was because we were primarily non-Singaporean researchers who thus had little influence with Singaporean policy-makers, and shifting policy can be lengthy and unpredictable. In addition, since saiga horn is legal and common in Singapore, we did not see a readily evident angle for an industry-level intervention. We felt, though, that a behaviour change intervention at the consumer level was well placed because: Singapore is a spatially discrete and relatively small area, despite its large population; and unlike many wildlife trade study systems (e.g. rhino horn in Vietnam) (Olmedo et al. 2017), at the time of intervention development there were no other saiga horn interventions being implemented in Singapore or elsewhere in Southeast or East

Asia, which might confound our evaluation. Nor were there relevant national or international policy changes ongoing or anticipated. Lastly, our consumer surveys showed that saiga horn users were already purchasing alternative products to treat fever and heatiness (Chapter 2), and thus might be open to shifting more to these options. With these factors in mind, we felt targeting individual consumers' health product purchasing behaviour, as a way to reduce saiga horn purchases, was an appropriate intervention for this study system.

3.4.2 Target Audience

Attempting to target all saiga horn users in a single intervention with limited resources was not desirable because audience segmentation and message tailoring are known to increase the likelihood of intervention success (Greenfield & Veríssimo 2018). We therefore sought to identify a target audience that was among the largest saiga horn consumers, potentially had strong influencing power over *others'* saiga horn consumption, and was feasible to target. Clear trends from the consumer surveys and existing literature suggested the target audience: female, middle-aged (36-59 years old) Chinese Singaporeans.

Middle-aged Chinese Singaporeans were the largest saiga horn user group (40%), and females of this age were the most likely to buy saiga horn for other people (Chapter 2). Past research found that Singaporean wives made more decisions than their husbands about over-the-counter medication for their families (Xia et al. 2006). However, adults are often viewed as 'set in their ways'; as such, conservationists often champion efforts targeting youth (Ngusaru 2016). The rationale for this is that younger age-groups haven't yet begun, or made habitual, a given undesirable behaviour, and thus may be more persuadable. But with the ageing of developed nation populations, and the power of leveraging 'opinion leaders' whose decisions influence others (de Lange et al. 2019), it is crucial that conservationists do find effective

measures to engage with and elicit change in non-youth, highly influential, generations. This is particularly true when impacts on species are time-sensitive.

3.4.3 Broader Behavioural Theories – Social Cognitive Theory

Many factors contribute to an individual's health treatment decisions. Some are more apparent, such as their ability to afford a treatment. Others are less obvious, like their parents' health decisions. Some speak to larger social, religious, and cultural norms surrounding an individual (Evans et al. 2001). All these influences play a part, to varying degrees, in determining how an individual treats a condition such as heatiness. Fields like public health and psychology propose many theories (Glanz et al. 2015), as well as a number of frameworks (Michie et al. 2011), for how to best determine (and change) an individual's behaviour based on these influences.

Having analysed the consumer survey and focus group results, we reviewed the literature to identify human behaviour theories that would be most useful in: explaining our observed findings, filling gaps in our understanding, and ultimately helping us form a cohesive and structured narrative as to which influences led our target audience to using saiga horn. We selected a subset of well-evidenced theories that seemed most useful in understanding a health behaviour with conservation impacts (Table 3.1). These included the Health Belief Model, Transtheoretical Model, Integrated Behavioural Model, Model of Pro-Environmental Behaviour, Value Belief Norm Theory, and Social Cognitive Theory (SCT) (Davis et al. 2015). Each of these theories approach human behaviour in a different way, and provide different insights into our study system (Table 3.1). Comparing the merits and limitations of these theories for our purposes, we decided SCT provided insights that would be especially helpful in developing our intervention.

Table 3.1 Comparing a subset of human behaviour theories from public health and social psychology for their applicability to understanding our target audience's saiga horn usage.

	Overview	Study System Specific:		Example of Use
		Merits in Use	Limitations in Use	
Social Cognitive Theory (SCT) (Glanz et al. 2015) (see text for more details)	An individual's behaviour is an interactive processed response to 1) personal factors (e.g. cognition), and 2) their perception of environmental factors (both physical and social); behaviour in turn affects these factors. Highlights social learning as a critical influence.	Emphasizes social influences while still highlighting an individual's interaction with these factors based on internal reasoning and desires for personal agency – all of which are highly relevant to our study system.	Some components of the SCT that may be of interest to us are less directly operational or have not been tested in a wide range of contexts (such as for wildlife trade products).	Improving cancer patients' quality of life: intervention review (Graves 2003)
Integrated Behavioural Model (including Theory of Reasoned Action/Planned Behaviour) (Darnton 2008; Glanz et al. 2015)	Behaviour is most determined by an individual's intention, and intention is formed from attitudes, perceived social norms, and personal efficacy. Inhibition of behaviour is due to barrier factors.	Easy to operationalise and previously used to address a wide range of behaviours. It also highlights perceived social norms, along with personal attitudes, which appear to be large influences on our target audience.	Compared to the interactive perspective of SCT, this model is less detailed in how social-level or cultural factors, interactions with others, and gained information, all interplay to result in a given behaviour. And these factors are likely important in our study system.	Increasing cervical cancer screening in the Netherlands (Knops-Dullens et al. 2007)
Health Belief Model (Glanz et al. 2015)	Predicting pro-health behaviour based on an individual's perceived 1) risk of not performing the behaviour, 2) mitigation of risk by performing the behaviour, and 3) ability and confidence in performing the behaviour.	A straightforward and operational theory with many examples of its use.	Most used for encouraging preventative health behaviours where the personal consequence of not performing the behaviour is easily comprehensible and high. There is, however, no easily argued strong personal consequence related to saiga horn use.	Understanding condom use in Kenya (Volk & Koopman 2001)
Transtheoretical Model (Glanz et al. 2015)	An individual's 'readiness' to change a certain health behaviour is dependent on which of five stages they are on along a behaviour change process. Thus, the model calls for 'stage-specific' interventions.	Can identify which individuals are 'ready' to change, and target the intervention accordingly. Such as saiga horn users who always use saiga horn and who know but do not care about the impact on wild populations, versus those who	Helpful for countering behaviours where there are clear gradients in frequency of use, and willingness to change. However, gradients in use (given the data we had) were less definitive (e.g. all saiga horn users were significantly likely to also use herbal products, and FGs did not	Review of smoking cessation interventions (Aveyard et al. 2009)

		<p>may use saiga horn or other treatments and who do not know (but may care) about the conservation impact. Further, the model is useful for habitual behaviours, and though saiga horn use is inherently not particularly frequent it is arguably 'habitual' in that it is based on long-standing patterns of use.</p>	<p>suggest who in the group might be willing to change based on conservation impact).</p>	
<p>Value Belief Norm Theory (Stern et al. 1999)</p>	<p>An individual will engage in pro-environmental behaviour when their <i>personal</i> norms are activated, i.e. when they feel 1) that not performing the behaviour will result in adverse consequences for things they value, and 2) they hold significant responsibility in preventing these consequences.</p>	<p>Aimed at eliciting pro-environmental behaviour, and not using saiga horn could be framed as a pro-environmental choice.</p>	<p>Best used when the consequences of not performing the pro-environmental behaviour can be shown to negatively impact something the individual strongly values like their air quality. Saiga populations, though, are far removed from our target audience, and thus difficult to link to personal consequence.</p>	<p>Predicting pro-environmental behaviour in Taiwan (Chen et al. 2015)</p>
<p>Model of Pro-Environmental Behaviour (Kollmuss & Agyeman 2002)</p>	<p>An individual is most likely to perform a pro-environmental behaviour when internal factors (like knowledge and values) align with external factors (like political structure), and there are not strong opposing habitual patterns in place.</p>	<p>Aimed at eliciting pro-environmental behaviour, and not using saiga horn could be framed as a pro-environmental choice. Attempts to incorporate factors of many models, including the Value Belief Norm Theory.</p>	<p>Saiga horn usage appears most based on reasoning around personal health, and so it would be limiting to posit it solely as a pro-environmental/non-environmental (altruistic) behaviour. Saiga horn use also appears habitual in nature, in that it is based on long-standing patterns of use, which is the largest 'barrier' in this model. This is also a younger theory with less direct application to interventions.</p>	<p>Understanding pro-environmental behaviour of park visitors in Canada (Halpenny 2010)</p>

The SCT is widely used as a foundation for behaviour change interventions, counselling, and education (Glanz et al. 2008). For example, it has been used to assess climate change perceptions (Devine-Wright et al. 2004), and influence energy saving choices (Cornelius et al. 2014) and sustainable product purchases (Schutte & Bhullar 2017). A core SCT principle is the 'triadic reciprocity' (i.e. triple interaction) between person (e.g. cognition), behaviour, and environment (both physical and social; Figure 3.2) (Bandura 1978). SCT argues these vertices are inherently linked. SCT is of particular interest to our study system where the target audience is highly integrated into their social setting yet still strives to exert personal control over their life and health behaviour.

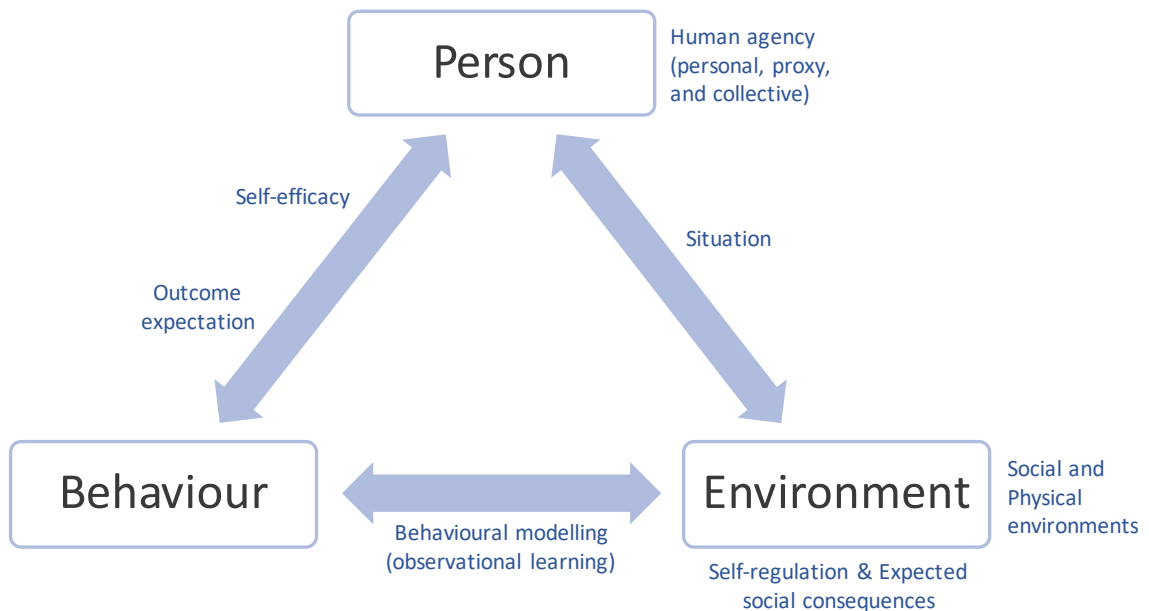


Figure 3.2 SCT triadic reciprocity. Adapted from Bandura (1978) to include additional SCT concepts relevant to our study system and discussed in proceeding sections.

3.4.4 Understanding the Context – Medical Pluralism

When attempting to understand behaviour, it is critical to use a lens relevant to the individual's culture, age, or gender (Quah 1985; Airhihenbuwa 2007). There is little information on broader human behaviour theories employed to understand the health choices of Chinese Singaporean women. The few studies that do target (or heavily involve) this audience, are focused on women-centred health and sex practices (Wong et al. 1995; Straughan & Seow 2000). However, there is highly applicable medical anthropology literature discussing medical pluralism: i.e. instances where individuals are deciding between multiple coexisting medical systems (Shih 2008). In such instances, individuals must weigh their desire to be healthy with their perceived understanding of the different medical systems, and personal, social, or cultural factors (Cant 1999). Our study system is characterised by a medically pluralistic choice between biomedical and traditional medical options (Hong 2001; Shih 2008): Singapore is simultaneously home to an extensive biomedical infrastructure, and a thriving TCM community (MoH Singapore 2012).

A study on medical pluralism among elderly Chinese Singaporean women found participants exerted strong personal agency over their choice to use biomedical or traditional medicine, and this choice was highly situational, depending on the ailment and severity (Chang & Basnyat 2014). Past research has found 95% of Singaporean participants who used non-biomedical treatments (mainly TCM) also used biomedicine (Lim et al. 2005). Singaporean patients generally prefer traditional treatments when looking for overall improvement of health and wellbeing, or for minor ailments (Loh 2009; Tan & Freathy 2011). Chang and Basnyat (2014) also found that to retain personal agency and avoid criticism, their female Chinese Singaporean participants withheld their full medical decisions from professionals in either medical system. This caused participants to depend heavily on self-diagnosis and personal opinion when treating themselves and their family. This observation is supported by other research (Lim et al. 2005).

3.4.5 Influences on the Target Audience

Using our consumer research data, existing literature, and insights from SCT and medical pluralism, along with general knowledge about the target audience, we identified the influences most likely to be affecting our target audience's saiga horn usage (Figure 3.3). We then detailed the evidence for these influences, whether they were supported by SCT and medical pluralism, and whether we felt they were feasible and wise to employ in a behaviour change intervention given the evidence and theoretical backing (Appendix 3.2). For example, past influences (such as experiences they had of being given saiga horn as a child) are likely to be quite strong for many individuals (see following section). However, it was not realistic, or arguably appropriate, in our intervention to contradict these longstanding personal influences, therefore we chose not to pursue this influence. It should be noted that every audience is heterogeneous and these influences have varying applicability to individuals within the target audience.

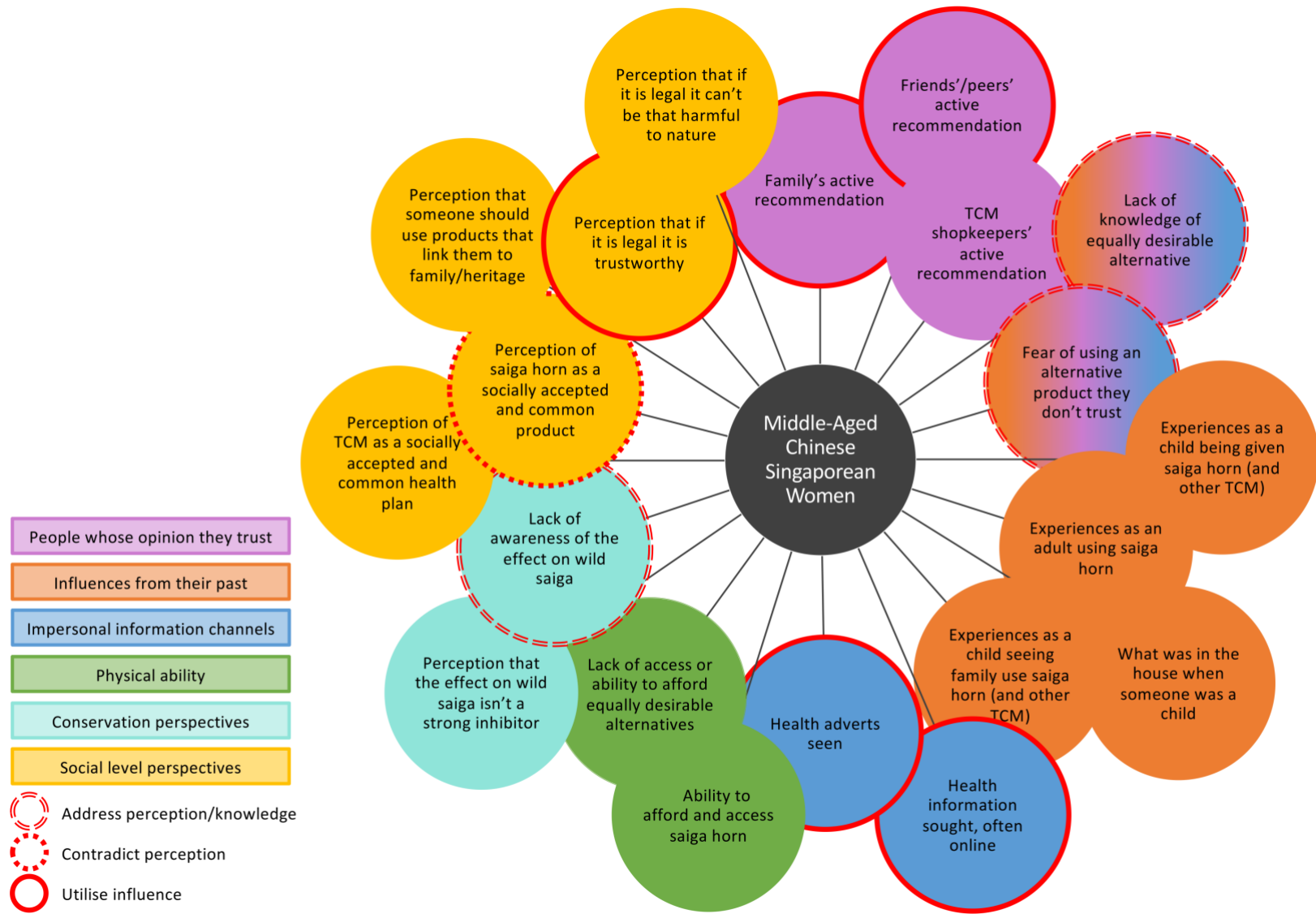


Figure 3.3 Potential influences around the target audience's saiga horn usage. We designate the decision about whether and how to address an influence in an intervention by the red outline of the circle. Selections were based on the evidence and theoretical backing (discussed in the following section), and thus whether we felt an influence was feasible and wise to employ (Appendix 3.2).

3.5 Contextualisation of Target Audience Influences

To more deeply understand the influences surrounding the target audience's saiga horn usage, we viewed them in the combined context of evidence and theory. The triadic reciprocity in SCT (Figure 3.2) aims to encapsulate every factor affecting an individual from birth onwards, and from physiological through to societal levels (Glanz et al. 2008). Here we discuss the axes of this SCT triangle, along with additional SCT principles, and how they relate to the evidence that we collected, medical pluralism literature, and additional existing evidence. This discussion highlights identified influences most related to these SCT concepts (Figure 3.3).

3.5.1 Person – Human Agency

Human agency according to Bandura is the active sentient thought enabling humans the intentionality and choice to act (Figure 3.2, top apex) (Bandura 2001). SCT defines three modes of agency (personal, proxy, and collective) that humans employ to feel they are in control of their actions and the subsequent outcomes.

Personal Agency

Personal agency is the personal thought processes of an individual that result in their actions (Bandura 2001). Modern preventative healthcare fosters personal agency and encourages individuals to exert it over their health (Bandura 1997a; Morahan-Martin 2004). Women, including our target audience, are particularly likely to exhibit personal agency by seeking out health information for themselves and their family (Yan 2010; Chang & Basnyat 2014). Our identified influences on the target audience relating to personal agency are: *Impersonal information channels*, and *People whose opinion they trust* (Figure 3.3).

Singaporean women actively and passively get health information through impersonal channels (Lim et al. 2011; Tang & Lee 2013). In a past study, Singaporeans preferred the internet and mass media, second only to doctors, as their health information source. 93% of individuals seeking health information online acted on that information (Siow et al. 2003). A study of Singaporean women found that, for health information, women aged 20-39 years old used the internet more than friends and family; and women aged 40-59 years old used the internet about the same as friends and family (Chang et al. 2017). In our focus groups, participants commented on health adverts they had seen, and often stated that they used the internet for health information (Appendix 3.1).

Interpersonal networks are also a highly important information source for our target audience. Elderly Chinese women in past research cited their spouses, parents, and peers as key health influences (Chang et al. 2014). Friends and family are a top information channel for Singaporean women of all adult ages (Chang et al. 2017). Another study found young-adult Chinese Singaporean women commonly gained health information from social networks (Basnyat & Lim 2017). Our consumer surveys found similar results: "someone recommended it to me" was the second most cited reason for saiga horn usage, with family and TCM shopkeepers being the most common recommenders (Chapter 2). This was echoed in our focus groups with participants noting family, peers, and fellow church-goers as individuals they asked for health advice (Appendix 3.1).

Proxy Agency

A proxy agent is someone whom an individual enlists in order to work on their behalf, or to help the individual perform or manage a necessary task (Bandura 2001). These people are trusted to act for, or with, the individual who may not have the time or ability to directly manage every aspect of life themselves. Proxy agents relate to the influences on our target audience through *People whose opinion*

they trust (Figure 3.3). Our target audience may not only actively listen to certain others, but allow that input to *heavily determine* their ultimate health choice. For example, Chang et al. (2014) found some elderly Chinese Singaporean women 'based' their health decisions on their husbands, or 'automatically trusted' friends. Another study with younger Singaporean women found they 'based' their vaccination decisions on validation from, and a sense of belonging to, their peer group (Basnyat & Lim 2017). In addition to our survey respondents who cited recommendations from others as their *reason* for using saiga horn (Chapter 2), many of our focus group participants mentioned *automatically following* the advice of family or friends (Appendix 3.1).

Collective Agency

Collective agency is community- or government-level bodies that an individual entrusts to act responsibly, or make appropriate decisions, on their behalf (e.g. government-mandated toxic ingredient labels). Collective agency relates to some target audience influences under *Social level perspectives* (Figure 3.3). Reliance on a collective agent would seem common in a country like Singapore, where government is perceived as heavily involved in citizens' lives. However, this agency is not often cited in Singapore health information literature. One study, though, highlights the strong trust that Singaporeans have in government-approved health information and products, including information garnered from Singaporean newspapers, which are government regulated (Tang & Lee 2013). Such insights might imply that for some target audience individuals, the legality of a health product, such as saiga horn, implicitly validates its effectiveness (or maybe even implies that it is ecologically sustainable). The former was anecdotally mentioned to us during our consumer research but not directly discussed during focus groups or consumer surveys.

3.5.2 Environment

Social & Physical Environment and Behavioural Modelling

In SCT, an individual's social and physical environment is composed of current and past surroundings (Figure 3.2, lower right-hand apex). It is likely that behavioural modelling (observational/social learning) has occurred during past experiences, such as an individual's home life as a child (Glanz et al. 2002). Bandura argues this learning involves individuals distilling observed 'rules' and then acting upon these rules in future instances (Bandura 1999).

Such concepts tie in with family influence literature repeatedly showing the home environment (particularly through caregivers), impacts multiple facets of children's health, including their medication use for minor ailments (Lokker et al. 2009). This effect can be caused directly via items adults give to children or have in the home (e.g. cough treatments (Paul et al. 2007)). But it can also result from adults' subconscious modelling of their own behaviour to children, which the children then resemble when they are adults (e.g. alcohol use (Ryan et al. 2010)). These effects can last long into adulthood. For example, due to psychological (and palate) conditioning, individuals often prefer foods they were served as a child (Singh et al. 2008). Marketing research also highlights that individuals prefer brands they know and trust (Park et al. 2016). Our identification of *Influences from their past* relates to these environmental impacts on our target audience (Figure 3.3).

A study with elderly Chinese Singaporean women found childhood memories of using TCM with family members, along with how they were taught to understand health, not only caused them to feel a current attachment to TCM, but shaped the lens through which they viewed biomedical health theories and treatments (Chang & Basnyat 2014). This melding of highly differing views from an individual's childhood and current experiences, is the foundation of medically pluralistic decision-making. Our focus group

participants similarly recounted experiences of seeing their family use TCM when responding to questions about their *own* health preferences, or a treatment's efficacy (Appendix 3.1). They also commonly cited experiences of being given saiga horn by their family.

Social Situation

In SCT, an individual's social 'situation' is their *perception* of the social environment in which they live (Figure 3.2, right-side arrow) (Glanz et al. 2002). Social norms are perceived socially appropriate behaviours and ways of thinking within this social situation (Heberlein 2012). These perceptions are based on direct interpersonal networks and past experiences, and views of society through indirect channels like social media, news outlets, and television (Bandura 1999). According to Bandura, personal behaviour is influenced by perceived social norms via expected social consequences from acting out-of-sync with these norms, and self-regulation due to an internalisation of socially acceptable behaviour (Figure 3.2, lower left-hand apex) (Bandura 1997b). Using this logic, efforts to alter behaviour could alter an individual's social situation (since it is only perceived), and this in turn will shift their behaviour as they respond to their 'new' situation. Our target audience's social situation is represented in Figure 3.3 as *Social level perspectives*.

Such perspectives were evidenced in focus group comments regarding the general use of TCM and saiga horn (Appendix 3.1). Not surprisingly, participants often felt a 'normal' behavioural choice (e.g. whether other mothers use biomedicine) aligned with their or their network's behaviour. Nonetheless, regardless of their own personal preferences, participants often commented that TCM is popular in Singapore and is a whole-body, safer, nourishing, or natural approach. Most participants used non-biomedical approaches, including TCM, in some capacity in their lives, and their preference appeared heavily context-specific; which is in line with medical pluralism literature (Chang & Basnyat 2014). Further, it was almost a source

of pride among participants that Singapore *does* straddle these two medical systems, for it gives residents the opportunity to choose between them and change that choice easily. Social level perspectives regarding saiga horn were that it is a common product (Appendix 3.1). Even participants who didn't state they currently preferred saiga horn would often state they had used it before, knew of someone who currently uses it, or had heard of it as a product used by Singaporeans.

3.5.3 Behaviour

Triadic Reciprocity and Outcome Expectation

SCT's triadic reciprocity suggests behaviour is a processed response to inputs from one's perceived environment and past behaviours (Figure 3.2, lower left-hand apex). Due to this internal processing, an individual *expects* a certain outcome regarding a behaviour, and if they feel they can adequately carry out that behaviour (i.e. they have self-efficacy), then they will perform the behaviour (Figure 3.2, left-hand arrow) (Bandura 1997b). In our study system the amalgamation of multiple influences (*People whose opinion they trust, Influences from their past, Impersonal information channels, and Social level perspectives*; Figure 3.3), results in an internal *expectation* regarding the efficacy of saiga horn, which individuals then act upon. This internal expectation is often the reason given by an individual when asked why they use saiga horn; which explains why "It works" was the most commonly reported reason for using saiga horn (Chapter 2), and why this answer is deceptively multifaceted.

3.6 Populating the Design Process

Saiga horn use by our target audience exists in a complex context in which all influences are interlinked to some degree, and together result in the action of using saiga horn. Given the power and practicability of leveraging various influences (Figure 3.3; Appendix 3.2), along with the insight gained into how each

influence affects the target audience, we hypothesised we could shift the behaviour of saiga horn users in our target audience by attempting to subvert perceived saiga horn usage at the societal level (i.e. their perception of saiga horn as a *socially accepted* and common product; Figure 3.4). We hypothesised we could accomplish this by strategically employing facets of:

- their family and friends' active recommendations;
- health adverts they see, or health information they seek, often online;
- their perception that if it is legal it is trustworthy (e.g. through news outlets);
- their lack of awareness of the effect on wild saiga;
- and their lack of knowledge of, or their fear of, alternative products.

The overall aim of this approach was to decrease the target audience's desire to buy saiga horn products, while increasing their awareness of and desire for alternative products, such that current saiga horn users would select alternative products.

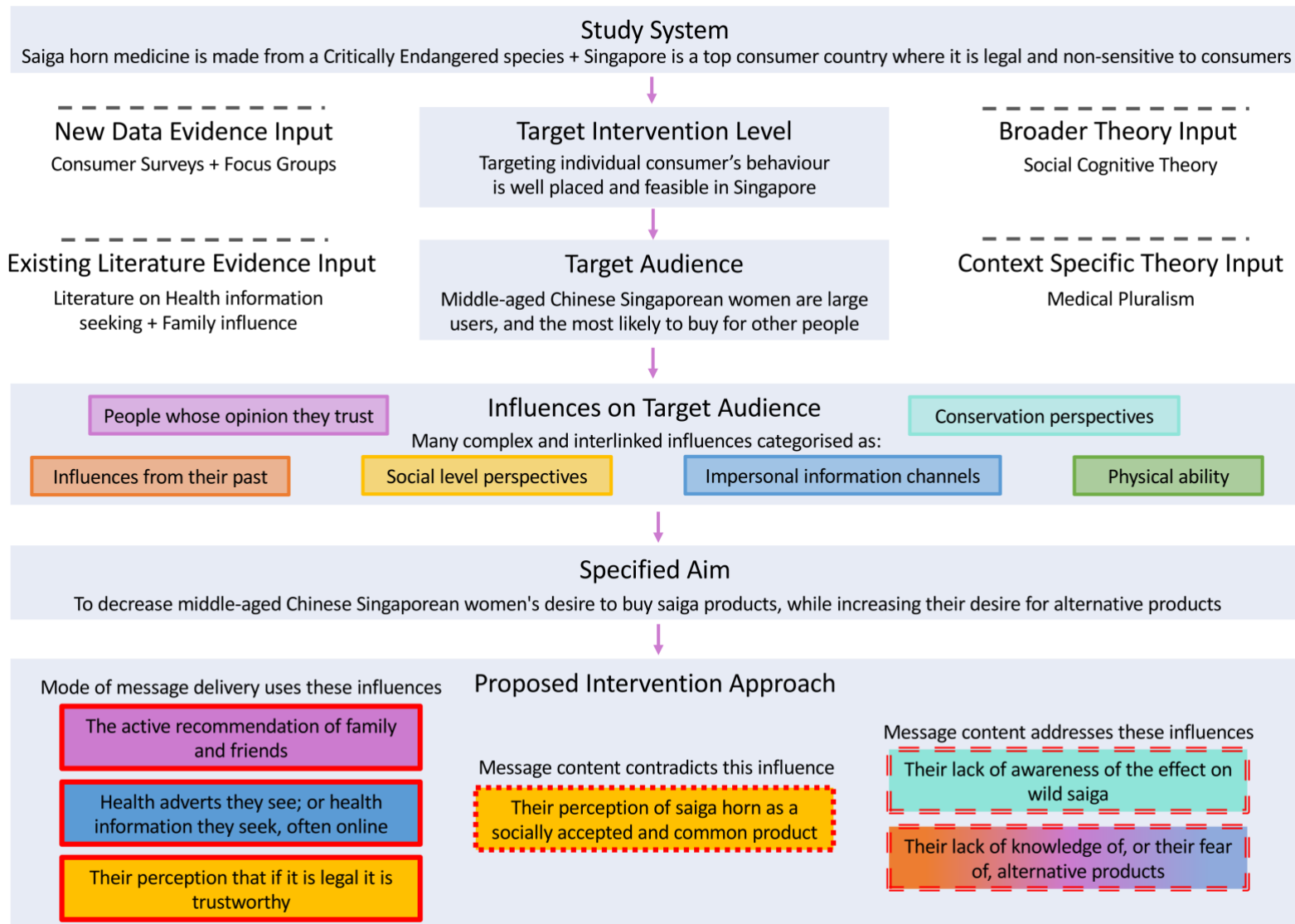


Figure 3.4 Populated intervention design process for understanding and influencing saiga horn usage among Chinese Singaporean women aged 35-59 years old. The red borders in the Proposed Intervention Approach box denote: use influence (solid), contradict perception (dotted), and address perception/knowledge (double-dashed).

3.7 Conclusion

Conservation interventions and management decisions are developed and evaluated via a range of approaches, including decision support frameworks like Structured Decision Making and Systematic Conservation Planning (Young & Van Aarde 2011; Schwartz et al. 2018; Adams et al. 2019). Conservation organisations also use tools such as Miradi (Miradi 2007) to design and evaluate interventions. However, these frameworks and tools usually do not directly incorporate human behaviour theory or structured ways to deeply address and harness the often complex social environments within which conservation projects operate (Schwartz et al. 2018). Calls have regularly been made for wider use of theories or models which address social-level behaviour within intervention design (de Lange et al. 2019; Travers et al. 2019).

In addition, the foundation for conservation actions, including wildlife trade behaviour change interventions, is often built upon the experiences and expertise of practitioners on the ground, or on previous research conducted by them or others (Cook et al. 2010; Young & Van Aarde 2011; Greenfield & Veríssimo 2018). This first-hand knowledge is especially useful in designing interventions, however on its own it lacks the deep and broad conceptual understanding of a system that is gained from using human behaviour theory coupled with robust primary research. Thus, employing such theory and data inputs alongside practice-based knowledge would broaden intervention options, give a better predictive understanding of outcomes, and increase an intervention's likelihood of achieving its conservation aims.

Through this work we learned that to fully benefit from both theory and evidence we had to embrace the iterative nature of gaining an understanding of a study system. For instance, we used Social Cognitive Theory to help explain our many empirical findings, and in doing so we found ourselves going back to various bodies of literature in order to gain further insight into specific

concepts that we realised were most applicable to our target audience and behaviour. Thus, the ‘identifying and understanding influences’ stage (Figure 1), took a concerted effort and significant time. However, this investment was worth it, as the foundational intervention design process discussed in this manuscript led us to an intervention approach we would not have otherwise selected. For example, without new data, we would be limited to prior exploratory findings that suggested young people were primary consumers (Theng et al. 2017). Similarly, by combining our data and the available literature we realised that middle-aged women, instead of older audiences, are the primary individuals influencing others’ saiga horn use. Finally, without SCT, medical pluralism, and existing literature insights, we would not have understood the intricate influences surrounding our target audience, nor have known that leveraging our audience’s social-level *perception* of saiga horn acceptance via other influences (e.g. their trust of news articles) was a feasible and highly *appropriate tactic* for addressing our target audience and behaviour.

Using the intervention approach developed through the design process in this text, we carried out the next steps in the intervention: 1) identifying applicable behaviour change techniques; 2) conducting thorough testing of selected technique components (Chapter 4); and 3) implementing and evaluating the intervention (Chapters 4 and 5). These steps enabled us to assess whether the assumptions we had made about these influences on our target audience held, and whether the intervention based on these assumptions did in fact induce the desired change.

In summary, the discussed process gave us an actionable understanding of our study system that we would have otherwise been missing. Thus, stepping through this foundational design process may prove beneficial to others wishing to carry out behaviour change interventions within a wildlife trade context, or more broadly across conservation.

3.8 Acknowledgements

Focus groups were conducted by R Tan. This research was funded by the Oxford Martin Programme on the Illegal Wildlife Trade at the University of Oxford.

3.9 Supplementary Materials

[Appendix 3.1](#) Consumer Focus Groups

[Appendix 3.2](#) Target Audience Influences

Chapter 4 Intervening on saiga horn usage

4.1 Abstract

Changing human behaviour is essential for biodiversity conservation, but robust approaches for large scale change are needed. Concepts like repeat message exposure and social reinforcement, and mechanisms like online news coverage and targeted advertisements, are currently used by private and public sectors, and could prove powerful for conservation. Thus, to explore their potential in influencing wildlife consumption, we used online advertisements through Facebook, Google, and Outbrain, to promote news articles discussing the use of saiga horn as a traditional Chinese medicine in Singapore. Our message, tailored to middle-aged Chinese Singaporean women, framed saiga horn products as being no longer socially endorsed. Through advert performance and in-depth analyses of Facebook user engagement, we assessed audience response. Our message pervaded Singapore's online media (e.g. our adverts were shown almost five million times; and the story ran on seven news outlets), and resulted in widespread desirable audience responses (e.g. 63% of Facebook users' engagements included identifiably positive features like calls for public action to reduce saiga horn consumption, anger at having unknowingly used a Critically Endangered species, and self-pledges to no longer use it; only 13% of engagements included identifiably negative features). This work shows that targeted dissemination of online news articles can have promising results, and may have wide applicability to conservation.

4.2 Introduction

The global expansion of the internet has rapidly made it an integral part of communication at personal and societal levels. It offers unmatched channels to disseminate ideas and information.

Some online mechanisms have been used for social good via public health and social marketing interventions targeting individuals' behaviour (Clarke et al. 2015; Krzysztof Kubacki et al. 2015), however, few have been strategically employed to promote behaviour change for biodiversity conservation.

Online profiling and targeted advertising underpin the business model of most large online platforms (Wu 2016). Paid advertising is offered on most platforms like social media, search engines, and websites; and the platforms' ability to identify and present relevant advertising to consumers on the basis of demographic and behavioural factors (Berghel 2018) could be used to identify groups likely to perform undesirable conservation behaviours, and directly target messages accordingly. Non-paid content (i.e. 'organic content') includes user-created social media posts, blog posts, and newspaper articles, which can be similarly used to strategically influence audiences. For instance, the effect of news coverage on political opinion and voting behaviour is well studied (Reeves et al. 2016), and has been shown to affect awareness and behaviour in health and climate change (Weeks et al. 2012; Maxwell Boykoff et al. 2015).

4.1.1 Idea Adoption

Which ideas people pay attention to, remember, and adopt depends on a number of factors. For example, ideas that are framed to better align with strongly held beliefs and attitudes are more likely to be adopted (Heberlein 2012); and idea framing that employs social norm structures can also increase idea adoption (Farrow et al. 2017). Additionally, adoption can be affected by dissemination characteristics, like the perceived source of the idea (Fishman et al. 2017), or the frequency of exposure to an idea (Zhou et al. 2015).

Literature on information-spreading (i.e. the way information flows through social networks) shows that repeated passive exposure to an idea can affect the adoption of both attitudes and behaviours,

including increasing an individual's likelihood of further spreading the idea (Bao et al. 2013; Zhou et al. 2015). Some idea adoption, such as the transfer of neutral information, flows through a network like many diseases would – requiring only one source of exposure in order for the next individual to adopt it (i.e. *simple contagions*) (Centola 2010). In contrast, ideas that go against social norms or ingrained behaviours, for instance, are likely to require multiple different sources of exposure in order for them to be adopted (i.e. *complex contagions*) (Centola 2010). In addition, the adoption of some ideas is augmented by social reinforcement (i.e. hearing it from other people); for example, shifting an individual's perception of whether consumer products are socially acceptable or not (Heal & Kunreuther 2010; Zheng et al. 2013).

Aside from passive idea exposure, individuals actively seeking information can also adopt ideas they find, if the ideas are discoverable and attractive to them. For example, health information-seeking literature details the notable effect that available health information can have on the individuals actively looking for it, often online (Morahan-Martin 2004).

4.1.2 Study Context

There has been critique on the design and impact of the many recently implemented consumer-focused demand reduction efforts in wildlife trade, some of which have been online (UNEP 2016; Greenfield & Veríssimo 2018). As such, there is a clear need for robust, scalable, and effective intervention methods to help tackle demand for illegal or unsustainable wildlife products.

Chapter 2 found that 19% of Chinese Singaporeans stated saiga horn was the product they use *most often* to treat fever and *heatiness* (a TCM state of illness with symptoms like sore throat). This chapter also found that the largest consumer group was aged 35-59, and women of this age were the most likely to purchase saiga horn for both themselves and others. Saiga horn use was based heavily on influences from others and perceptions of its efficacy (Chapter 3). Most consumers,

however, were wholly unaware of the saiga's conservation status (Chapter 2). There are general misunderstandings around saiga horn in Singapore (such as beliefs that it is an herb, or that saiga horns fall off), and this knowledge gap can be utilised to influence consumer choices via a carefully-designed intervention accounting for the social influences on saiga horn usage.

Singaporeans use the internet heavily for news, entertainment, information seeking, and social networking. Singaporean daily internet usage was estimated at 92% for those aged 35-44, 85% for those aged 45-54, and 78% for those aged 55+ (Statista 2016). This high level of internet usage together with the pivotal role of middle-aged women in saiga horn consumption, suggest that an online intervention targeting this group could be an effective way to reduce consumption.

We thus assessed the applicability of information-spreading and -seeking approaches to changing individuals' perception of wildlife products via a case study of saiga horn consumption in Singapore. Using online news outlets and targeted advertising, we: 1) spread information among Chinese Singaporean women aged 35-59 which discussed saiga horn as coming from a Critically Endangered species, in a way that implied saiga horn usage was now no longer socially endorsed; and 2) made this information discoverable to information seekers within this audience. Our three main approaches were to:

- treat our core message as if it were a complex contagion, by spreading it via online platforms to our target audience in diverse ways repeatedly,
- promote social sharing of the core message within our target audience, and thus socially reinforce the message,
- make accurate information readily available to target audience members actively seeking such information.

We assessed the effectiveness of advertising platforms and news sources at inducing message engagement and analysed how individuals engaged with, responded to, and further spread the message.

4.3 Methods

Our implementation process (detailed in Figure 4.1) began with us working with a trusted Singaporean news outlet to publish an article containing information about saiga horn medicine. Subsequently, other news outlets generated their own articles based on this original article. All such articles were then considered 'seed sources' of the core message. We promoted these seed sources through online adverts on multiple advertising platforms. These adverts passively exposed the target audience to our core message in diversely repeated ways and encouraged social sharing of the message. We also used adverts to promote older online resources (considered 'support sources') discussing saiga horn use and its conservation impact, to individuals actively seeking related information or verifying our core message.

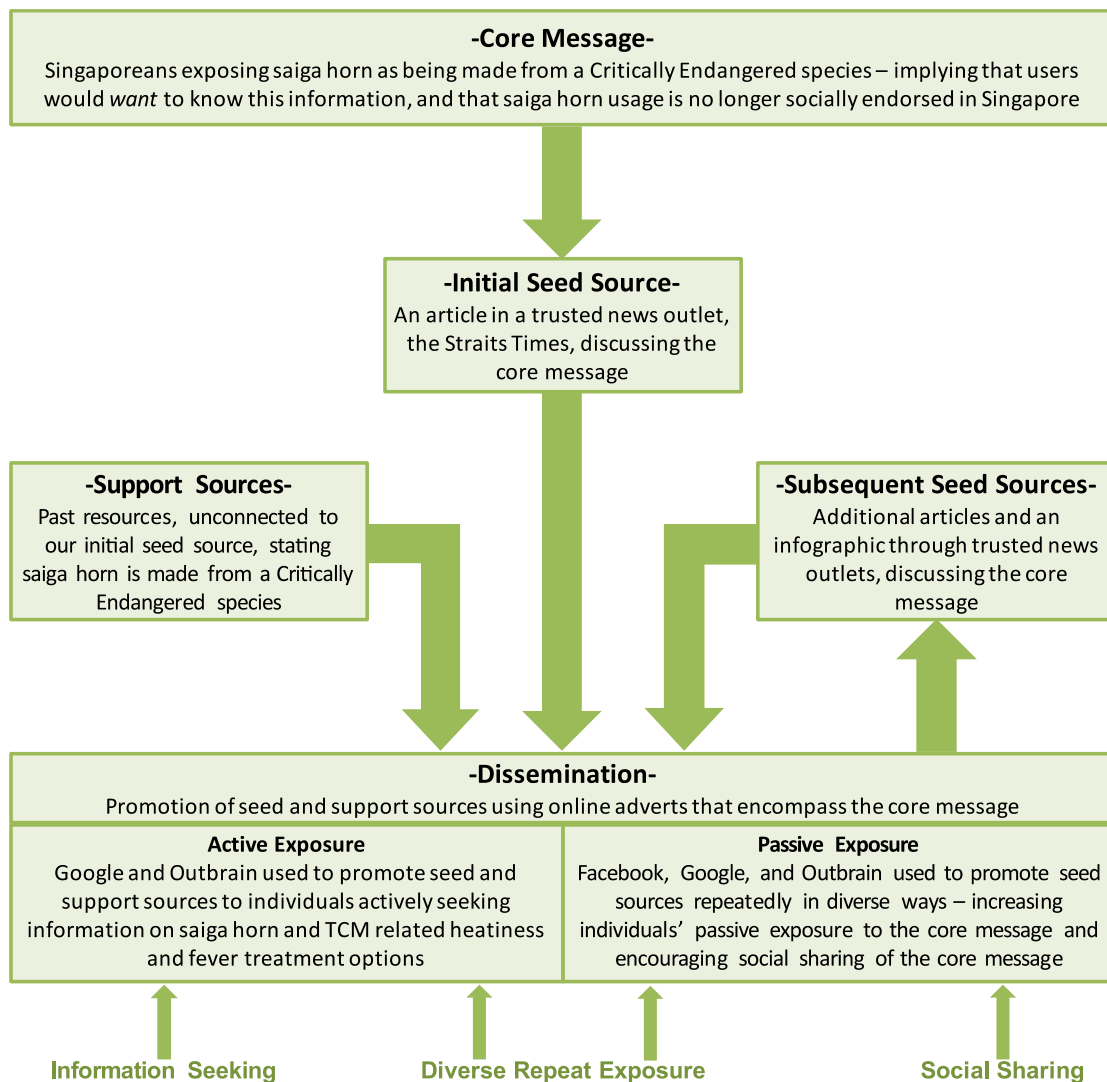


Figure 4.1 The intervention implementation process used to target saiga horn consumers in Singapore. The key components are described in boxes with black text. Three concepts founding the dissemination approach are in green text at the bottom.

This experimental design was exploratory in nature because we did not have access to news articles before they were published, nor control over their publication timeline. Thus, adverts were not entirely pre-defined, and instead implemented and removed adaptively depending on article publications and real-time advert performance. Where possible, though, we advertised specifically to our target audience so that a future evaluation comparing effects on the target and non-target audience would be feasible (see below for advertising platform details). Our design was based on a theory of change shown in supplementary material Appendix 4.1.

4.3.1 Message

Several factors determined our core message. Firstly, saiga horn is a socially endorsed product tied to recommendations from others and perceptions of its commonness (Chapter 3; Appendix 4.2). Secondly, in pilot focus groups with middle-aged Chinese Singaporean women, (both saiga horn users and non-users), many participants aligned strongly with the notion that Singaporeans strive to be health conscious and *responsible* consumers (Appendix 4.2). Participants were upset to learn saiga horn comes from a Critically Endangered species because that new information did not align with their self-identity. Most participants felt this new information was persuasive enough to dissuade them from using saiga horn. Thirdly, participants appreciated suggestions of cheap, common, and cultivated alternative TCM products. It was important for us to suggest alternatives that did not force individuals to choose between personal/cultural values and being a ‘responsible’ consumer (Manfredo et al. 2017). Lastly, participants trusted Singaporean universities more than foreign universities for health research.

Based on these factors, we used 1) results from Chapter 2 by our team (including the Singapore-based Nanyang Technological University), and 2) Singapore-based seed sources (see below), to form a core message: Singaporean researcher and news outlets expose that numerous consumers in Singapore are unknowingly using a Critically Endangered species. This message implied that, based on this ‘new’ information on the source of saiga horn, its usage was no longer socially endorsed. TCM alternatives made from cultivated plant species (chrysanthemum tea, barley water, and honeysuckle) were also included in the source articles.

We couldn’t specify the exact text that journalists chose to write within news articles, but we did have control over text in our adverts (which were probably a primary exposure point for many individuals). We aimed for these adverts to express the core message (See Appendix 4.3 for all advert text); and based advert text around: 1) phrasing found in the source articles (so that adverts

were not misleading relative to article content); and 2) the hypothetical adverts we tested in our pilot focus groups (Appendix 4.2). We also chose to slightly vary the advert text across different promotions in an attempt to further augment audience perceptions that this new information was coming from multiple sources, and thus was a socially popular message.

4.3.2 Sources

We chose content published through news outlets to be our seed sources because news outlets are perceived by many Singaporeans to be credible for health-related news (links to all source articles can be found in Appendix 4.3) (Tang & Lee 2013). For the initial seed source we chose the Straits Times newspaper because our focus group participants trusted international sources less than national sources, and they particularly trusted the Straits Times – the most read English language newspaper in Singapore (Kok 2017) (Appendix 4.2). We provided relevant material to the Straits Times, which published an article in print and online behind a paywall (Figure 4.1). This article’s story was picked up by other online news outlets, which we identified via daily online searches and then included in our advertising as additional seed sources.

English and Chinese are the most common languages among Chinese Singaporeans (DoS Singapore 2019), so we promoted articles in both languages. The Singapore-based English outlets aside from the Straits Times included: the Mothership (a popular source for younger audiences); The New Paper (the third most-read English newspaper; (Kok 2017); and The Asian School of the Environment at Nanyang Technological University’s News Blog (ASE News). The Chinese language outlets included: Lion City News (a.k.a. Shicheng News, 獅城新聞; a Singaporean outlet); and China Press (中國報; a Malaysian outlet). Additionally, we promoted an infographic on Nature Society Singapore’s Facebook page as a seed source. Nature Society Singapore is a well-known Singaporean non-profit, which fit our general aim of employing trusted local sources.

The support sources (corroborating our message but not linked to our initial seed source), included: a 2012 The Asian Scientist article in English discussing Singaporean saiga horn consumption, and a 2017 Mongabay article, 2015 Taiwan Animal News article, and 2016 Taiwan Environmental Information Center article – all in Chinese and discussing saiga antelopes and their consumption in Asia more broadly (Figure 4.1).

4.3.3 Dissemination

The dissemination goals included: repeatedly and diversely expose the target audience to the core message, encourage social sharing of this message, and provide readily discoverable resources for information seekers (Figure 4.1). Dissemination lasted for five weeks (February–April, 2019).

For the first goal, we employed Facebook, Google, and Outbrain (a company that places adverts on third-party websites) to passively expose the core message to our target audience. Facebook also encouraged, and easily allowed for, social sharing of the message. For the second goal: since our target audience actively seeks information on health topics (Tang & Lee 2013) and often does so through impersonal channels like Google (Appendix 4.2), we promoted seed and support sources on Google. Google thus made these sources among the top links advertised to individuals performing a relevant Google search (since this is how Google Ads displays promoted links). Similarly, to capture individuals actively reading related articles on third-party websites, we used Outbrain. Adverts on all three platforms were implemented using guidelines and information provided by the platforms themselves. Platform-specific implementation notes for our process can be found in Appendix 4.3, and broader considerations for others wishing to use these platforms can be found in Appendix 4.4.

Facebook is a social media platform with 4.7 million users in Singapore, including 890,000 women aged 35-59 (Facebook 2019). Our focus group participants frequently used Facebook to learn about and share health-related information (Appendix 4.2). Facebook therefore met our objectives of diversely repeated message exposure and social sharing. We promoted all of our seed sources on Facebook. See Appendix 4.3 for details on how Facebook advert audiences were selected. For most of our Facebook adverts, the 'promoter' (which is automatically displayed on the advert) was the non-profit organisation Saiga Conservation Alliance - as this was the relevant Facebook Page we had access to. The infographic promoter was Nature Society Singapore. We recognise the potential for bias from using conservation groups as promoters. For example, individuals who are disinclined towards conservation may be put off from engaging with our adverts. However, this bias was unavoidable given our constraints and Facebook's requirements. Further, the extent of this bias was likely moderated by the fact that the majority of the advert – the text, images, and enlarged link – focused on our core message which included the Singapore-based seed sources. See Appendix 4.3 for Facebook advert snapshots.

Google is a top search engine in Singapore (We Are Social 2018), and the most commonly used search engine by our focus group participants for health information (Appendix 4.2). Google met our objectives of diverse repeat exposure and providing accurate sources to information seekers, so we promoted some seed sources, and all support sources, on Google. See Appendix 4.3 for details on how we selected Google search terms.

Outbrain sells native adverts on third-party websites. Native adverts appear more seamless on a webpage than traditional adverts and are argued by some to be more effective (PG Media & Sharethrough 2019). They often look like 'suggested articles' on the bottom of an article that an individual is viewing. Outbrain met our objectives of diverse repeat exposure and capturing information seekers by reaching individuals while they read articles related to heatiness and fever.

We promoted some of our seed sources through Outbrain. See Appendix 4.3 for the topics selected for Outbrain adverts.

4.3.4 Audience response

For all newspaper sources, clicking on an advert sent an individual to the source article. For Nature Society Singapore, clicking opened the infographic as a full Facebook image. To compare the performance of adverts between advert platforms, we used the following metrics provided by all three platforms: the number of times adverts were shown (impressions), the number of times adverts were clicked on (clicks), the rate at which an advert was clicked on (click-through rate, CTR; i.e. number of clicks per impressions), and the cost we incurred for each click (cost per click, CPC). We also measured the highest and lowest CTR, and the cheapest and priciest CPC.

We used the same performance metrics to compare between sources, but on Facebook, we were also able to measure the number of *different* Facebook users reached, and the average number of times each user saw an advert. Since we treated the core message like a complex contagion, we would have liked to assess whether diversely repeated exposure was correlated with audience engagement. We were unable to do so, however, because the information required to analyse this was not available.

To test whether advert text affected engagement, we compared adverts *within* each source on Facebook, so that all other things being equal (i.e. source, image, release date, run-time, platform), we could assess which text phrasing performed better.

4.3.5 Facebook-specific analysis

On Facebook there are multiple ways for a user to engage with a message and to explicitly express their response to that message, thus our Facebook-specific analysis was particularly helpful in assessing audience response (Figure 4.2). We grouped audience engagements on both our paid adverts and the organic Facebook posts created by the Straits Times and the Mothership, into four types (reactions, comments/responses, shares, and clicks). To gauge whether engagement varied across adverts, we visualised the engagement type frequencies for the five adverts with the most clicks.

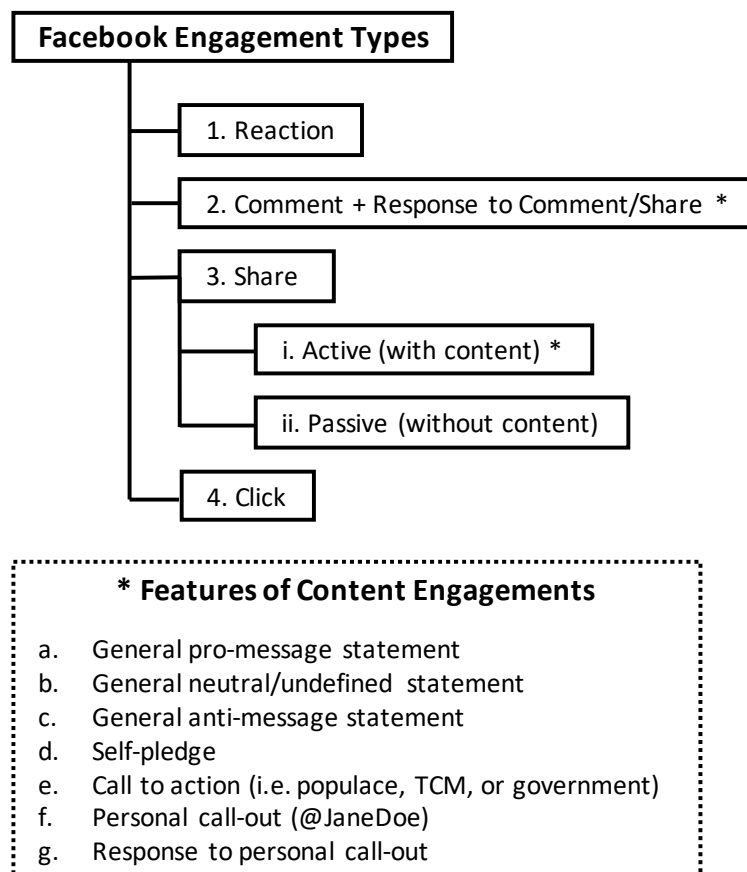


Figure 4.2 The types of engagement that an individual performed when interacting with an intervention advert on Facebook. Audience-created content was coded for listed features.

To capture how an individual was 1) reacting to the message, 2) relating this message to their own or others' behaviour, and 3) endorsing/not endorsing this message to their networks or wider

society, we conducted a qualitative features analysis of all content engagements (Figure 4.2). Facebook engagements (e.g. comments or shares) that included user-created content such as text and emojis were defined as ‘content engagements’. Data included only publicly visible content engagements. This content was coded for features determined via a pilot coding of two adverts (Figure 4.2). Before coding, Chinese language content was translated to English by a native Chinese Singaporean fluent in English and Chinese. To evaluate content differences between adverts, we visualised the proportion of features for the four most engaged-with Facebook adverts.

4.3.6 Ethics

This research was approved by the Oxford Internet Institute’s Departmental Research Ethics Committee of the University of Oxford (SSH OII C1A 19 005 and SSH OII C1A 18 094). Publicly visible Facebook content was obtained via review board-approved web scraping. All names were pseudonymised by HD before analysis.

4.4 Results

4.4.1 Reach

The core message was published on at least five English and two Chinese language news outlets, with the Straits Times, The New Paper, and the Mothership being widely popular. Through just our Facebook adverts, we reached 479,258 women in Singapore aged 35-59. The proportion of the total Singaporean population is unknown because Facebook reach includes citizens and non-citizens; but within Facebook users, Facebook estimates 890,000 individuals were eligible to see our adverts (Facebook 2019). Across all three platforms our adverts were shown almost 5 million times. Though large, these numbers underrepresent the intervention spread. Through others’ promotions and the news outlets themselves, the number of individuals reached was potentially vast. For example, 2,700 people shared the Mothership’s Facebook post, but an *additional* 26,500

people shared the article directly from the Mothership website onto Facebook (Tan 2019). The full saliency of the message, and how many times a target individual was exposed, is thus not known, but the message was evidently prevalent among Singaporean internet users.

4.4.2 Platforms and sources

CTR (click-through rate) is an important metric because it indicates some level of audience interest and is useful for comparing between adverts. Google had the highest average CTR (2.1 %), followed by Facebook (1.89%) and then Outbrain (0.31%) (Table 4.1). For general context, Google search adverts average at 1.9%, and Facebook page adverts average at 1.4% (CXL Institute 2020). CTR range indicates how consistently adverts perform on a platform. Outbrain had the smallest CTR range (0.82%, 0.13%), followed by Google (4.37%, 0%), and then Facebook (4.96%, 0.42%). CTRs for our seed sources were generally correlated across platforms, with The Mothership, the Straits Times, and The New Paper having the highest recorded CTRs (Table 4.1).

Table 4.1 Comparisons of analytics for advert platforms and news sources. CTR = Click-through rate, CPC = cost per click. English language sources include: ASE News, Mothership, Nature Society Singapore, Straights Times, The New Paper, and Asian Scientist. Chinese language sources include: China Press, Lion City News, Mongabay, Taiwan Animal News, and Taiwan Environmental Nature Center.

	Platforms	Total Impressions	Total Clicks	Total CTR (Highest, Lowest)	Total Average CPC ^a (Cheapest, Priciest)	Total Reach ^b (Advert Average Reach)	Total Average Frequency ^b (Advert Average Frequency)
	Facebook	3,340,628	63,189	1.89% (4.96%, 0.42%)	0.34 USD (0.17 USD, 1.03 USD)	479,258 (98,921)	6.97 (1.99)
	Google	17,306	366	2.11% (4.37%, 0%)	7.44 USD (1.32 USD, 21.16 USD)	-	-
	Outbrain	1,628,512	5,037	0.31% (0.82%, 0.13%)	0.65 USD (0.63 USD, 0.72 USD)	-	-
Sources	Platform	Total Impressions	Total Clicks	Total CTR	Total Average CPC ^a	Source Average Reach ^b	Source Average Frequency ^b
-Seed Sources-							
ASE News	Facebook	517,606	2,647	0.51%	0.95 USD	85,882	2.63
	Google	544	6	1.10%	20.21 USD	-	-
	Outbrain	848,613	1,598	0.19%	0.65 USD	-	-
Mothership	Facebook	792,785	17,258	2.18%	0.34 USD	182,813	1.66
	Google	2,930	113	3.86%	6.50 USD	-	-
	Outbrain	219,675	1,552	0.71%	0.63 USD	-	-
Nature Society Singapore	Facebook	193,366	6,028	3.12%	0.18 USD	97,284	1.99
Straits Times	Facebook	134,555	4,933	3.67%	0.22 USD	37,690	1.19
The New Paper	Facebook	445,266	14,685	3.30%	0.18 USD	150,809	1.47
	Google	1,339	36	2.69%	4.68 USD	-	-

China Press	Outbrain	188,723	644	0.34%	0.67 USD	-	-
	Facebook	396,759	4,716	1.19%	0.58 USD	64,111	1.97
	Google	550	7	1.27%	10.44 USD	-	-
Lion City News	Outbrain	371,501	1,243	0.33%	0.65 USD	-	-
	Facebook	860,291	12,922	1.50%	0.39 USD	121,063	3.44
	Google	559	9	1.61%	10.84 USD	-	-
-Support Sources-							
Asian Scientist	Google	6,582	136	2.07%	5.04 USD	-	-
Mongabay	Google	922	12	1.30%	15.22 USD	-	-
Taiwan Animal News	Google	1,738	24	1.38%	14.01 USD	-	-
Taiwan Environmental Information Center	Google	2,142	23	1.07%	13.96 USD	-	-

a = Values were converted from SGD or GBP to USD (OANDA 2019) and do not include taxes.

b = Reach and Frequency were given by Facebook at the advert and account level, and did not include which individuals saw which adverts.

Cost-effectiveness depends on both CTR and CPC (cost per click). In total, we spent about 20,900 USD on Facebook, 3,300 USD on Outbrain, and 2,700 USD on Google (values converted from SGD or GBP to USD; taxes not included (OANDA 2019)). Facebook was the cheapest (CPC of 0.34 USD), and Google the most expensive (CPC of 7.44 USD). Google also had the largest CPC range, with some individual clicks costing as much as 20.93 USD. Because Facebook had a relatively high CTR compared to Outbrain, but was much cheaper than Google, we consider Facebook our most cost-effective platform for passively exposing the target audience to the message. Since Facebook is a social media platform where adverts can be re-disseminated by individuals easily, Facebook was also a cost-effective way to engender visible social reinforcement of the message.

Only Facebook provided information on frequency of advert exposure. According to Facebook, on average, each person within our targeted Facebook audience was served some combination of our adverts 6.97 times while they were looking at their Facebook newsfeed. The overall average number of times each person was served *each* advert was 1.99. When comparing between seed sources, ASE News and Lion City News had the highest average frequency of exposure.

We were also interested in reaching individuals actively seeking saiga horn-related information. Google's low total impression frequency indicates how many people probably used Google to search for saiga-related information. Google Trends data similarly shows that such keywords are not often searched for, compared to say, 'paracetamol'. Thus, Google's high CTR suggests that, even though there were relatively few people searching for saiga-related information, those individuals were distinctly interested in the message topic.

Among the support sources (i.e. older online resources providing corroborating information) that we advertised on Google: the Asian Scientist article had the highest CTR and cheapest CPC (Table

4.1). This was our only English language support source and the only one focused on saiga horn consumption in Singapore.

4.4.3 Advert Text

When comparing between Facebook adverts *within* a seed source, we found that adverts specifically referencing ‘Chinese Singaporeans’ or ‘Singaporean consumers’ were more effective than adverts not referencing Singaporeans – i.e. the Singapore-specific adverts had a higher average CTR, cheaper CPC, and larger reach in their first four days of running (see Appendix 4.3 for all advert performance data). This trend is exemplified in the comparison of Mothership adverts shown in Figure 4.3, and confirms past research around the importance of message tailoring (Hine et al. 2014).

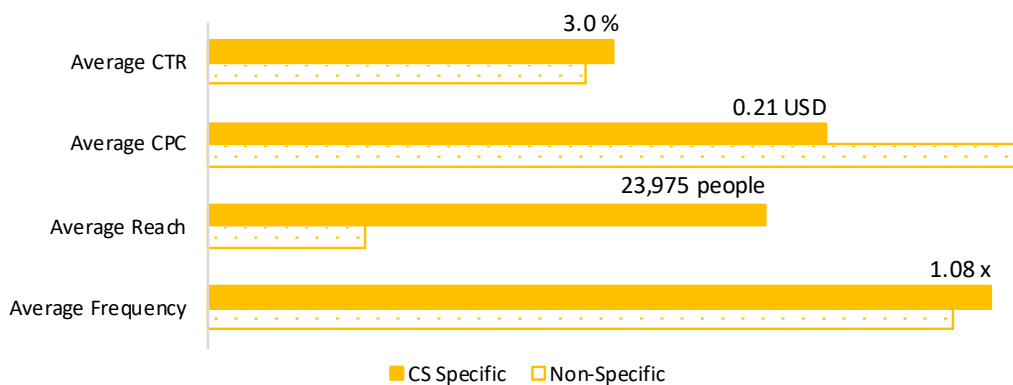
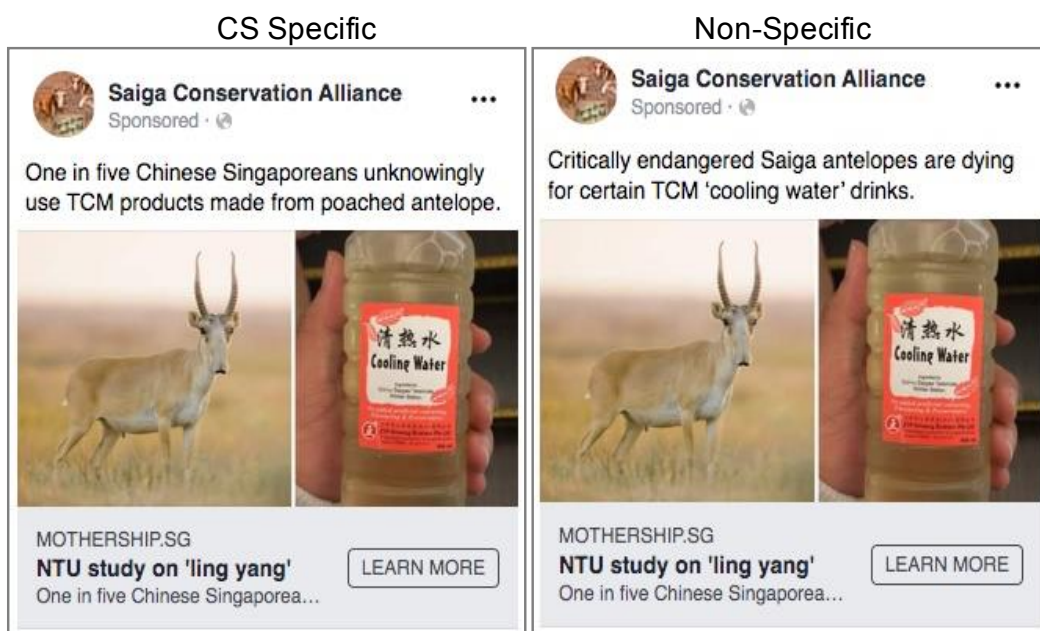


Figure 4.3 Facebook advert comparisons for the Mothership article. The advert referencing Chinese Singaporeans is 'CS Specific' and the advert not referencing Chinese Singaporeans is 'Non-Specific'. Advert analytics include the averages for the first four days of advert runtime.

4.4.4 Facebook engagement and spread

We measured Facebook users' engagements with our adverts and the Mothership and Straits Times organic posts. The most common engagement on our adverts was clicks (63,189); click data for the organic posts were inaccessible. The other publicly viewable engagement types across the adverts and organic posts totalled:

- 540 comments and responses on an advert/post or direct share,
- 5,581 direct shares of an advert/post, of which 12-22% were *active* shares, meaning the user added their own content like text or emojis,
- and 6,233 reactions on an advert/post or direct share; not including reactions to others' comments or responses.

Additional comments, responses, and reactions using privately viewable shares we could not access are likely. Therefore, these statistics are estimates of minimum engagement. Individuals could also engage multiple times, so values do not equate to numbers of people.

Proportions of engagement types varied across adverts (Figure 4.4). For instance, the Mothership advert in Figure 4.4 had the most clicks, shares, and comments, but the Nature Society Singapore advert had substantially more reactions and a similar number of comments.

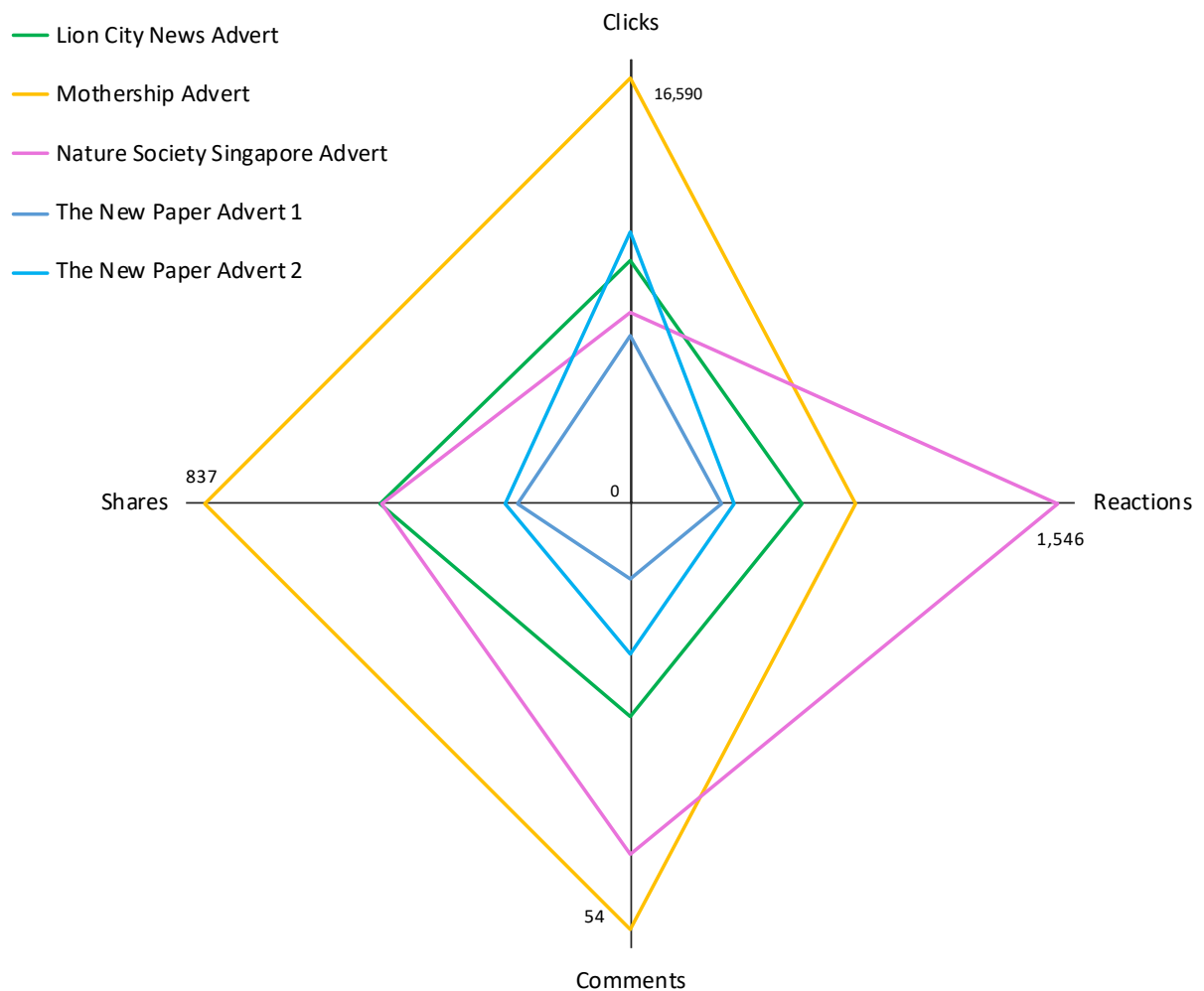


Figure 4.4 Engagement types for the five most clicked-on Facebook adverts. Axes are relative to the highest value obtained by any advert for a given engagement type. Values include only interactions directly on an advert and not shares of that advert.

4.4.5 Facebook features analysis

We coded 926 publicly visible content engagements (e.g. text or emojis), on our Facebook adverts and the Straits Times and Mothership organic posts, or direct shares of these adverts/posts. (Figure 4.5). Feature category descriptions with example quotes are available in Appendix 4.5 and all content engagements are available in Appendix 4.6. Many of these content engagements related to an individual’s own offline behaviour – e.g. past positive or negative experiences with saiga horn, or their future saiga horn use. This analysis also suggested that our core message angle of ‘exposing the unwitting nature of saiga horn consumption’ appeared to garner the desired response in those

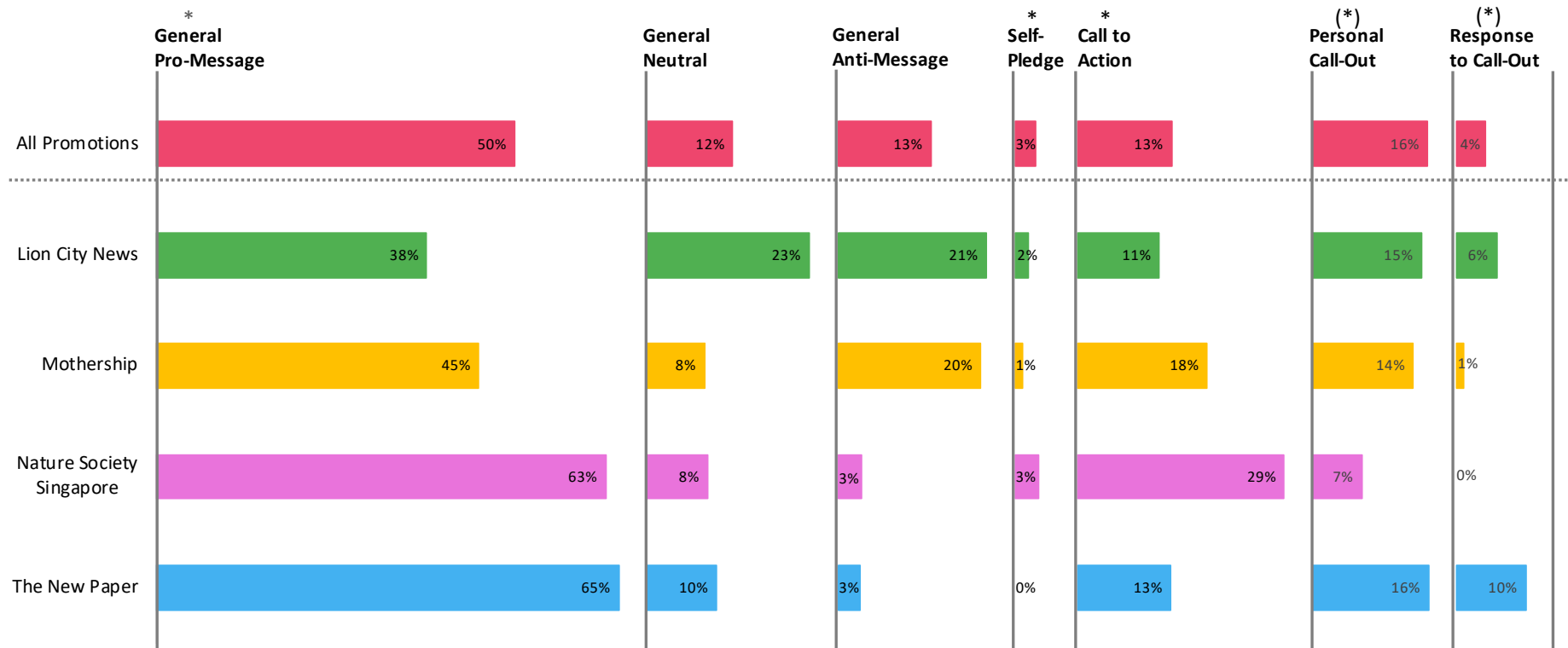


Figure 4.5 The proportion of features in publicly viewable content engagements for all our Facebook paid adverts and the Straits Times and Mothership organic posts, and then specifically for the four advert sources with the most content engagements. Bars indicate the percentage of content engagements containing a given feature. * indicates an identifiably positive feature, (*) indicates a *sometimes* identifiably positive feature.

who chose to write content: with numerous content engagements expressing individuals' shock, guilt, or anger at having consumed a Critically Endangered species 'without their knowledge' or at having these products in stores without potential consumers being aware of their provenance. Additionally, content engagements where individuals discussed TCM alternatives confirmed the value of seed sources mentioning these products.

Overall, we found 63% of content engagements contained features that were identifiably in line with the core message or showed a pro-conservation response to the message. The most common were general pro-message statements (in 50% of content engagements) and ranged from single crying emojis to detailed text describing outrage at the sale of an endangered species, pro-environmental opinions, or comments around the keratin composition of saiga horn and therefore its lack of medical efficacy. Based on Chapter 2 we hypothesized that there were widespread prior misunderstandings about saiga horn, and this hypothesis was evidenced by the high number of engagements indicating that individuals were previously unaware of, or misinformed about, the source of saiga horn.

Personal call-outs, (when individuals engaged someone else using the @ symbol), were found in 16% of content engagements, and 17% of these were identifiably pro-message (e.g. advising the target individual not to use saiga horn). The rest were not identifiable as pro- or anti-message. Further, 25% of personal call-outs were responded to by the target individual, accompanied by both positive and negative features. Calls to action (in 13% of content engagements), involved the individual calling for the populace at large, or for specific entities outside of their social network, to take action (e.g. telling the government to ban saiga horn or telling a well-known TCM store to stop selling it). Self-pledges were the rarest feature (in 3% of content engagements), and consisted mainly of individuals stating they would no longer use saiga horn or that they would find alternatives.

Only 13% of content engagements contained identifiably negative features regarding the core message. Some anti-message statements indicated the individual misunderstood the intended message or wished to discredit the stated source of saiga horn products. Some common inaccuracies which we recorded were: saiga horns came from farmed saigas, the horns fall off naturally, or all products marketed as *líng yáng* are now fake. An equally common form of anti-message statement included perceptions of saiga horn's efficacy and feelings that saiga horn is safer and/or more potent than alternatives.

Different sources yielded different features compositions (Figure 4.5). For example, Nature Society Singapore had the highest proportion of calls to actions and self-pledges, but the lowest personal call-outs. Lion City News had the highest proportion of general anti-message and neutral features, and the lowest general pro-message features.

4.5 Discussion

4.5.1 Synthesizing the Results

We found a high level of positive intervention engagement, based on CTR and CPC data across Facebook, Google, and Outbrain, as well as data on Facebook engagement types and audience-created content engagements. Our Facebook analysis yielded pro-message responses from Facebook users, like furthering message spread, calling for social change, expressing angst over the previously unknown sale and use of a Critically Endangered species, and self-reporting intentions to reduce saiga horn usage. All these engagements suggest that our selected message of 'exposing' the source of saiga horn medicine resonated with the target audience and may have affected perceptions of saiga horn in Singapore.

We were unable to directly test whether diversely repeated passive exposure to our adverts resulted in reduced saiga product consumption. We can say that the coverage across multiple top Singaporean news outlets, high volume of advert runs, and the news outlets' own promotions, likely resulted in a vast number of individuals in our target audience viewing the intervention message multiple times, from multiple sources. In a 2015 Chinese microblogging study, probability of forwarding an online message peaked at 3 exposures (Zhou et al. 2015), a frequency we far exceeded. Given the importance of social influence around saiga horn use (Chapter 3), our intervention design also assumed some individuals in our target audience would require social reinforcement in order to adopt the core message (Appendix 4.1). The many Facebook shares and personal call-outs (particularly with identifiably positive responses from targeted individuals), indicates that we achieved our objective of social sharing, thereby socially reinforcing the message. Further, since our target audience looks to their social network for health treatment advice (Chang et al. 2014), even if individuals did not adopt the message *directly* from our adverts, social reinforcement online or offline by their networks increased the likelihood they would subsequently adopt it.

Google's high CTR suggests some individuals were seeking saiga horn related information. As such, having the core message readily discoverable to them at the moment of searching meant the message was delivered to individuals for whom it was likely highly applicable.

CTR is not a perfect engagement measure. It indicates audience interest, but clicking on an advert in no way determines whether an individual endorses and retains the message, or shifts behaviour. In fact, an individual may never click on an advert, but may write a self-pledge on Facebook or actively share that advert with friends, and these actions potentially tell more about their response to the underlying message. However, none of these guarantee actual behaviour change, nor stand

alone as reliable indicators of intervention impact. A full assessment of potential effects on the target audience's saiga horn purchases requires a follow-up evaluation.

The content engagements on Facebook, though, helped elucidate the target audience's immediate sentiments towards the core message. There is likely a self-selection bias, in that individuals *choose* to write content, nonetheless, the majority of content engagements (63%) contained features in line with the core message or desired intervention effect. Additionally, differences in feature proportions between seed sources (e.g. Lion City News versus The New Paper), which possibly relate to differences in these sources' population-wide audiences, help to confirm that the Facebook 'promoter' being a conservation group didn't strongly dictate audience response – since adverts with the same promoter but different seed sources yielded different audience engagement.

Our core message assumed that our focus group participants, and the prior research findings we employed to shape the message, portrayed a fairly reliable image of the target audience (Appendix 4.1). In particular, that the target audience wished to identify as a 'responsible consumer', and that consumption impacting a Critically Endangered species contradicted this identity. Had our focus group participants not indicated this sentiment, then we would not have chosen a seemingly conservation-based message. Similarly, our expectation of desirable target audience response assumed: 1) that the target audience perceived that the Singaporean seed sources viewed the common use of a Critically Endangered species without consumers' knowledge, to be a negative thing; and 2) that the target audience perceived this negative viewpoint to be socially popular among Singaporeans. Since saiga horn is legal, commonly available, and already culturally engrained, it was unlikely that by stating the proportion of saiga users in Singapore (i.e. "One in Five Chinese Singaporeans") we would make saiga horn appear more common than consumers initially perceived (Farrow et al. 2017). Instead, confirming its popularity helped to form our desired

view that this behaviour with previously unknown ‘negative impacts’ was highly pervasive and needed to be addressed. This audience response was confirmed through the comments made on Facebook, and discussions during subsequent consumer surveys (not reported here).

4.5.2 Wider Considerations

The potential for large-scale dissemination and uptake makes online intervention approaches enticing (e.g. major corporations and organisations have reached millions of people via online promotions; (Laskin et al. 2018), and specific mechanisms linked to news coverage, repeat exposure, and social reinforcement could prove powerful for many conservation efforts. For example, there are numerous wildlife trade products where socio-cultural influence determines product desirability (e.g. luxury seafood consumption in China) (Fabinyi 2012), and careful online interventions could leverage this influence. More broadly, attempts to shift behaviour for pro-environmental aims are globally ubiquitous (e.g. the many climate change campaigns) (Barratt 2017), and these efforts could be dramatically augmented by strategic repeat-exposure.

However, like any intervention medium, the internet should only be used when it is target audience and behaviour appropriate. Singapore is an internet-heavy country, and the target audience uses it daily – prerequisites to intervention success. Furthermore, our prior research gave us the understanding that:

- saiga horn use was influenced by social endorsement, so social perceptions could be leveraged,
- our target audience gained health information from impersonal content, like news articles,
- and our target audience used the internet for social exchange and accessing impersonal content.

In other words, we first identified specific influences to be leveraged in the intervention and then determined whether leveraging these influences online would be applicable to our target audience.

To use many online mechanisms, it is also necessary to be able to identify online sources perceived as trustworthy by the target audience, direct channels that reach the audience, and tested message framing that induces the desired effect. These insights hold for any behavioural change intervention, and speak to the need for robust baseline research before embarking on any intervention (Greenfield & Veríssimo 2018). Further, through our intervention process we learned that there are a number of things to consider when carrying out this type of online work (Appendix 4.4). For example, when using online channels, spill-over of the intervention message to non-targeted individuals is likely, and may need to be mitigated to meet research needs. For our study, spill-over wasn't an issue because we wanted general social reinforcement of the intervention message. But for an evaluation of our intervention's impact, comparing effects on targeted and non-targeted individuals would be useful.

To improve our intervention process in future research, we would more systematically test message framing and the exact text and images used in the adverts (even if news article text was beyond our control). Depending on the scale of the intended audience, we would also assess whether building in a control group, or possibly a model-based counterfactual, was feasible. We elected not to conduct statistical analyses given the opaque differences between how each platform promotes adverts, and our organic approach to advert roll-out, but such analyses would be feasible in a follow-up evaluation, and may also be possible during implementation of future interventions given changes to the experimental design.

4.5.3 Conclusion

By spreading a carefully shaped message via online news stories shown to an audience in diversely repeated ways, with added social reinforcement, and meeting the interest of information seekers, we achieved high saliency and desirable target audience engagement. Given the ever-increasing

number of internet users globally, and the undeniable power of news coverage and targeted advertising, harnessing an audience's information-spreading and -seeking tendencies has great potential for disseminating conservation ideas in change-inducing ways. These influential tools are already being exploited by many sectors to promote consumer goods and political ideas (Berghel 2018), but conservationists have yet to fully employ them to achieve conservation goals.

4.6 Acknowledgements

We would like to acknowledge the Straits Times, Nature Society (Singapore), Saiga Conservation Alliance, R Tan, and JH Tam, for their contributions. This research was funded by the Oxford Martin Programme on the Illegal Wildlife Trade.

4.7 Supplementary Materials

[Appendix 4.1](#) Intervention Implementation Theory of Change (*separate file*)

[Appendix 4.2](#) Pre-Intervention Focus Groups

[Appendix 4.3](#) Advert Performance Data (*separate file*)

[Appendix 4.4](#) Considerations for Online Interventions

[Appendix 4.5](#) Content Engagements Feature Categories

[Appendix 4.6](#) Content Engagements (*separate file*)

Chapter 5 A multi-pronged evaluation

5.1 Abstract

Whether behaviour change interventions in wildlife trade are effective is largely unknown due to a dearth of detailed evaluations. We previously conducted a country-level online behaviour change intervention targeting saiga horn consumers in Singapore. The intervention had pervasive reach within the target audience of Chinese Singaporean women aged 35-59, and immediate online engagement was predominately positive towards the intervention message. In order to robustly evaluate intervention impact, though, we carried out in-person consumer surveys with over 2,100 individuals pre- and post-intervention, and 93 in-person post-intervention surveys with traditional Chinese medicine (TCM) shopkeepers. The proportion of high-usage saiga horn consumers in the target audience did not change from pre- to post-intervention. However, within the post-intervention dataset: when compared to the non-target audience, the target audience was more likely to accurately recall the intervention message and to decrease their saiga horn usage. Within the target audience, high-usage consumers were more likely than lower-usage consumers to recall the message and state a behaviour change. Additionally, across all respondents, misunderstandings of the saiga's conservation status decreased from pre- to post-intervention. Further, respondents who decreased saiga horn usage cited the intervention message as a specific reason for their behaviour change. TCM shopkeepers cited outside factors such as price and availability as the strongest influences on saiga horn sales. Our evaluation suggests this intervention did influence some consumers. We explore the reasons for these findings, including competing consumer influences, intervention characteristics, and evaluation timing. This work suggests our online intervention approach has potential, and is a rare example of a mixed-methods pre-post evaluation of a wildlife trade consumer intervention.

5.2 Introduction

The lack of detailed evaluations of wildlife consumer demand reduction interventions has been critiqued (Olmedo et al. 2017; Greenfield & Veríssimo 2018), following similar calls for empirical intervention evaluation across conservation sciences (St. John et al. 2014; Baylis et al. 2016). Applied behavioural sciences in fields like public health, development, and social marketing, offer examples of intervention evaluation approaches and standards that could be useful to conservation and sustainability projects (Hopwood 2011; MRC & NIHR 2019). Such evaluations strive to assess the causal effect of an intervention, rule out alternative explanations for observed effects (Baylis et al. 2016), and some argue, should also assess how that effect occurred (White 2018).

There is a plethora of methods available for intervention evaluation. For example, researchers can assess temporal changes in a target audience's behaviour through longitudinal data, in which the same individuals are measured at various time points, or through repeated cross-sectional data, in which a different sample of the population is measured at each time point (Rafferty et al. 2015). And when the use of treatment-control designs is not feasible or appropriate (Byrne 2013; Attanasio & Cavatorta 2017), other evaluation approaches could include using multiple data methods in conjunction: e.g. combining self-reported surveys and third-party measurements (Tonkin-Crine et al. 2016). These multi-pronged approaches are also helpful in providing a more complete picture of intervention effects, and reducing the likelihood that evaluations are biased by the limitations of any one method.

Self-reported data is directly collected from respondents (e.g. consumer surveys) and are commonly used in wildlife trade evaluations (Veríssimo & Wan 2019). These can be useful for many reasons, such as when the behaviour would be otherwise difficult to measure. However, self-reporting is inherently open to response biases (Althubaiti 2016). Third-party reported data come from sources other than the person of interest, such as a building's electricity usage meter (Wynes

et al. 2018), or key-informant interviews. These are not affected by self-reporting biases but have their own limitations, such as being access-limited.

In addition, mixed-method approaches employing both quantitative and qualitative data can provide evaluations that are both in-depth and statistically robust (Lanthorn & Iversen 2016). Mixed-method approaches are also useful in creating funnels of attribution (White 2018), which detail steps along a causal chain leading individuals from the target behaviour, through intervention exposure, and subsequent behaviour change. Funnels of attribution help explain causal mechanisms and impact heterogeneity (i.e. variability).

Study System

In February – April, 2019, a country-level online behaviour change intervention targeting Chinese Singaporean women, aged 35 – 59 years old, was implemented to reduce saiga horn usage in Singapore (Chapter 4). The intervention design used targeted online advertisements promoting news articles, in order to spread information about saiga horn throughout the target audience.

Following an initial online analysis of audience engagement (Chapter 4), we conducted a multi-pronged evaluation in order to determine the intervention’s impact on the target audience. This evaluation consisted of thorough on-the-ground surveys with both consumers and TCM shopkeepers, to determine whether:

- the target audience, and high-usage saiga horn consumers within this group, remembered the intervention message, and decreased their saiga horn consumption;
- TCM shopkeepers remembered the intervention message, and discerned changes in saiga horn sales.

This work offers a rare example of both a detailed mixed-methods pre-post evaluation of a large-scale wildlife trade intervention, and an assessment of the impacts of on online intervention

on offline behaviour. As such, it may prove useful to the many researchers and practitioners working to promote sustainable human consumption globally.

5.3 Methods

Given the nature of our intervention, and the high likelihood that the intervention message spilled-over to non-target audience individuals (i.e. they were exposed to the intervention message), a standard treatment-control design was not feasible.

An initial online analysis helped to assess whether the assumptions underpinning the intervention and chosen intervention design were valid, as well as to show whether the intervention did in fact reach the target audience (Chapter 4). However, in order to truly assess assumed stages of impact resulting from the intervention, we carried out a detailed follow-up evaluation using two on-the-ground datasets (our evaluation theory-of-change is shown in Figure 5.1). These datasets included repeated cross-sectional intercept surveys with the consumer population (pre- and post-intervention, in 2017 and 2019), as well as a cross-sectional survey of TCM shopkeepers (post-intervention, in 2019).

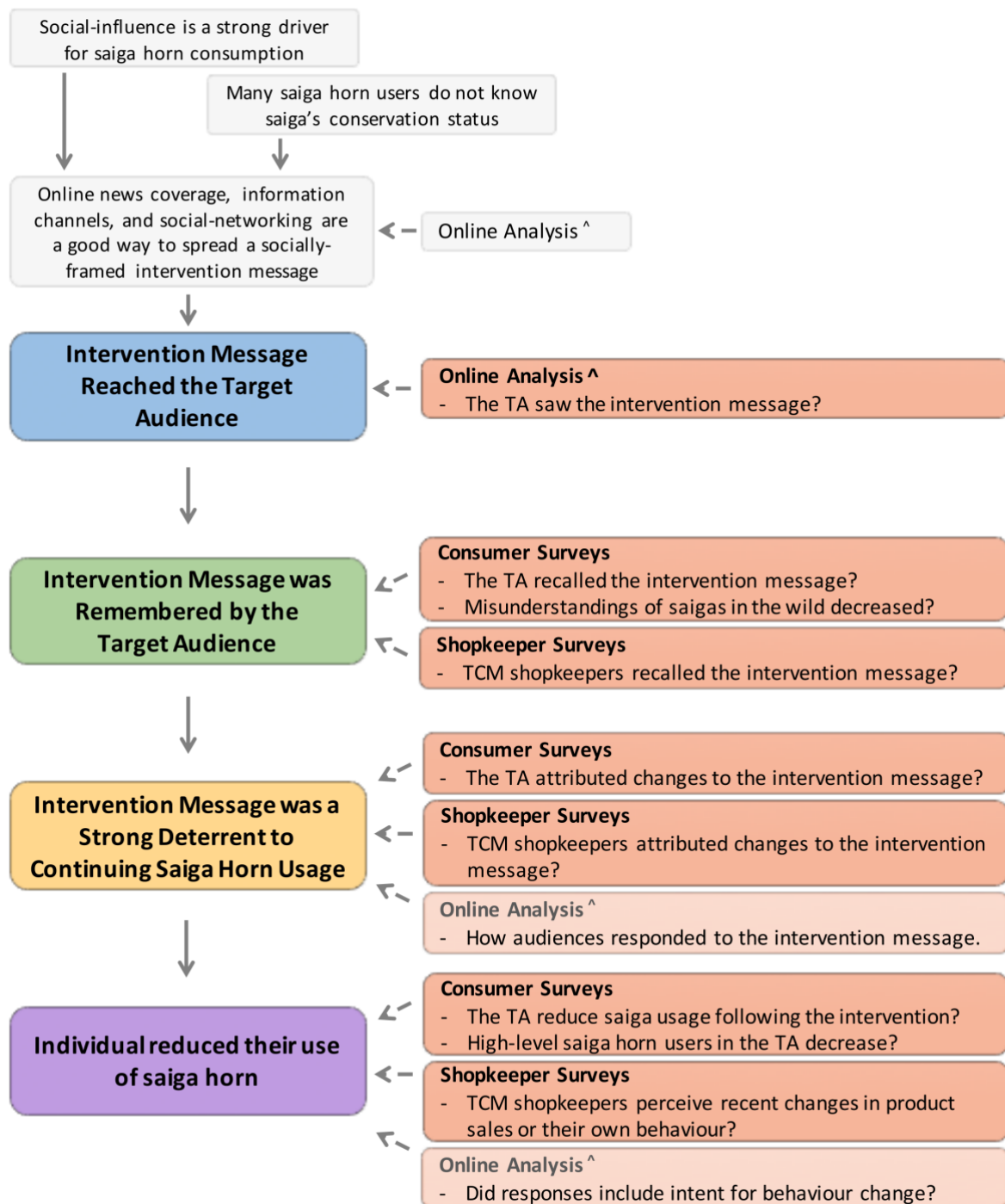


Figure 5.1 Evaluation theory-of-change. Shows the dataset(s) used to assess assumed stages (blue, green, yellow, and purple boxes) resulting from the intervention. The top grey-boxed stages include assumptions founding the intervention and the intervention design. ^ See Chapter 4 for those initial stages and online analysis findings. The final two stages (yellow and purple) were assessed primarily using consumer and shopkeeper surveys, with the online analysis a supporting dataset (indicated by transparent colouring). TA = target audience (middle-aged Chinese Singaporean women).

5.3.1 Consumer Surveys

The consumer surveys assessed intervention effects on our target audience of Chinese Singaporean women, aged 35-59 years old. For our intervention, we targeted a select demographic of people because baseline research found middle-aged women were among those most likely to use saiga horn themselves and most likely to purchase it for other people (Chapter 2). Thus, the target audience demographic included both saiga horn users and non-users. In order to better evaluate intervention impact, though, we also identified 'high-fidelity' saiga horn users within this demographic – i.e. people who specifically selected saiga horn as a fever/heatiness product option they use *most often*. The reason we chose to focus on high-fidelity users in the pre-intervention survey (Chapter 2) was because we wanted to identify users who would be most impacted by a consumer intervention. Additionally, in order to minimise cognitive burden in the survey (Lenzner et al. 2010), we had to balance how many questions we could ask about level of saiga use with the number of other questions we were interested in, particularly around consumers' purchases for other people. As such, our post-intervention surveys also only asked about high-fidelity saiga horn usage, so that the saiga horn use questions pre- and post-intervention would be comparable. However, we realise the limitations that this choice presents, in that we are now unable to assess temporal changes in lower-fidelity saiga horn users, nor see clearly if and how different levels of users were impacted by the intervention. Regardless of these limitations, though, our consumer survey analysis was able to assess:

- accurate recall of the intervention message across the target audience,
- temporal changes in misunderstandings of the saiga's conservation status, across the target audience,
- behaviour change attributed to the intervention message across the target audience,
- and temporal changes in prevalence of high-fidelity users within the target audience.

So that our pre- and post-intervention consumer surveys (in 2017 and 2019) would be comparable, the post-intervention surveys employed the same specific sampling method and sampling locations, general survey format and question phrasing, and general data analysis methods, that were used in the pre-intervention surveys (i.e. Chapter 2). The surveys involved university-aged Chinese Singaporean students (fluent in both English and Mandarin) conducting in-person, tablet-based surveys with Chinese Singaporean members of the public, outside of public places such as malls and food centres. These locations were selected to capture differing socio-demographic levels, and survey collection timings were stratified across day of week and time of day. See Appendix 5.1 and Chapter 2 for methodology details.

The post-intervention survey was piloted (~50 surveys) at the National University of Singapore and a public mall not used in our study. Through our survey methodology, particularly via neutral question phrasing, we aimed to reduce social desirability bias (i.e. unintentionally prompting respondents to answer a certain way based on their perceptions of the researchers) (Althubaiti 2016). Additionally, we chose to survey two months after the intervention ended in order to trade-off two slightly opposing biases: 1) respondents may forget, or mis-remember, their own behaviour (Althubaiti 2016), and thus it's useful to reduce the timespan respondents have to recall; and 2) behaviour change often decays with time (Allcott & Rogers 2014), and thus allowing more time to pass may give a more realistic assessment of intervention effects.

The survey primarily asked about respondents' preferences for fever and heatiness treatments (which is where we identified 'high-fidelity' saiga horn users), and their demographic information. Another question asked respondents which animals they think are common in the wild (out of a list of animals often used in TCM), in order to gauge their awareness of the saiga's conservation status. This question was asked prior to any questions regarding the intervention. Additional

questions asked respondents about any changes to their treatment preferences, and their knowledge of, and potential effects from, the intervention. See Appendix 5.2 for the full survey.

Intervention Recall and Exposure

To measure recall of the intervention message without prompting respondents as to the content of that message, we stated to participants only that there had been some 'media attention in the last four months about a TCM treatment for heatiness and fever called ling yang'. We then asked respondents if they had heard about it. All those who indicated that they had, or may have, heard about this media attention, were labelled as stating intervention message recall. We then asked them how they heard about it, and what the media attention was about. These answers were coded. Answer content relating to saiga as an endangered/protected animal, the poaching/killing of saiga, and raising awareness of saiga, were taken to indicate the respondent was likely accurately recalling elements of the intervention message. Responses could contain more than one type of content.

Behaviour Change

There were two means of assessing behaviour change among the target audience. Firstly, immediately after respondents discussed their treatment preferences, they were asked whether their preferences had changed for any reason in the last four months (with no mention of the intervention). Secondly, respondents who stated they recalled 'recent media attention' were asked whether this media attention affected their choice to use ling yang. At this point, respondents indicated whether prior to the media attention they used ling yang or not and whether they currently use ling yang or not. This was followed by an open-ended 'why' question (Appendix 5.2). Through these intervention-specific answers we identified: pre-intervention saiga horn users, whether these users decreased their usage post-intervention, and their reason for changing behaviour.

5.3.2 Shopkeeper Surveys

We conducted a cross-sectional TCM shopkeeper survey (in 2019). We defined anyone working at the counter during a survey as "shopkeepers". In the pre-intervention consumer survey, TCM shopkeepers were a top recommender of saiga horn, and TCM stores were the most commonly cited location to purchase saiga horn (Chapter 2). Thus, TCM shopkeepers were well-placed to witness potential changes in saiga horn sales trends. Through this dataset we assessed:

- shopkeeper perception of the saiga's conservation status,
- shopkeeper recall of the intervention message,
- perceived customer behaviour change due to the intervention message,
- and shopkeeper behaviour change due to the intervention message.

Using the same survey team, we surveyed TCM shops within the Planning Areas (i.e. neighbourhood districts) or surrounding Planning Areas where we conducted our consumer surveys – in order to have some rough comparability between consumer and shopkeeper surveys (Chapter 2; Appendix 5.1) (URA 2014). An online search for 'TCM stores' using Search.insing.com yielded about 900 results across Singapore. With this number as an estimated total for TCM shops, we aimed to survey 90 shops with a 10% margin of error and a 95% confidence level (assuming random sampling), which we felt was acceptably robust and feasible to obtain (Israel 1992). Using this directory and Google Maps to identify shops, we randomly selected shops to visit. Where shops did not sell saiga horn-like products (e.g. acupuncturists' offices), or were permanently closed, we randomly selected another shop. Those that were open and did sell relevant products (i.e. TCM products similar to saiga), were asked to take the survey. Regardless of whether they agreed to take the survey, we used visual cues and discussions during the survey process to assess whether they sold saiga products. Visible evidence included: products that were labelled as 'ling yang' with no reference to them being made from a non-saiga alternative; products that explicitly stated they

included saiga horn; and products that were evidently saiga horn (e.g. intact horns). See Appendix 5.1 for more survey method details.

Shopkeeper surveys were structured similarly to consumer surveys: first asking about customer's preferences for heatiness/fever treatments (for both their overall customer base and their middle-aged female customer base), then asking which animals used in TCM were common in the wild, followed by intervention-specific questions, and finally shopkeeper demographic questions (see Appendix 5.2 for the full survey). The survey was piloted with 20 TCM shops not included in our study. This piloting process, along with iterative survey drafts, helped to minimise social desirability bias and ensure shopkeepers felt comfortable discussing sales trends and customer preferences.

Intervention Recall and Exposure

Through piloting we found that an introduction was needed to justify to shopkeepers why we were bringing up media attention around ling yang without prompting them to our research interests. Thus, our surveyor stated that there were many factors that can influence or change customers' choices, and that to understand the role of media better we were going to ask about recent media attention from the past four months around ling yang. We then asked the shopkeepers if they recalled this media attention and how they were exposed to it. The recall answers were coded similarly to the equivalent questions in the consumer survey.

Behaviour Change

Like the consumer surveys, the first non-intervention-specific questions assessing behaviour change were open-ended and were asked after shopkeepers described their customers' preferences. Later, shopkeepers were asked whether, in their opinion, the recent media attention had changed sales of ling yang to their middle-aged female customers, or their overall customer

base. We then asked why and to what extent sales had changed. Additionally, we asked whether they thought sales of alternative products had changed, and whether they themselves had changed what products they recommended to customers.

5.3.3 Statistical Analyses

All statistical analyses for the consumer survey results were conducted using the R statistical environment (R Core Team 2017). For pre- and post-intervention comparisons we used the MatchIt package to match the 2017 and 2019 datasets, in order to account for possible sampling variances between years (Ho et al. 2018a). Specifically, we performed an ‘optimal’ match, with a ‘mahalanobis’ distance measure, and a 1:1 ratio. Variables matched include Chinese dialect, education, generation Singaporean, religion, and target audience (for the total sample comparisons).

We then used Generalized Linear Models (GLMs) with sum contrasts applied (Fox 2002), to assess differences (e.g. saiga horn usage) between: pre- and post-intervention datasets, post-intervention target audience and other respondents, and post-intervention high-fidelity users and other respondents within the target audience (Table 5.1). We chose GLMs because they account for differences between the datasets, as well as variance caused by other demographic factors when comparing across groups. We next used 2-sample z-tests for equality of proportions with a continuity correction to assess intervention message exposure sources, and reasons for behaviour change. This test was chosen because the respondent’s answers on these questions were not mutually exclusive. See Appendix 5.1 for full statistical analyses methods.

Table 5.1 Consumer survey analysis questions answered using statistical tests. GLM variable descriptions and variable levels are detailed in Appendix 5.1. Target audience = women aged 35-59 years old. 2017 = pre-intervention sample; 2019 = post-intervention sample.

GLMs with sum contrasts applied
Question asked
Independent = Dependent variables

“+” indicates the addition of a stand-alone variable, “-” indicates the interaction of two variables

Did high-fidelity saiga horn use, across the total samples, change from 2017 to 2019?

High-fidelity use = year – target audience + Chinese dialect + education + generation Singaporean + religion

Did high-fidelity saiga horn use, in the target audience, change from 2017 to 2019?

High-fidelity use = year + Chinese dialect + education + generation Singaporean + religion

Did misconceptions of saigas being common in the wild, across the total samples, change from 2017 to 2019?

Misconception = year – target audience + Chinese dialect + education + generation Singaporean + religion

Did misconceptions of saigas being common in the wild, in the target audience, change from 2017 to 2019?

Misconception = year + Chinese dialect + education + generation Singaporean + religion

Did the 2019 target audience accurately recall the intervention more than the non-target audience?

Accurate recall = target audience + Chinese dialect + education + generation Singaporean + religion + income

Did 2019 high-fidelity users in the target audience accurately recall the intervention more than others?

Accurate recall = high-fidelity user + Chinese dialect + education + generation Singaporean + religion + income

Did the 2019 target audience change their behaviour more than the non-target audience?

Decrease usage = target audience + Chinese dialect + education + generation Singaporean + religion + income

Did 2019 high-fidelity users in the target audience change their behaviour more than others?

Decrease usage = high-fidelity user + Chinese dialect + education + generation Singaporean + religion + income

2-sample Z-tests

Was one (or more) intervention exposure source reported more often than other sources?

Proportion of one exposure source = or \neq proportion of second exposure source

Was one (or more) reason for behaviour change reported more often than other reasons?

Proportion of one reason = or \neq proportion of second reason

5.3.4 Ethics

This research was approved by the Oxford Internet Institute’s Departmental Research Ethics Committee, University of Oxford (SSH-OII-C1A-19-005), and the Institutional Review Board, Nanyang Technological University (IRB-2017-04-018-01).

5.4 Results

Overall, there was no significant temporal change in the prevalence of high-fidelity users in the target audience, however, compared to the non-target audience, the target audience accurately

recalled the intervention message and stated a subsequent decrease in saiga horn usage significantly more often (Figure 5.2). Within the target audience, high-fidelity users were significantly more likely than lower-fidelity users to recall the message and state a behaviour change. Additionally, across all respondents, misunderstandings of the saiga's conservation status decreased significantly post-intervention. Further, saiga horn users who did decrease usage were significantly more likely to cite the intervention message over other topics as their reason for changing behaviour. Those who did not decrease their usage cited saiga horn's efficacy most commonly. Furthermore, TCM shopkeepers accurately recalled the intervention message more than the average customer (Figure 5.2). However, few shopkeepers perceived recent changes in saiga horn sales, and they cited unmeasured external trends (e.g. purchase price and availability) as contributing to potential observed changes.

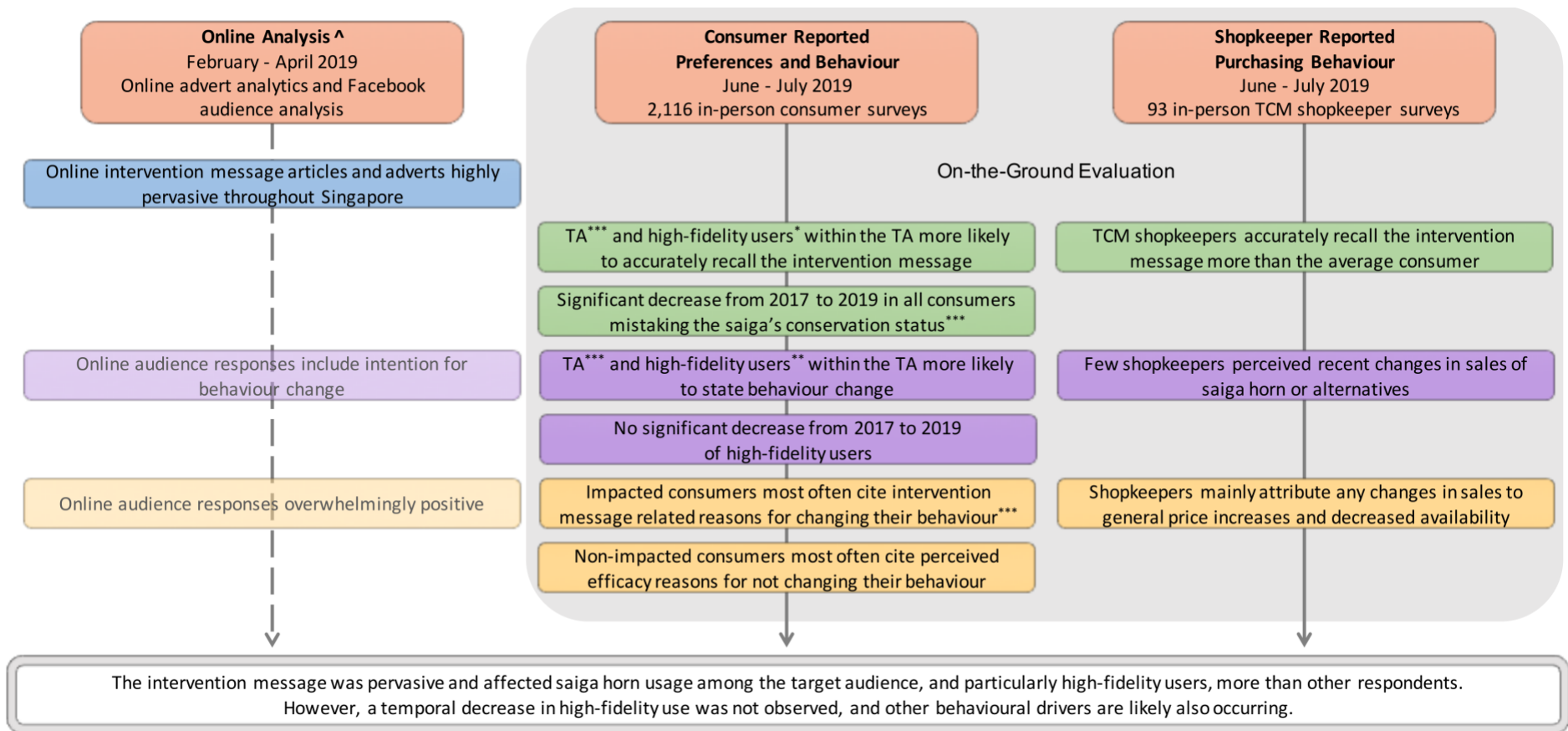


Figure 5.2 Evaluation summary, including key results from multiple datasets that most elucidated intervention effects. Result box colours correspond to the Theory of Change stages outlined in Figure 5.1. Transparent colouring indicates a result was supporting but not central to assessing a stage. TA = target audience (middle-aged Chinese Singaporean women). Statistical significance denoted with * for $p < 0.05$, ** for $p < 0.01$, and *** for $p < 0.001$. ^ Online performance findings are presented in Chapter 4.

5.4.1 Consumer Reported Preferences and Behaviour

In total, 2,116 consumer surveys were conducted post-intervention, in June-July 2019 (see Appendix 5.3 for raw data). For pre-post intervention comparisons, this dataset was compared against the 2,294 consumer surveys carried out pre-intervention, in June-July 2017 (Chapter 2).

High-fidelity use did not differ significantly from pre- to post-intervention (Table 5.2). See Appendix 5.4 for full consumer survey GLM outputs (including all significant and non-significant variables), along with additional findings on consumer treatment preference trends.

Table 5.2 Comparing high-fidelity saiga horn user frequencies pre- and post-intervention. The proportion of high-fidelity users in the total sample, and the target audience specifically, are shown.

	Pre (2017)	Post (2019)
Total sample:	2,294 respondents	2,116 respondents
High-fidelity users	438 (19%)	389 (18%)
- Those who use saiga horn themselves	403 (18%)	343 (16%)
- Those who buy saiga horn for others	223 (10%)	228 (11%)
Target audience:	447 respondents	438 respondents
High-fidelity users	109 (24.4%)	99 (22.6%)

Animal Status in the Wild

For both the total sample, and the target audience, pre-post intervention comparisons show that respondents post-intervention were significantly less likely than those pre-intervention, to mis-identify saiga antelopes as being common in the wild ($\beta = -0.44$, $z = -5.22$, $p = 1.8E^{-7}$; and $\beta = -0.36$, $z = -2.25$, $p = 0.024$ respectively; Appendix 5.4).

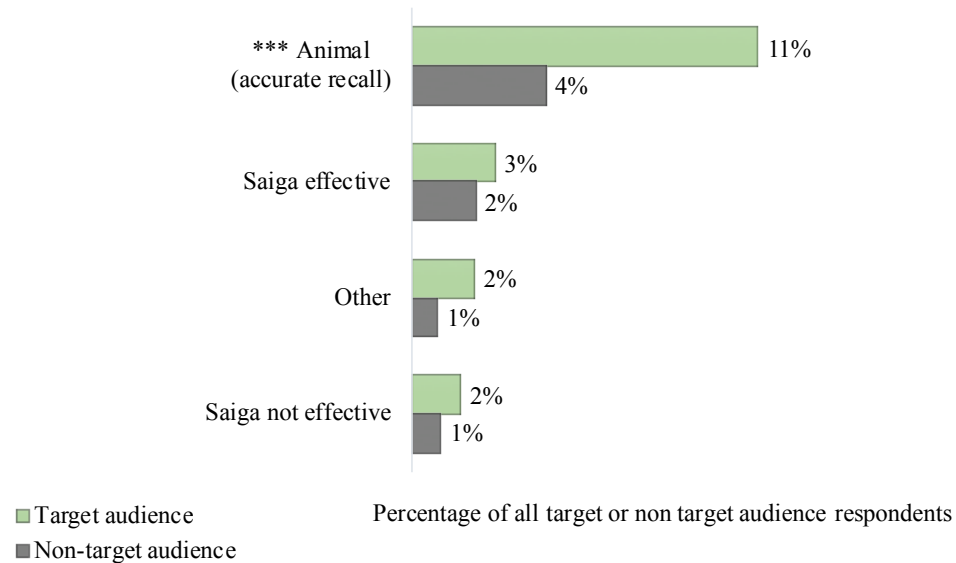
Intervention Recall and Sources of Exposure

Overall, 195 respondents post-intervention stated they recalled some recent media attention about saiga horn (including 69 target audience respondents). Based on descriptions given by

respondents, 124 people (6%) accurately recalled the intervention message (including 50 target audience respondents; Figure 3A). Other descriptions given by respondents most commonly included saiga horn's effectiveness/non-effectiveness (Appendix 5.4).

Target audience respondents were significantly more likely than other respondents to accurately recall the intervention message ($\beta = 0.94$, $z = 4.69$, $p = 2.8E^{-6}$; Figure 5.3A). Within the target audience, high-fidelity users were significantly more likely than other respondents to accurately recall the intervention message ($\beta = 0.46$, $z = 2.02$, $p = 0.043$).

A) Intervention Recall



B) Behaviour Change

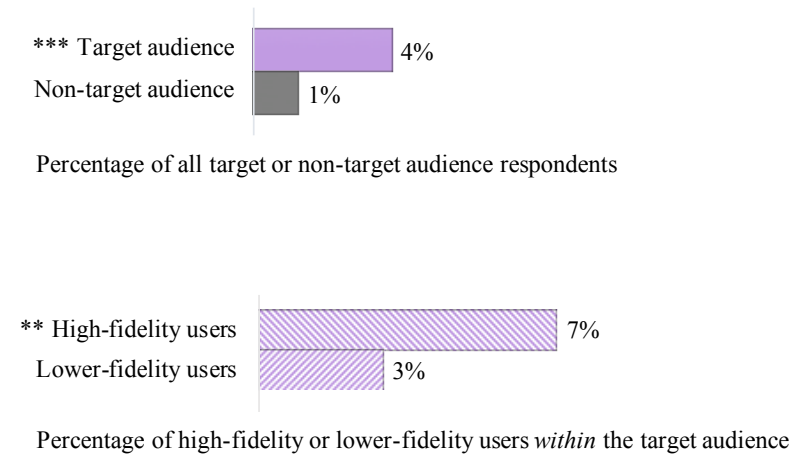


Figure 5.3 A) Content of the ‘media attention’ respondents described. ‘Animal’ content refers to generally accurate descriptions of the intervention message. Percentages are out of the total number of target or non-target audience respondents (438 and 1,678 people respectively). *** denotes a $p < 0.001$ significant association between the target audience and accurate intervention recall. **B)** Stated decrease in saiga horn usage following the intervention for those with accurate intervention recall. Percentages of the top graph are out of the target or non-target audience respondents (438 and 1,678 people respectively). Percentages of the lower graph are out of high-fidelity and lower-fidelity users within the target audience (99 and 339 people respectively). Asterisks indicate the target audience and high-fidelity users within this audience were significantly more likely to state a behaviour change (** for $p < 0.01$, and *** for $p < 0.001$).

The most common ways any respondent heard about the intervention message were the news followed by social media (Appendix 5.4). Respondents with accurate intervention recall were significantly more likely to cite the news or social media over other sources ($\chi^2(1, N = 124) = 15.81, p = 3.5E^{-5}$; $\chi^2(1, N = 124) = 14.88, p = 5.7E^{-5}$ respectively). Respondents with inaccurate intervention recall were significantly more likely to cite family and friends ($\chi^2(1, N = 90) = 3.74, p = 0.027$; $\chi^2(1, N = 90) = 3.78, p = 0.026$ respectively).

Behaviour Change

During general preference questions, no respondent who stated there had been a recent change in their herbal or biomedical treatment preferences mentioned they had switched to these options from saiga horn, or referenced the intervention. However, 9 people (3 target audience respondents) who had selected saiga horn as a product they purchase 'most often' (and thus were categorised as high-fidelity users), also stated that their preference had changed away from saiga horn in the last few months (Appendix 5.4). Four of them (1 target audience respondent) discussed herbal alternatives they were switching to. Two respondents (1 target audience respondent) specifically stated the change was due to news/Facebook posts.

In the intervention-specific questions: among respondents with accurate intervention recall, 38 people (17 target audience respondents), stated that they had fully stopped (or heavily decreased) their saiga horn use (Figure 5.3B). This value included both high-fidelity (14 people) and presumably lower-fidelity (24 people) saiga horn users. These lower-fidelity users are respondents who did not explicitly state in earlier questions that saiga horn was a product they use 'most often', nor that they had recently shifted away from saiga horn. But in these later questions, these respondents indicated they did use saiga horn prior to the intervention. No respondents with accurate intervention recall stated that they increased their saiga horn usage. One non-target audience respondent with inaccurate message recall stated they intended to increase usage.

Target audience respondents were significantly more likely to state they had decreased their saiga horn usage ($\beta = 1.19$, $z = 3.42$, $p = 6.3E^{-4}$; Figure 5.3B). Within the target audience, high-fidelity users were significantly more likely to state they had decreased their usage ($\beta = 1.11$, $z = 3.11$, $p = 0.0019$). A funnel from the total sample down to those stating a decrease in saiga horn use following accurate intervention recall, can be seen in Figure 5.4.

Among all respondents with accurate intervention recall who did decrease their saiga horn use, the significantly most common reason given for changing behaviour was animal-centric: discussing the media attention specifically, the plight of the animal, general pro-environmental opinions, etc. ($\chi^2(1, N = 38) = 19$, $p = 6.5E^{-6}$). Other stated reasons included preferences for saiga horn alternatives and perceptions that saiga horn was ineffective. Among respondents with accurate intervention recall who did not decrease their saiga horn use, the most common reason given was saiga horn's efficacy (mentioned by 10 out of 22 people). Other stated reasons included that respondents felt they didn't use saiga horn often, that they didn't think their purchases alone made an impact, or that they didn't care about the impact.

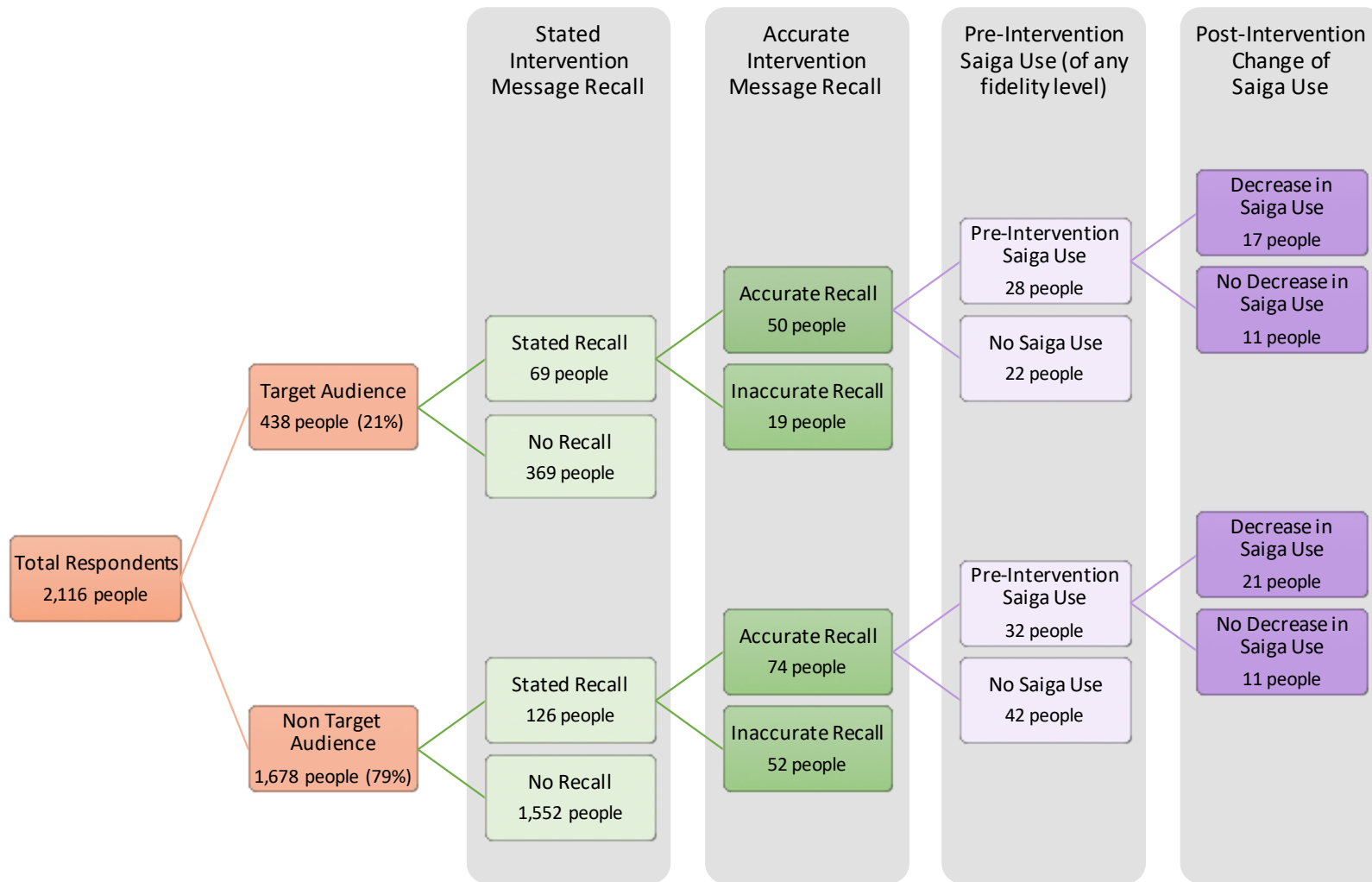


Figure 5.4 A funnel of consumer survey respondents from the total sample through till stated decrease in saiga usage following the intervention. Colours correspond to the Theory of Change stages outlined in Figure 5.1.

5.4.2 Shopkeeper Reported Purchasing Behaviour

TCM shopkeepers at 119 shops were asked to take the survey. Out of which, 93 shopkeepers accepted (see Appendix 5.3 for raw data). All 119 shops were assessed for the presence of saiga horn: 104 had visible saiga horn-like products, and 64 shopkeepers verbally indicated they sold saiga horn during survey-related discussions. We thus confirmed the likely presence of saiga horn at all surveyed shops. There were 116 non-relevant or permanently closed shops that were visited but not surveyed.

There was variation in perceived heatiness/fever treatment purchases between a shopkeeper's target audience customers (mid-aged females) and their overall customer base (Appendix 5.5). They perceived target audience customers as purchasing animal products most (62%), and their overall customer base as purchasing herbal products most (55%). The most commonly purchased animal product was distinctly saiga horn (98% of animal product selections, for both the target audience and overall customer base).

Animal Status in the Wild

When asked if species used in TCM were common in the wild, 16% of shopkeepers stated saiga was common in the wild. Sea cucumber (45%) and goat (34%) were the species most perceived as common in the wild, while rhino (1%) and turtle (0%) were the least. When answering this question the shopkeepers discussed: saiga being a protected/'endangered' species (16 people), other species populations doing well (16 people), restrictions on saiga products (14 people), and farming of other species (13 people; Appendix 5.5).

Intervention Recall and Sources of Exposure

Overall, 23 shopkeepers said they recalled recent media attention about saiga horn. Eight shopkeepers (9%) accurately recalled the intervention message. Inaccurate message recall topics included: saiga being effective, 'other' answers, and saiga bans/restrictions (Appendix 5.5).

Shopkeepers predominately stated they heard about this recent media attention through 'news outlet/newspaper' (13 people) and 'other' sources (8 people; Appendix 5.5). When asked to elaborate on 'other', shopkeepers mentioned things like company training books, personal experience, Google searches, and radio broadcasts. Those with accurate intervention recall specifically listed these sources and social media the most often.

Behaviour Change

In the non-intervention specific questions, one shopkeeper stated they had seen a recent decrease in saiga horn purchases across customers, but they did not know why. Another shopkeeper stated that they had seen a recent decrease among the target audience and believed this was due to increasing prices of saiga horn products. There were no stated recent changes for other treatment types.

In the intervention-specific questions: among those with accurate intervention recall, one shopkeeper perceived a decrease in saiga horn purchases across customers, including the target audience (Figure 5.5). They did not know the amount it decreased, but also said it was due to increasing saiga horn prices. Among those with an inaccurate message recall, four shopkeepers stated they had seen a decrease in saiga horn purchases, ranging from an unknown amount, to 25%, and more than 70%. They stated it was mainly due to saiga horn prices and changing customer preferences. Shopkeepers who stated there had been no sales change predominately discussed

saiga horn's efficacy, along with topics like tradition. No respondents mentioned an increase in saiga horn purchases.

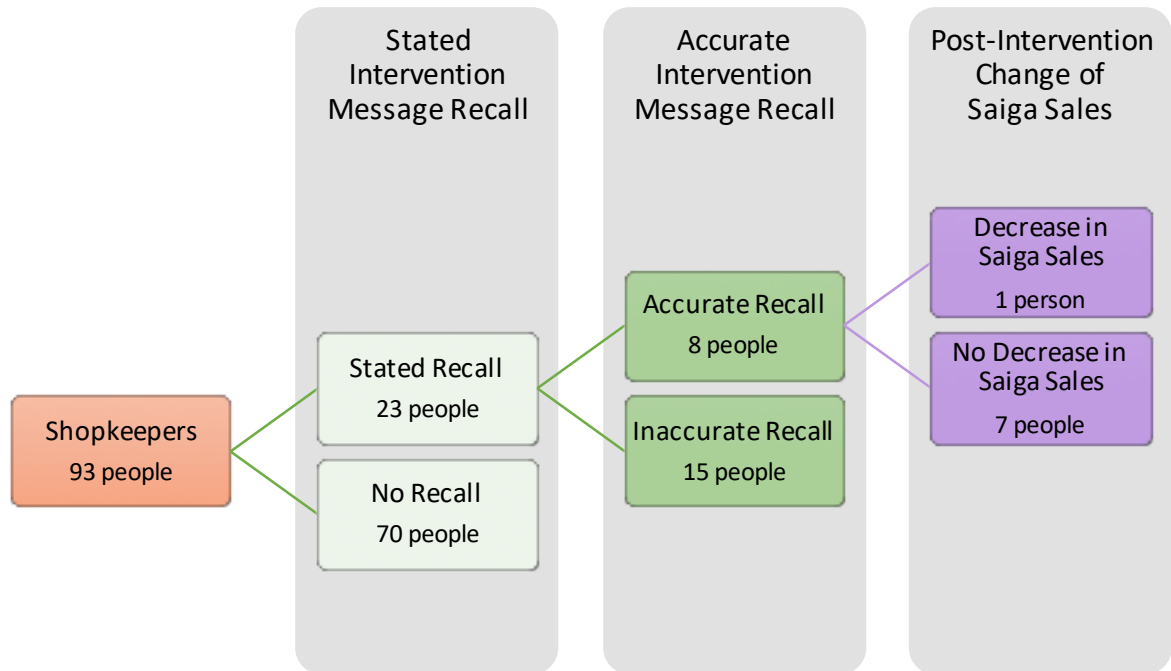


Figure 5.5 A funnel of shopkeeper respondents from the total respondent pool through till perceived decrease in saiga sales following the intervention. Colours correspond to the Theory of Change stages outlined in Figure 5.1.

Four shopkeepers with inaccurate intervention recall perceived there had been an increase in alternative products sales due to prices of saiga horn, convenience, the loss of tradition, and decreased imports of saiga horn. Further, three shopkeepers with inaccurate intervention recall said that they now recommend saiga horn less. Two said this was because of saiga horn prices and import regulations, while a middle-aged female shopkeeper cited decreasing saiga population numbers as her reason.

5.5 Discussion

5.5.1 Overview of Impacts

Our multi-pronged evaluation confirmed that the intervention did reach and affect members of our target audience of Chinese Singaporean women aged 35-59 years old. Specifically, 61% of previous saiga horn users in the target audience with accurate intervention message recall, stated that they had fully stopped (or heavily decreased) their saiga horn usage following the intervention, and when asked why, these respondents mentioned intervention message-related reasons significantly more often than other reasons. These findings were supported by online sentiments during the intervention, in which some individuals stated they intended to change their behaviour in response to the intervention message (Chapter 4). Additionally, across all respondents there was a significant decrease from pre- to post-intervention in mis-perceptions that saigas are a common species in the wild, which was similarly supported by online responses indicating the message informed individuals of the saiga's conservation status (Chapter 4).

We did not, however, find a significant decrease in proportion of high-fidelity users from pre- to post-intervention, and TCM shopkeepers suggested that sales trends were predominately related to price (rather than the intervention message).

5.5.2 Unpacking the Impact

It is thus worth exploring why our approach did not have a larger discernible impact. One likelihood is that for some saiga horn users, particularly high-fidelity users, their perception of saiga horn's efficacy is a stronger driver of behaviour than external influences like social-level perceptions (Chapter 3). Some respondents with accurate intervention recall did choose not to shift their behaviour, citing saiga horn's efficacy. Some shopkeepers also mentioned efficacy, and cultural tradition, as reasons why sales hadn't decreased. This consumer sub-group is thus not likely to be

influenced by conservation or social messaging alone. Trying to shift their perception of saiga horn's efficacy using biomedicine-based reasoning is also not likely to prove effective, given TCM users' trust in their own experiences, and in the longevity of usage, as an indicator of product efficacy (Spence & Li 2013; Chung et al. 2014). Consequently, this sub-group would probably be more affected by regulatory-type interventions that impact access to, or affordability of, saiga horn (Park & Barker 2020).

Another key possibility is that the study was under-scaled. The intervention design centred around the concept that individuals are more likely to adopt ideas they are exposed to repeatedly and in diverse ways (Zhou et al. 2015). Despite having notable online reach, with the intervention generating high rates of individuals engaging with and sharing intervention message adverts and articles (Chapter 4), it is *unlikely* we reached a saturation point of repeatedly exposing the entire target audience within Singapore to the intervention message in potentially change-inducing ways. Past research indicates there is variation in the number of repeated exposures that are necessary for different adverts to be effective (Schmidt & Eisend 2015). As such, it is possible that given a longer-running intervention, and thus increased target audience frequency of exposure, more of the nation's target audience would have adopted the intervention message.

The timing of the post-intervention survey may have also impacted results. A challenge in doing cross-sectional surveys is that they are only snapshots of a study context. We surveyed two months after the intervention ended to minimise inaccurate respondent recall. However, even if a respondent's perceptions of saiga horn may have changed, because saiga horn is only used when an individual is unwell, it is likely that many individuals did not yet have a reason, in that short time period, to consider acting upon a newly formed perception, or to identify as a non-saiga horn user based on a changed behaviour choice.

Variability in Saiga Horn Use

For our intervention we assumed that everyone who identified as a high-fidelity user had the same attachment to the product. However, the conflicting statements about saiga horn use in our results (i.e. respondents selecting saiga horn as a product they use 'most often' but then stating they had actually switched to other products) indicates that not everyone who was categorised as a high-fidelity user may in fact still use saiga horn all that often, or be attached to saiga horn products to the same extent. For example, we know that high-fidelity users are also likely to use traditional herbal products (Appendix 5.4), but the frequency with which they employ either treatment type is not known. On a related note, our treatment preference questions were designed to identify high-level users, not those who had used saiga horn in the past, or those who use it infrequently. This was done in order to identify a target group whose behaviour change would be most impactful. But because of this choice, we were unable to gauge temporal trends among more 'peripheral' users, though our findings show that this lower-fidelity group did include people who stated that they had changed behaviour. All of which suggests that future work should better segment consumer-groups by levels of usage, and gather psychographic information that would better unpack user fidelity to the product (Liu et al. 2012; Haustein & Hunecke 2013).

5.5.3 Additional Considerations

Response Bias

There are a number of challenges around using recall to measure impact (Althubaiti 2016). For instance, consumers may have known about the intervention message, or been affected by it, but they may not have realised what we were referring to during the survey. Additionally, the finding that respondents with inaccurate message recall mostly cited family and friends as the message source, rather than social media and news, speaks to the diminished accuracy of word-of-mouth information (DeFleur & Cronin 1991). Lastly, when recounting behaviour, it is expected that some

individuals will mis-remember their own behaviour, or possibly downplay behaviour they think is socially undesirable (Althubaiti 2016), which is precisely what our intervention message attempted to promote about saiga horn.

It is thus possible that, for the intervention-specific behaviour questions, some consumers felt uncomfortable to reveal saiga horn usage after having described the intervention message (e.g. through value priming or social priming) (Molden 2014; Loebnitz & Aschemann-Witzel 2016). We strove to mitigate social pressure through question phrasing that would not prompt respondents into thinking that we, as researchers, wanted a particular answer regarding their behaviour. In confirmation, there were a number of respondents with accurate intervention recall who still stated they were continuing to use saiga horn. And no consumer respondents seemed visibly uncomfortable or made comments to suggest they believed we were affiliated with, or promoting, the discussed media attention.

For our third-party reported dataset, we would have preferred quantitative sale trends data. However, this was inaccessible so we conducted TCM shopkeeper surveys. These surveys proved challenging as many shopkeepers were busy, unwilling to answer questions, or keen to discuss off-topic narratives. For example, immediately after the surveyor had stated we were interested in recent media attention, many shopkeepers instead discussed old company textbooks, 'years of experience', etc. We also realised from the survey results that it might be difficult for shopkeepers to recognise or differentiate short-term changes from broader trends, especially since they did not have sales data to reference.

Additionally, Singaporeans do not always divulge their full medical choices to health professionals like TCM practitioners or biomedical doctors, for fear of disapproval (Lim et al. 2005; Chang & Basnyat 2014). So even though our customers may take advice from TCM shopkeepers, they may

not be willing to disclose their *own* reasons for selecting, or changing, purchase preferences. For example, consumers switching away from saiga horn may have cited more neutral reasons, like price, instead of value or norm-related reasons relating to wild animals, for fear it would be sensitive to shopkeepers with wild-derived products.

Possible confounders

There were no other saiga horn related interventions or major media attention running in Singapore between the baseline and evaluation periods that would confound attribution of our intervention's impact. There was one news story about saiga horn seizures in China near to the evaluation time, but this was only mentioned by a single non-target audience respondent. There was also a letter sent out by the government to TCM shops during our 2017 surveys which reminded shopkeepers that saiga horn products require proper permits, but many shopkeepers had no recollection of this particular letter. There was mention among shopkeepers, though, of increased regulation and decreased availability as a general trend, which may be linked to government or industry communications like that letter, which we are not privy to, but which could impact shopkeepers' sensitivity around discussing saiga horn, or their recommendation of the product to consumers.

5.5.4 The Bigger Picture

The use of online social networking sites for public health goals is increasing, but many of these efforts are only observational in nature (Capurro et al. 2014). Similarly, there have been numerous online efforts to increase sustainable consumption (UNEP 2016; WCS Perú 2019); however, few efforts have robustly assessed how their online work translates to offline behaviour change (Young et al. 2017). Furthermore, no other efforts directly targeting wildlife product consumers, to our knowledge, have utilised our specific online approach of strategically spreading news information, nor evaluated this approach's impact on offline behaviour.

Given the pitfalls that can occur in evaluating large-scale projects (Sherry 1997), we strove to use an evaluation design that was both robust and feasible. Since our goal was for country-level change and our baseline research incorporated demographic information, our target and non-target audiences were based on an entire demographic, rather than on who was exposed to the intervention, or who was definitively a saiga horn user. We also selected a cross-sectional design rather than a longitudinal one, as a longitudinal design at the country-level was cost-prohibitive (Rafferty et al. 2015).

If we relied solely on online performance metrics indicating intervention reach and immediate engagement (which are often the measures of success in wildlife trade interventions (Veríssimo & Wan 2019)) we would have over-characterised our intervention's impact. Through our multi-pronged evaluation, we could more accurately discern how, and how not, the intervention was effective. Despite high public exposure and promising online engagement, we yielded only a small number of people who had decreased their saiga horn usage and who *explicitly* indicated this was due to the intervention. However, even in fields like public health, where interventions tend to be better funded, meta-analyses highlight that single interventions often have relatively small effect sizes (Snyder et al. 2004; LaCroix et al. 2014). In addition, it is expected that behaviour change interventions will have heterogenous impacts on a target audience. Some implementers even argue that focusing on average impact per person, rather than total proportion of people impacted, is a more insightful gauge of an intervention's success (Attanasio & Cavatorta 2017). We thus need to be realistic in our expectations of unsustainable consumer intervention impacts, and more nuanced in our understanding of them. In sum, our evaluation found the online intervention approach did impact perceptions and behaviour of consumers, and suggests that employment of this approach could benefit global sustainable consumption efforts. Though overall effect size, particularly on users of varying product fidelity, warrants improvement in future efforts.

Behaviour change interventions are iterative processes (MRC & NIHR 2019), and no study system is stagnant, nor identical to any other system. Consequently, regardless of an intervention's impact, we should carefully and transparently document what was and was not effective, and what led to this outcome, so that future interventions can learn from these efforts. A recent review of behaviour change interventions on wildlife product consumers found that only 25% reported outcomes regarding behaviour or awareness changes resulting from an intervention (Veríssimo & Wan 2019). Among this 25%, there was a dearth in transparency regarding evaluation methodology and robustness. Evaluation, though, affords the opportunity to use resources effectively by learning from past work, thereby provoking ever-adapting, larger, and more timely impacts.

5.6 Acknowledgements

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5.7 Supplementary Materials

[Appendix 5.1](#) Additional Survey Methodology Details

[Appendix 5.2](#) Full Surveys (*separate file*)

[Appendix 5.3](#) Raw Data (*separate file*)

[Appendix 5.4](#) Supplementary Consumer Results

[Appendix 5.5](#) Supplementary Shopkeeper Results

Chapter 6 Discussion

6.1 Meeting the Aims and Objectives

This thesis had five research objectives and two overarching aims. Objectives 1 – 4 helped to achieve the primary thesis aim of carrying out an evidence-based behaviour change intervention on saiga horn in Singapore: one which was informed by a strong understanding around the drivers of saiga horn consumption. Specifically, Objective 1 (assessing Singaporean trends in saiga horn usage and consumer preferences) was met through Chapter 2. Here the extensive consumer surveys provided key findings such as 19% of Chinese Singaporeans were high-fidelity saiga users, and that middle-aged women were the most likely to purchase saiga horn for other people. They also found that “it works” and “someone recommended it to me” were the main reasons for using saiga horn, and saiga horn users were significantly more likely to mistake the saiga for being common in the wild.

Objective 2 (using theory and empirical evidence to develop a detailed understanding capable of informing an intervention) was addressed through Chapter 3. Using Social Cognitive Theory (SCT), literature on medical pluralism and health information seeking behaviour, along with consumer surveys and focus groups, we mapped out the main influences on middle-aged women’s usage of saiga horn. A set of influences relating to social-level perspectives, impersonal information channels, and interpersonal networks, were then selected to inform a behaviour change intervention.

Objective 3 (implementing a tailored behaviour change intervention on saiga horn) was met through Chapter 4. We used Chapter 3 and additional focus groups to design and implement a

country-level intervention targeting saiga horn consumption among middle-aged women. The intervention spread the intervention message via targeted online advertising of news articles, so that the target audience was exposed in diversely repeated ways, and with added social reinforcement. An immediate online analysis indicated the chosen message and delivery approach garnered an overall desirable audience response.

Objective 4 (evaluating intervention impacts on the target audience's perception and usage of saiga horn) was addressed via Chapter 5. Offline pre-post intervention consumer surveys and post-intervention shopkeeper surveys, found high-fidelity saiga horn use decreased from 19% to 18%, and post-intervention respondents were significantly less likely to mistake the saiga as being common in the wild. Compared to the non-target audience, the target audience (and especially high-fidelity saiga users) were significantly more likely to accurately recall the intervention message and to report decreasing their use of saiga horn. They also specifically cited the intervention message as a reason for changing behaviour.

Objective 5 and the second thesis aim of highlighting methods and findings that can be used in future demand reduction efforts, were also met through Chapters 2 – 5. For example, through the novel application of strategically spread news articles for a conservation intervention, or via our findings around the intricate social influences on the usage of a wildlife product.

6.3 Wider Discourse

6.3.1 Intervening on the Interveners

Despite calls for and progress towards robust behaviour change interventions in wildlife trade demand reduction (Greenfield & Veríssimo 2018; Smith et al. 2020), the paradigm has been slow to shift. There still exists the underlying perception that behaviour change is a Superman-like fix in

which we can win-over 50% of consumers in a six-month campaign with Jackie Chan. But human behaviour is complicated. There are an infinite number of influences from before we are born ranging till after we select an item from a store shelf, that lead us to making that single pro- or anti-environmental 'choice' (Gifford & Nilsson 2014). It is naïve of us to think that we can haphazardly change behaviour in a desirable and scalable way without a clear understanding of the behaviour and at least the major factors contributing to it, not to mention an understanding of what the potential impacts of our efforts may be (Travers et al. 2019).

Informing the Intervention

There is a need for implementers to first consider the latticework of social, cultural, and political influences that a given behaviour is existing in, and then select the choice of intervention channels and messaging that are most appropriate (Heberlein 2012; de Lange et al. 2019; Park & Barker 2020; Thomas-Walters et al. 2020a). For example, the social and cultural insights gained in Chapter 3 allowed me to formulate an intervention message in Chapter 4 that was not only more likely to be successful because it was tailored to my audience (Hine et al. 2014), but one that, for the vast majority of my audience, did not incite a negative response. Chapter 5 then confirmed the work did not have discernible negative impacts such as increasing saiga horn usage among my target audience.

There are also a plethora of different behaviour change techniques that implementers could utilise (Osbaldiston & Schott 2011), however, it seems most wildlife trade behaviour change interventions rely on only a handful of non-study-site-specific approaches. For instance, the blanket use of celebrities in demand reduction marketing campaigns is widespread, but their perceived inherent effectiveness has been contested (Duthie et al. 2017), and their use has been critiqued as sometimes colonialist or promoting prejudice (Margulies et al. 2019). Instead of using celebrities, implementers could find more creative or applicable voices to give their intervention message

social clout, such as Chapter 4's exemplification of using Singaporean news outlets, and a Singaporean university, as the intervention messengers, so to speak.

Michie et al. (2008) for example, suggests there are at least 136 behaviour change techniques spanning 12 theoretical domains that are used to influence human health behaviour (as well as other non-health behaviours). Some of which are less applicable to wildlife trade, but others, such as building up to a behaviour by systematically shaping/reinforcing surrounding or related behaviours until the desired behaviour is achieved, might prove useful (Michie et al. 2008). In addition, Münscher et al. (2016) details 9 nudge specific techniques that target a given behaviour by changing the choice architecture (i.e. context) in which the behaviour occurs. Many of these context 'tweaks' could also have applicability to influencing wildlife consumer behaviour, e.g. reducing meat consumption by making vegetarian dishes the default option on a menu (Campbell-Arvai et al. 2012).

However, due to the complexity of human behavioural webs, we should not expect interventions to be automatically transferable from one study system to the next. This thesis illustrates the stepwise nature of interventions, in that each research chapter is dependent upon the previous chapter. Thus, if an implementer changes the consumers or product being studied in the initial empirical data collection stage, then all subsequent stages will be affected. This argument, though, does not mean that the techniques, approaches, or lessons learned throughout this thesis in themselves are not transferable, just that an intervention in a new study system needs to be built from the ground up: incorporating the methods and concepts most appropriate to that system (MRC & NIHR 2019).

Lastly, consumer landscapes inherently change over time (Steenkamp & Maydeu-Olivares 2015). An intervention that was effective 10 years ago will likely not work the same today, and the

permanence (i.e. sticking power (Allcott & Rogers 2014)) of intervention impacts from even the most effective interventions will also ultimately decay because of this changing landscape. As such, shifting consumer behaviour alone will likely not permanently reduce demand. If no other changes also take place (e.g. legislation or product availability) then at some point in time the demand may reoccur.

Outcome Expectations

Not only do implementers need transparent and robust measurements to determine what an intervention's impact actually is, we also need to readjust our perception of what impact we *expect* to have. Given the mentioned intricacies in human behaviour, and the inherent heterogeneity in target audiences, we cannot expect to change behaviour quickly, or unanimously. The evaluation in Chapter 5 of this thesis was carried out two months after the intervention ran (in an effort to reduce recall decay) and found that despite pervasive spread of the intervention message among a highly targeted audience in an interconnected and relatively delineated space, accurate recall for the target audience was 11%. And behaviour change of saiga horn users within this accurate recall group was 17 people (61%).

The impact of 'successful' interventions varies widely, but in general is it likely much more modest than what conservationists envision or report (e.g. questionable reported shark fin campaign impacts in China (WildAid 2014)). For instance, in meta-analyses, effect sizes are calculated as a means of comparing the results from multiple different studies (Michie & Abraham 2004; Osbaldiston & Schott 2011). An effect size of 0.20 can be interpreted as 8% of participants performed more of the target behaviour than they would otherwise have been expected to without the treatment; an effect size of 0.50 refers to 19% of participants, and 0.80 refers to 29% (Cohen 1988; Osbaldiston & Schott 2011). When looking at meta-analyses of public health interventions, which are traditionally better funded than conservation, the reported effect sizes can often be seen

as small to moderate (Michie & Abraham 2004). As examples: mass media interventions promoting condom use had an average effect size of 0.25-0.39 (LaCroix et al. 2014), eHealth interventions for mental health had an average effect size of 0.24 (though some ranged up to 0.69) (Stratton et al. 2017), and online social marketing health behaviour campaigns had an overall effect size of 0.19 (Cugelman et al. 2011). Though these values do not directly compare (without further calculation) to the way impact was calculated for this thesis for example, they do highlight that even among successful interventions, the actual proportion of individuals affected by the intervention is often smaller than we think.

Additionally, it should be emphasized that plenty of behaviour change trials in public health do not yield statistically significant results at all (US NLM 2020), and even if they do, since proportion of individuals affected, or the amount they are affected, can be small, the trialled approach may still not be cost-effective (Michie & Abraham 2004). This is likely why there exists an emphasis on piloting in public health. Pilot testing helps indicate to implementers what effect size they can reasonably anticipate from a full intervention, and thus help determine if an intervention roll-out would be a good use of resources or whether more refining and testing is needed (MRC & NIHR 2019).

It is important for conservationists to recognise what impacts they can realistically expect for a given behaviour change intervention, so that we can deflate currently inflated perceptions of impact feasibility. These unrealistic expectations ultimately harm conservation by disincentivising organisations from conducting robust evaluations, or from reporting evaluation methodology details and accurately stated impacts, because organisations inevitably cannot meet the false ideals expected by funding bodies. All of which perpetuates a system where funding is further siphoned into ineffective projects, as opposed to encouraging the improvement of these projects.

A Whole-System Perspective

Interventions can be targeted at different levels (Cleary et al. 2012), such as at the consumers purchasing a product, the industries selling the product, or the laws enabling product consumption to occur (either through legislation itself or the lack of enforcement). They can also be targeted at different scales (Domegan et al. 2016). For example, an intervention could target individual consumers and policy makers, or it could target community groups composed of consumers and the international agreements influencing policy makers. Further, direct 'behaviour change' may well not be applicable or the best approach for a given target level and scale. Instead, implementers may realise that structural changes (e.g. reducing home energy consumption through policies that make insulation free for homeowners) or technological changes (e.g. making said insulation more effective) are a better use of conservation resources in a given study system (Heberlein 2012).

Ultimately, a combination of multiple intervention types and levels is likely to be the most effective for wildlife trade demand reduction in the short term, and the most permanent in the long term. There are arguably three interlinked reasons for this outcome. One, as stated, behaviours do not exist in isolation and thus there are likely a number of different influences from different levels that are resulting in the target behaviour. Two, changes at different levels often feed into one another. For instance, a shift in public norms is often necessary, or the catalyst, for new legislation, and enforced legislation can in turn help establish a new public 'normal' (e.g. smoking cessation in the United States (Nelson et al. 1994; Tang et al. 2004)). Three, multiple interventions over time can cumulate in behaviour change (e.g. decrease in poaching and demand of Lora parrots on Bonaire island due to a combination of subsequent interventions and events (Salazar et al. 2019)).

As such, in social marketing there has been a push for 'systems thinking', in which implementers consider the entire system in which a given behaviour occurs, and strive to address the issue

through multiple angles, in other words, “getting *all* eyes on the problem” (Domegan et al. 2016). Public health literature similarly shows calls for multi-level interventions that address undesirable behaviour using simultaneous approaches at different levels (Riekert et al. 2013; Kaufman et al. 2014). A mass matrix of intervention types and levels of implementation could thus be mapped solely across the demand end of any given wildlife product, not to mention across the trade chain or supply end. Deciding which intervention approach to take is therefore a non-negligible component of the intervention development process. As shown in Chapter 3, implementers should consider which intervention level and target is appropriate to the study system, feasible to carry out, and has a reasonable likelihood of success.

Shifting the paradigm

Given the many components that would improve demand reduction conservation – what could speed-up a shift towards more evidenced, evaluated, and effective interventions? Probably many factors. A paramount player, though, will be funding bodies. By not only stipulating that human interventions be based on robust evidence, incorporate human behaviour theory, and have transparent evaluation, but also by providing the funding and timelines to allow for this work to be carried out, funding bodies could, fairly quickly, change the expectations of what a demand reduction intervention ‘should’ look like. And if this expectation is made publicly popularised by both these bodies and conservationists themselves, then it could put pressure on conservation organisations who rely instead on private donors, to also implement interventions in this rigorous manner. In essence, the culture in conservation around behaviour change interventions, needs an intervention, or two.

6.3.2 A Philosophical Rabbit Hole

For any behaviour change intervention, including the one in this thesis, there exists the fundamental question of whether we should be shifting others’ behaviour at all. For example, in

disciplines with behaviour change intervention approaches, discourse abounds on topics such as what constitutes as paternalism (i.e. undermining an individual's autonomy in order to influence them into making a choice that will make them better off) and whether paternalism is justified (Sunstein & Thaler 2006; Häußermann 2020). So how far should an external body, be it a conservation organisation or a government, be expected or allowed go to ensure that wildlife is saved for the 'greater good' or even just for another person's preference (Veríssimo et al. 2019)?

There exists a number of lenses with which to situate a possible answer to whether one should intervene for conservation. For instance, an anthropocentric lens would consider human actors in a conservation system (Vucetich et al. 2018) – assessing the needs of these actors and the impacts of a possible intervention on them, only considering the value of non-humans (e.g. wildlife) in regards to the services they provide for humans. A non-anthropocentric lens, though, would consider non-human actors alongside humans. Vucetich et al. (2018), for example, argues that the subject of 'social justice' does include non-human actors and thus if upholding the standard of "no human should infringe on the well-being of others any more than is necessary for a healthy, meaningful life" then one must consider impacts on non-humans as well. This lens usually implies that non-humans have intrinsic value regardless of what they provide to humans (Vucetich et al. 2019), as such *their* needs and survival must be weighed when determining whether an intervention is justified. Ethical debates on topics like trophy hunting and wildlife trade are often tied to discussions around the intrinsic versus non-intrinsic value of wildlife as many people (and cultures) globally feel that non-humans do hold intrinsic value while many others do not (Coals 2019; Vucetich et al. 2019). But aside from the overarching lens that is used to view a possible intervention, any action on its own (e.g. the act of intervening or the method used to intervene) can also be assessed for its ethical validity. For instance, Immanuel Kant would argue that there is a moral imperative for/against any given action based on the idea that each action is inherently good or bad regardless of any one situational positive or negative outcome (Macdonald et al. 2016).

Contrasting this view, however, a more consequentialist philosopher like Jeremy Bentham would argue that an action's ethical validity is determined by the outcome it produces in a given situation (Macdonald et al. 2016). In sum, the initial proposed question of whether we should intervene for conservation could thus be analysed using a number of philosophical perspectives. The discussion in the following paragraphs of this section is limited to just one of these perspectives: an anthropocentric lens with a consequentialist viewpoint.

Given the current COVID-19 pandemic and debates around vaccines, societies are having to ask: at what point is someone's personal right to not put something into their own body outweighed by that action's impact on other people (Schwartz 2020)? The same question could be asked about conservation. Does one individual fulfilling a personal 'need' (be it protein, clothing, status, or religion) by using wildlife, hold weight against another's potentially mutually exclusive need for that wildlife not to be used, or for it to be used in a way that prolongs its availability to everyone? At what point does one need outweigh the other, and does the specific need an individual is fulfilling affect its weight? It is generally viewed that fulfilling subsistence or basic needs is intrinsically important (United Nations 2015), and if considering a classic model like Maslow's hierarchy of human needs (Maslow 1987), then the more basic the need, the weightier it is. By this argument, a vaccine intervention that allows another individual to live outweighs a personal, say religious, need not to be vaccinated. In conservation, an individual's need for protein would thus hold substantial weight, implying that their behaviour to obtain this protein should not be intervened upon unless maybe if that intervening maintains the individual's ability to still fill their protein need (Kaimowitz & Sheil 2007). But by the same argument, interventions that prevent a tragedy of the common's scenario (e.g. a situation where no one ends up with the protein they need to survive) (Burger & Gochfeld 1998), might quantifiably outweigh one individual's need for protein.

However, hierarchally classifying human needs has been debated (Rouse 2004), and determining what constitutes as a basic need is also not straight forward. For example, since ailing mental health can cause suicide, a lower quality of life, or physical health conditions that ultimately result in death (Mental Health Foundation 2020), then would not mental health hold weight as a type of basic need? There is growing awareness of the toll of ecological destruction and climate change on mental health (Majeed & Lee 2017; Whitmore-Williams et al. 2017), and through ‘eco-anxiety’ and related psychological despair, such impacts can affect individuals the world over (Albrecht 2011; Usher et al. 2019; The Lancet Planetary Health 2020). Thus bringing us full circle to the question of when do the scales tip and indicate that the impact of one individual’s behaviour on others’ needs, now justifies a conservation intervention.

Given wildlife trade’s often inherently international nature, along with the global reach of eco-anxiety, we must further ask how far away our ‘needs’ can stretch. Do country lines demarcate what wildlife we are allowed to have claim over? Is there a universal value of wildlife that outweighs a given individual’s desire to use it? Some argue that there should be (Dickman et al. 2015; Ives & Fischer 2017; Kendal & Raymond 2019). Dickman et al. (2015) reason that the world’s cultures fluctuate constantly, and thus human action “that has a negative conservation impact does not acquire more validity by being rooted in tradition or culture, as compared with any other motivation...” (Dickman et al. 2015). Instead, they state that biodiversity conservation (which would include interventions) should be based on a universal objective basis for morality that considers the longitudinal needs of all future humans (Dickman et al. 2015). By this argument, a universal need to maintain wildlife for future generations would outweigh an individual’s need to unsustainably use it. This view, however, is not shared by everyone (Manfredo et al. 2017). There is a current push for culturally-relevant conservation (Gavin et al. 2018; Margulies et al. 2019; Owosuyi 2019), implying that ‘moral relativism’ based on cultural differences (Gowans 2019), or at least current political borders, should to some extent determine the boundaries of what we are

allowed to need and have influence over. The extreme end of this reasoning would suggest that no amount of intervening on others' use of wildlife is justified if that individual resides outside of our own cultural or national sphere, unless the intervening was explicitly warranted by their culture or nation. But this rational still does not fully detail how to address international wildlife trade issues, when the behaviour of multiple players along a trade chain spanning many cultures could be intervened upon. In this thesis' research, I am an individual from one culture working on a species from a second culture that is consumed by individuals in a third culture. Would the justification of my research thus have to come from saiga range states, Singapore, or both?

Therein raising the issue of practicality. For instance, even if in support of a universal value of wildlife, in present societies this may simply be unfeasible or unwise to directly push for in a given conservation project (Dickman et al. 2015). It could hamper efforts by reducing uptake among target audiences (St John et al. 2019), and risk accusations of being tone deaf in the current climate of recognising the rights and cultures of non-western races. For example, in order to increase the likelihood that the intervention in this thesis would be successful, to respect the individuals it was targeting (CUREC 2019), and to account for the inherent biases that arise from me being an outside researcher working in a foreign culture, a number of efforts were undertaken to ensure the research was culturally relevant. These included decisions such as 1) collaborating with two in-country researchers (one of whom is of the demographic targeted in the intervention), 2) meeting early-on with both government officials and TCM industry leaders in Singapore, 3) having the field teams in Chapters 2, 3, and 5 be of the Chinese Singaporean community, 4) being careful not to target or criticize TCM as a medicinal system during discussions with participants or during Chapter 4's intervention, and 5) suggesting TCM products instead of biomedicine products as the possible saiga horn alternatives in intervention materials.

But even more foundational than whether or how we should be intervening, we may ask ourselves, what counts as intervening? As discussed throughout this thesis, we are constantly being influenced (Gifford & Nilsson 2014; Park & Barker 2020). Marketing, for instance, heavily influences our decisions to purchase products or select brands, as well as helped mould the very society we live in today (Cim & Kourdi 2011). Schools, as another example (which are notably often government supported), play a significant role in shaping a child well into adulthood (Reber 1986; García Bacete et al. 2014). As such, if we are already being influenced to the extent that our needs, and the behaviours we perform to fill these needs, are demonstrably shaped by influences anyway, then is additional influence ‘intervening’ on an individual’s current behaviour any different?

6.2 Future Research

Harkening back to the intervention cycle displayed in Figure 1.1, conducting behaviour change interventions is a continuous loop, and there are a number of things learned throughout this thesis that I would build upon in future research on this study system. As discussed in Chapter 5, a key change I would make would be to better assess levels of saiga horn usage. I designed the structure of the consumer survey in Chapter 2 based on two main factors: 1) I wanted to identify high-level saiga users, and 2) preliminary work by Theng et al. (2017) along with anecdotal discussions during our scoping trip, suggested that the individuals using saiga horn products were not necessarily the ones buying it. As such, the survey structure included an extensive decision tree on purchasing products for other people, in order to tease out this buying pattern and to see if trends in purchasing for oneself were different than trends when purchasing for other people. The structure was thus a trade-off between self-using details and buying-for-others details. The resulting survey outcomes were able to show us that middle-aged women were primary buyers for other people, which was key to our intervention. But the results also showed that trends in consumer preferences and reasoning, for example, were overall the same for when consumers were purchasing for

themselves versus for others. Consequently, in future research, respondent cognitive burden (Lenzner et al. 2010) spent on buying-for-others trend questions could be instead spent on splitting out consumer levels of usage, and perceptions of saiga horn. In this way we could more clearly deduce how much saiga horn is being used by an individual consumer, who is in fact a 'high-fidelity' user, and what it looks like to be a middle- or low-fidelity user. Additionally, we could garner more of the often elusive psychographic data (Thomas-Walters et al. 2020b) to give insight into the attitudes of various consumers along this fidelity spectrum.

With these details on levels of saiga horn users and psychographic data I would implement an additional change in the underpinning intervention design process: incorporate the Transtheoretical Model (TTM) (Glanz et al. 2015) alongside SCT. TTM is a health behaviour model stating an individual's 'readiness' to change a certain health behaviour is dependent on which of five stages they are placed along a behaviour change roadmap (Glanz et al. 2015). The model thus recommends 'stage-specific' interventions. I would employ a TTM style approach to better identify who (even among high-fidelity users) is most ready to stop using saiga horn and target the intervention accordingly. This may lead to higher impacts, and a better use of resources, because we would be able to more specifically target users who are receptive to a given intervention approach.

There were multiple other factors discussed in Chapters 4 and 5 that likely affected the intervention effect size, and our ability to assess it. Out of these, two key priorities for future research would be to try securing 1) greater funding to allow for a longer running intervention period and thus increased opportunity to repeatedly expose the target audience to the intervention message; and 2) access to saiga horn sales data as a more reliable and thorough measure of a third-party reported dataset.

Lastly, in light of the current global pandemic, any future intervention on this study system would need to conduct research assessing the post COVID-19 consumer landscape. The pandemic has changed the way the media, policy-makers, and the public view, discuss, and regulate wildlife trade. But what implications these changes have had, or will have, on wildlife consumer behaviour is unknown. For instance, it's possible that increased awareness of perceived, or actual, disease risk or social pressure might cause some saiga horn consumers to instead opt for herbal or biomedical treatments. But it's also possible that fear of decreased future product availability will cause saiga horn consumers to 'stock up' on products while they are still accessible. Additionally, given the weight of medically pluralistic decision making in consumer health behaviour (Cant 1999), it is likely that current global discourse might cause a particularly complex issue for users of TCM. From the Facebook analysis in Chapter 4, for example, it seemed that some Facebook users were defending TCM when they felt the medical system was being threatened by news articles against saiga horn (Appendix 4.5). Similarly, some saiga horn consumers may see discourse around COVID-19 as a threat to TCM, and respond by defending or relying on the medical system even further. This 'doubling-down' in response to negative or attacking arguments against one's behaviour is well-evidenced in intervention literature (Park & Barker 2020). As such, the influences on our target audience and behaviour, including their perception of impersonal information channels like news outlets, may have been affected by the current situation and thus need to be better understood before future interventions can be implemented.

The improvements or changes that have been suggested for future interventions on this study system are also applicable to implementers deciding how they will develop, carry out, and evaluate behaviour change interventions across wildlife trade. For instance, understanding how the choices made during baseline research will affect what type and depth of evaluation is possible following an intervention, is a lesson with wide applicability.

6.4 Conclusion

In conclusion, the impact of illegal and unsustainable wildlife trade on the world's species is far from waning, and conservationists need to think more methodically, creatively, and strategically in order to exact extensive change. With this thesis, I carried out the most extensive study to date on saiga horn consumers (inclusive of mixed-methods datasets and the application of human behaviour theory), implemented a tailored country-wide behaviour change intervention utilising innovative and timely approaches and resulting in measurable impacts, as well as carried out one of the most thorough evaluations presently conducted on a demand reduction behaviour change intervention. These findings and efforts provide new insights and methodology advances, thereby bringing us one step closer in our ability to induce impactful behaviour change among unsustainable or illegal wildlife trade consumers. Further, this thesis sits within a larger wave pushing for more evidenced and effective projects and policy addressing biodiversity conservation and sustainability challenges worldwide. The work thus benefits implementers across the environmental space working to better understand and influence unsustainable human behaviours.



Figure 6.1 Saiga antelope bust and horns on display in a traditional Chinese Medicine shop in Singapore.

Photo credit: Hunter Doughty.

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Appendices

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Appendix 2.2 Survey Size Power Calculation

Using nested analyses as a gauge, we conducted a power calculation for performing a three-tiered nested proportion statistical test with three of our most integral questions. Example three nested proportion questions we hoped to analyse:

Highest level question: Saiga use -> 13% for usage -> $202.5/0.13 = 1558$ people

Second level question: Reasons for use -> est 40% for recommendation -> $81/0.4 = 202.5$ people

Third level question: Recommenders for use -> est 30% for family -> 81 people

(Margin of error = 10% at the third level)

Equation Used:

$$n = N * X / (X + N - 1),$$

“Where, $X = Z_{\alpha/2} \cdot \sqrt{p \cdot (1-p)} / \text{MOE}$, and $Z_{\alpha/2}$ is the critical value of the Normal distribution at $\alpha/2$ (e.g. for a confidence level of 95%, α is 0.05 and the critical value is 1.96), MOE is the margin of error, p is the sample proportion, and N is the population size” [1].

Reference

1. Select Statistical Services Ltd. Population Proportion – Sample Size. Exeter, UK. Available at <https://bit.ly/2qMON7Z>. Accessed August 2020.

Appendix 2.3 Survey Locations

Within each Planning Area, we identified four locations that attract varying socio-economic levels. Two ‘low’ locations were chosen for each Planning Area as these tended to be smaller in scale and traffic.

Table A2.3.1 Consumer Survey Locations.

Planning Areas with the largest population of Chinese		Locations within each Planning Area whose clientele include members of the below income levels (all locations likely have clientele from <i>all</i> income levels).			
Planning Area	Number of Chinese	Includes High Income	Includes Medium Income	Includes Low Income	
		Location 1	Location 1	Location 1	Location 2
Bedok	208,880	Siglap Centre	Bedok Mall	Bedok South Food Centre	The Market Place @58
Jurong West	190,240	Jurong Point	Gek Poh Shopping Centre	Boon Lay Shopping Centre	Taman Jurong Shopping Centre
Hougang	181,700	Heartland Mall	Hougang Mall	Hougang Green Shopping Mall	Hougang 105 Hainanese Village Centre
Tampines	175,470	Tampines Mall	Eastpoint Mall	Hawker Centre 201	Prime Supermarket (Tampines Street 81)
Sengkang	160,590	Rivervale Mall	Compass One	The Seletar Mall	Kopitiam @ Block 275 D Compassvale Link
Total in top 5 Planning Areas		916,880			
Total in Singapore		2,900,010			

Appendix 2.5 Buyers of Any Treatment

When comparing saiga buyers to buyers of any treatment type for others we found that the two groups were fairly similar in gender and age, but that for this larger buyer group, education was positively related to buying for others, and religion was not a variable of importance. Buyers for Others was composed of participants who buy any treatment type for others to treat heatiness and/or fever (1196 respondents). Statistical Analysis: GLM dredge and average, with sum contrasts applied.

Table A2.5.1 A priori hypotheses.

Variable	Hypothesis	
	Effect Y/N	Direction of Effect
Age	Y	Middle-age more likely to buy for others
Education	N	No difference between education levels
Religion	N	No difference between religions
Gender	Y	Females more likely to buy for others
Dialect	N	No difference between dialect groups
Income	N	No difference between income levels
Generation	N	No difference between generations

Table A2.5.2 Model selection table.

	(Intrc)	age	education	gender	generation	df	logLik	AICc	delta	weight
30	-0.1592	+	+	+	+	12	-1462.081	2948.3	0	0.858
14	-0.208	+	+	+		8	-1467.918	2951.9	3.6	0.142

Table A2.5.3 Relative variable importance.

	age	education	gender	generation
Importance:	1	1	1	0.86

Table A2.5.4 Model-averaged coefficients.

(full average)	Estimate	Std. Error	Adjusted SE	z value	Pr(> z)	P-value•	Likelihood ^
(Intercept)	-0.16611	0.07641	0.07645	2.173	0.0298	*	
young	-0.66039	0.07525	0.07529	8.771	< 2e-16	***	negative
mid-age	0.68968	0.06431	0.06434	10.719	< 2e-16	***	positive
old	-0.02929	0.07747	0.07751	0.378	0.7056		neutral
primary	-0.24929	0.11241	0.11247	2.216	0.0267	*	negative
secondary-ite	0.07054	0.08957	0.08962	0.787	0.4312		neutral
preuni-postsec	0.09932	0.09399	0.09404	1.056	0.29091		neutral
uni-grad	0.58744	0.09979	0.09984	5.884	< 2e-16	***	positive
unknown edu	-0.50801	0.16583	0.16592	3.062	0.0022	**	negative
female	0.36633	0.08888	0.08893	4.119	3.80E-05	***	positive
male	-0.36633	0.08888	0.08893	4.119	3.80E-05	***	negative
first	-0.02194	0.08805	0.0881	0.249	0.8034		neutral
second	-0.11389	0.08785	0.08789	1.296	0.195		neutral
third	0.13688	0.10411	0.10415	1.314	0.18873		neutral
more than third	0.26325	0.17849	0.17855	1.474	0.1404		neutral
unknown gen	-0.26431	0.17674	0.1768	1.495	0.1349		neutral

•Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

^Direction of likelihood of being a saiga user at this level of confidence

Appendix 3.1 Consumer Focus Groups

In order to have a more in-depth understanding of saiga horn consumers in Singapore. We conducted 10 detailed focus groups simultaneously to our extensive consumer surveys in June-July, 2017 (Chapter 2).

Forty-three individuals participated in our focus groups, though in order to analyse women's preferences and behaviours (which ended up being our focus), we excluded the results for the four male participants. The remaining 39 participants were all Chinese Singaporean women aged 18-70+ years old; 26 of whom had either used saiga horn before or currently used it. The original gender imbalance of the groups was not intentional. We focused this research on Chinese Singaporeans because they are the largest consumers of complementary and alternative medicines (including traditional Chinese medicine, TCM) in Singapore. Participants were recruited primarily via emails or in-person visits to community centres, parent's groups, universities, and places of worship, as well as through snowball sampling via the researchers' in-country networks. Focus groups were held at locations convenient to the participants including the above locations, public parks, and one participant's home.

Focus groups were framed to participants as a discussion around their preferences for fever and heatiness treatments, along with their larger perspectives on TCM versus biomedicine. No mention was initially made about saiga horn, conservation, or the intended behavioural intervention. During the focus group, question phrasing and order aimed to minimize response bias (Althubaiti 2016) and gain accurate insight into participants' preferences around health treatment options, their reasons behind these preferences, and their perceptions of others' preferences. Following the focus group, the research assistant running the discussion could divulge further research information with interested participants.

The research assistant was a university aged Chinese Singaporean female, fluent in both English and Chinese. She wore a Nanyang Technological University (NTU) logo t-shirt and carried with her a letter of information detailing the research and its ethics approval (see below). She also had contact slips available to give to participants should they request to speak to the project leader or the approving ethical review boards.

This research was approved by the Institutional Review Board of NTU (IRB-2017-04-018) and the Central University Research Ethics Committee of the University of Oxford (R50787/RE001). Informed consent was obtained in writing, as approved by the preceding review boards.

Key Discussion Points

- Participants commented on health adverts they had seen, and often stated that they actively look for health information on the internet.

E.g. When asked where they look for health advice or pay attention to health adverts:

- "Internet or TV ads, the claimed effectiveness mentioned."
- "When you are really sick and go online to search, you will see it online. Mostly online."

- Participants noted family, peers, or even fellow church members, as individuals that they may ask for health advice.

E.g. - "I get the advices from my friends, as they share about their user experiences, not really advertisements."

- "I get my advices from the older generation, and if it works for others."

- Participants mentioned directly (or automatically) following the advice of family or friends.

E.g. - "Usually I ask my friends, and if it's not too shocking or weird, I will heed their advice."

- "[I] will drink [saiga horn] when TCM uncle advises."
- "For heatiness I use [saiga horn]. My parents say that it is very good."
- "I think people use [saiga horn] because it is recommended by the seller. Normally you don't know what to drink till you consult them."

- Participants recounted experiences of seeing family use TCM, and specifically saiga horn, or instances of family administering TCM/saiga horn to them.

E.g. - "When I was young, I used TCM for a few years. I think it is effective, but it was because my mum brought me there. I had this good impression about TCM."

- "I think it's because you grow up with it, so you tend to hold some faith in it. You tried it and you think that it really works. When I was young, I had a very bad cough, and my grandmother boiled crocodile meat soup for me and I drank it. I

never really know if it truly worked, but if someone tells me that his or her kid is having a prolonged cough, I will tell them this story.”

- “I used [saiga] during my childhood days. My mum used to brew it. I remember when my children were young and they had very high fever, my mother-in-law would purchase it and brew it for them to drink. It does help. It helps to reduce their temperature.”

- Participants often felt that the norm for their treatment preferences was in line to what they themselves were doing, or what their interpersonal network was doing.

E.g. When asked where their preference came from:

- “I think it is society as a whole that influences my choice.”

- Regardless of an individual's personal health preferences, participants often commented that TCM is popularly practised in Singapore, and that it is a more whole-body, safer, nourishing, or natural approach than biomedicine.

E.g. - “I feel that people do have extensive knowledge about TCM these days. They would feel that TCM does have its effectiveness. Although it is slower, it is less damaging to our bodies, because sometimes Western medicine makes one weaker. TCM treats your body generally, and not targeted at certain problems.”

- “[Singaporeans] acknowledge the efficacy of TCM, just that the healing process is very slow and does not harm your body as much (compared to Western medicine). TCM rejuvenates your entire body.”

- “I feel that there is a growing market for TCM in general, in the recent years, there’s this natural and healthy trend, people are going into the TCM trend just because it is natural. I feel that for those who cannot find treatment through western (e.g. cancer), out of desperation, may switch to TCM because it might work. A form of hope.”

- Most participants use complementary and alternative medicine approaches in some capacity, and their preference was heavily context-specific. Further, it was almost a source of pride that Singapore *does* straddle these two medical systems.

E.g. - “I think we have the best of both worlds, and seek whatever that works. We have access to both types of treatments.”

- “I see that for most of us, we will seek certain treatment for certain illness. For example, if we have a sprain, we go for TCM, and if we have chest pain, we see the Western doctor. It is very dependent on the situation.”
 - “[Singaporeans] visit both for different reasons and switch over depending on which treatment is more effective for each illness.”
- Even participants who didn't prefer saiga horn currently, had often used it in the past, knew of someone who uses it, or had heard of it as a product in use by other Singaporeans.
 - E.g. - “As long as you are Chinese, there is a chance that you would purchase [saiga horn].”
 - “I know that there is an antelope drink. I heard from my friend that this drink is very effective.”
 - “I heard of others using [saiga horn]. I used to use it, but not anymore.”

Appendix 3.2 Target Audience Influences

Table A3.2.1 Potential influences on our target audience of Chinese Singaporean women aged 35-59. Each influence's evidence, contextualisation in SCT and medical pluralism, and our subsequent summary justification for whether it was feasible and wise to employ in a behaviour change intervention targeting saiga horn usage among this audience.

New Data and Existing Literature Substantiating the Influence	Influence	SCT and Medical Pluralism Supporting Concepts *	Employ?	Summary Justification (based on evidence and theory columns - discussed in the main manuscript)								
People whose opinion they trust (A)												
<ul style="list-style-type: none"> •CS (family and TCM shopkeepers are the first and second most cited recommender for use; "It Works" is most cited reason for use†) •Health seeking lit (interpersonal networks are important for Singaporean women seeking health info [1,2]) 	→ <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="border-bottom: 1px solid black; padding: 2px;">Their families' active recommendation</td> <td rowspan="4" style="font-size: 2em; vertical-align: middle; padding: 0 10px;">}</td> </tr> <tr> <td style="border-bottom: 1px solid black; padding: 2px;">Their friends' active recommendation</td> </tr> <tr> <td style="border-bottom: 1px solid black; padding: 2px;">The TCM shopkeepers' active recommendation</td> </tr> <tr> <td style="padding: 2px;">Their peers' active recommendation</td> </tr> </table>	Their families' active recommendation	}	Their friends' active recommendation	The TCM shopkeepers' active recommendation	Their peers' active recommendation	SCT proxy agents and social environment, Med Plur social/cultural ties	✓	These individuals, particularly family and TCM shopkeepers, act as proxy agents to our target audience. Further, they all compose our audience's direct social environment from whom they are likely to model their behaviour. All of which made these individuals a key influence to leverage if possible.			
Their families' active recommendation	}											
Their friends' active recommendation												
The TCM shopkeepers' active recommendation												
Their peers' active recommendation												
Influences from their past (B)												
<ul style="list-style-type: none"> •FG (stories about using saiga horn with family, etc.) •CS ("It Works" is most cited reason for use†)] •Family influence lit (home and caregiver influence on health choices [3] Singaporean women determine over-the-counter medical purchases in the home [4]) 	→ <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="border-bottom: 1px solid black; padding: 2px;">The knowledge they have gained in school about TCM and saiga horn</td> <td rowspan="5" style="font-size: 2em; vertical-align: middle; padding: 0 10px;">}</td> </tr> <tr> <td style="border-bottom: 1px solid black; padding: 2px;">Experiences they had as a child being administered it by their family</td> </tr> <tr> <td style="border-bottom: 1px solid black; padding: 2px;">Experiences they had as an adult using saiga horn</td> </tr> <tr> <td style="border-bottom: 1px solid black; padding: 2px;">What they saw their parents/family using themselves</td> </tr> <tr> <td style="border-bottom: 1px solid black; padding: 2px;">What their parents taught them about TCM and saiga horn</td> </tr> <tr> <td style="padding: 2px;">What was in the house while they were young</td> <td></td> </tr> </table>	The knowledge they have gained in school about TCM and saiga horn	}	Experiences they had as a child being administered it by their family	Experiences they had as an adult using saiga horn	What they saw their parents/family using themselves	What their parents taught them about TCM and saiga horn	What was in the house while they were young		SCT behavioural modelling, Med Plur family/cultural ties	X	This set of influences are likely quite strong for many individuals, however, it was likely not feasible, or wise, to attempt to directly contradict or commandeer such personal influences that happened in the past.
The knowledge they have gained in school about TCM and saiga horn	}											
Experiences they had as a child being administered it by their family												
Experiences they had as an adult using saiga horn												
What they saw their parents/family using themselves												
What their parents taught them about TCM and saiga horn												
What was in the house while they were young												

Impersonal information channels (C)			
<ul style="list-style-type: none"> •Health seeking lit (Singaporean women actively and passively get health info through impersonal channels [2,5-7]) •FG (comments about adverts they've seen and online searching) •CS ("It Works" is most cited reason for use†) 	<p>Health adverts they see</p> <hr/> <p>Health information they seek, often online</p>	<p>SCT self-efficacy, Med Plur personal agency</p>	<p>✓</p> <p>Self-seeking of health information, increasingly online, is common among our target audience and provides us with an opportunity to reach them. However, due to the strong influence of their interpersonal network, any impersonal message content would need to be carefully constructed to not overtly contradict the latter influence.</p>
A, B, and C			
<ul style="list-style-type: none"> •FG (knowledge exists of western alternatives and some TCM alternatives, though they are possibly perceived as lesser; fear was not mentioned but general precaution of using western medicine was often expressed) 	<p>Their lack of knowledge of equally desirable alternatives</p> <hr/> <p>Their fear of using an alternative TCM product they don't trust</p> <hr/> <p>Their fear of using an alternative western product they don't trust</p>	<p>SCT physical situation, Med Plur perceived understanding</p>	<p>✓</p> <p>To address any lack of knowledge or trust in desirable alternatives, the intervention could include information on other products that are already commonly used in Singapore by members of their social environment.</p>
Physical ability			
<ul style="list-style-type: none"> •CS (cost and location were not significantly cited reasons for use) •FG (mixed comments on price as a motive for use/non-use) 	<p>Their access to saiga horn</p> <hr/> <p>Their ability to afford saiga horn</p> <hr/> <p>Their lack of access or ability to afford equally desirable alternatives</p>	<p>SCT physical environment</p>	<p>x</p> <p>It was likely not feasible for us to shift someone's physical ability to afford or obtain alternative products, and these influences seemed relatively less impactful than others. Though, if we wanted we could target their perception that alternatives are expensive or unavailable by highlighting equally priced or cheaper alternatives that are readily available in Singapore.</p>
Conservation perspectives			
<ul style="list-style-type: none"> •FG (mixed comments on conservation awareness as an inhibitor to saiga horn use) •CS data (saiga horn users were significantly more likely to list saiga as common in the wild) •FG (majority had a lack of knowledge of saiga or its conservation status) 	<p>Their perception that the effect on wild saiga isn't a strong inhibitor</p> <hr/> <p>Their lack of awareness of the effect on wild saiga</p>	<p>SCT outcome expectations</p>	<p>x / ✓</p> <p>There was mixed new data evidence and little existing evidence on whether direct conservation message for a poorly known non-local species would be effective. However, we felt impact on wild saigas might be leveraged, if it was linked to other, stronger, attitudes, [8]. Much of the target audience is misinformed about saiga and could well be sympathetic to the conservation issue, so inclusion of this component to some degree was warranted.</p>

Social level perspectives			
<ul style="list-style-type: none"> •FG (comments implying the commonality of TCM, as well as its general benefits as nourishing, whole-body, and safe) 	→	Their perception of TCM as a socially accepted and common health plan	SCT social situation, Med Plur social/cultural ties ✓
<ul style="list-style-type: none"> •FG (comments on others use of saiga horn as commonplace) •CS ("It Works" is most cited reason for use†) 	→	Their perception of saiga horn as a socially accepted and common product	
<ul style="list-style-type: none"> •FG (comments about family usage or recommendations but no mention of fear or angst about using something contrary to family/heritage) 	→	Their perception that it's socially valued to use something that 'links' them to their family/ heritage	
<ul style="list-style-type: none"> •Med Plur (Singaporean women's' desire to use something that's socially acceptable [9], culturally appropriate, or links them to family tradition [10]) 	→	Their perception that there is a general allegiance to TCM over western medicine	
<ul style="list-style-type: none"> •Anecdotal (comments by Singaporeans stating this, however we need more information to ground this influence) 	→	Their perception that if it is legal it can't be that harmful to nature	SCT collective agency x / ✓
<ul style="list-style-type: none"> •Health seeking lit (Singaporeans' strong trust in government approved information (including via newspapers) and products [7]) 	→	Their perception that if it is legal it is trustworthy	
Acronyms: CS = 2017 consumer surveys with Chinese Singaporeans (Chapter 2) TCM = Traditional Chinese Medicine FG = 2017 focus groups with Chinese Singaporeans (Appendix 3.1) lit - literature SCT = Social Cognitive Theory Med Plur = medical pluralism literature *Some influences have relative importance to many components of these ideologies, we have included the most direct and useful link(s) †The Consumer Survey stated reason for using saiga horn "It Works": through our FGs and additional knowledge, we believe this statement is based on past influences and usage, along with active recommendations from others, and health seeking information. It is an internal perspective on the efficacy of saiga horn.			

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Appendix 4.2 Pre-Intervention Focus Groups

Based on the findings from our over 2,200 consumer surveys in 2017 which found that Chinese Singaporeans aged 35 – 59 years old were the most likely to use saiga horn, and that women of this age group were the most likely to purchase saiga horn for other people (Chapter 2), along with a detailed analysis of published research and human behaviour theories (particularly Social Cognitive Theory [1], medical pluralism [2]), we created in-depth focus groups to understand what health news consumers best respond to. Specifically, we wanted to assess what information and phrasing about saiga horn (marketed as ling yang) would be the most attention grabbing, interesting, and impactful to readers of a health news article.

In November 2018 we thus conducted three highly detailed focus groups with 15 Chinese Singaporean women aged 35 – 59 years old. Focus groups were framed to participants as a discussion around preferences for obtaining and sharing health information/news. No mention was initially made about saiga horn, conservation, or the intended behavioural intervention. During the focus group, question phrasing and order aimed to minimize response bias and gain accurate insight into participants' preferences around health news intake and their reactions to variously framed saiga horn statements. Following the focus group, the lead researcher could discuss research information in more detail with interested participants.

Key Discussion Points

- Participants strongly aligned with the message that Singaporeans strive to be health conscious and responsible consumers.
- Participants felt that Singaporeans want known and safe sources for their health treatment options, and that based on information provided to them during the focus group, saiga horn, by contrast, was a product from a questionable source.
- Many participants were quite concerned about the conservation implications of using saiga horn. This included discussions around both environmental angles of nature preservation and biodiversity, and more animal welfare concerns around animal suffering and the ethics of using (wild) animals.
- Some participants were concerned that due to the massive disease outbreaks among saiga antelopes in recent years, that the animal *their* horn medicine came from, may have died from disease instead of natural causes. This possibility was upsetting to them because it made them feel like saiga horn was not a 'healthy and natural' product – which are qualities they are looking

for when they use TCM. As a note, there has been no evidence of the diseases found in saiga antelopes crossing over into humans.

- Participants appreciated having suggestions for alternative TCM products that were easily accessible, safe, and reliable. These included such products as chrysanthemum tea, ginseng, honeysuckle, and goat's horn.
- Most all participants felt that they would share a news article on saiga horn information with others in their social network, particularly with those that they know use saiga horn.
- Most all participants said the information given in the focus groups impacted their desire to use ling yang going forward. A few participants, however, felt that due to saiga horn's efficacy they would continue to still use it, despite the given information.
- Regarding other aspects of health news intake and sharing:
 - Participants heavily preferred in-country news platforms, with the Straits Times being the most cited newspaper for reliable stories.
 - Participants preferred in-country 'experts' to be quoted in a news article.
 - There was a slight preference towards having scientists over doctors be the experts quoted in a health news article.
 - Facebook was the most commonly used platform for seeing health news articles and for sharing health news articles. A few participants also mentioned WhatsApp groups as a way they hear about and share such material, as well as YouTube videos detailing new health information.

Ethics

This research was approved by the Institutional Review Board of Nanyang Technological University (IRB-2017-04-018-01) and the Central University Research Ethics Committee of the University of Oxford (R50787/RE002). Informed consent was obtained in writing; this process was approved by the preceding review boards.

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Appendix 4.4 Considerations for Online Interventions

There are number of things to consider when carrying out online interventions that involve promoting specific materials. Compared to traditional offline marketing channels where detailed direct targeting of particular audience groups is far less possible, online advertising platforms offer a great deal more. However, audience demographic and psychographic specifications are still limited to what is made available by current online advertising platforms. These specifications meant that for our trial, each platform (Google, Outbrain, and Facebook) only allowed us to select from certain qualifications pre-set by the platform to narrow down our target audience. Most of these qualifications (such as an individual's past Facebook behaviour) are not transferable across platforms. Within the platform, an advertiser has to carefully select which of these qualifications they want to use when creating their audience pool. On Facebook, we had to balance wanting an audience large enough that the adverts would spread throughout the country, and specific enough that the adverts would be more likely to be shown, ideally often, directly to saiga users.

In addition, the way a platform determines who among a selected audience will actually see an advert also varies. All of our platforms use some form of advert 'auction' in which bidding advertisers (such as ourselves) are competing for their advert to be shown to an individual in their selected audience. The algorithms used by the platforms to decide which advert is shown in each auction are based on a number of factors that both differ between platforms, and are weighted differently, between platforms. These factors include the amount of money, per auction, that the advertiser is willing to pay, the length of time their budget has to spread across, the time of day an advertiser prefers, etc. This meant, for example, that our daily Google budget had to be high enough to out-bid competitors for advert slots, but low enough to maximise the amount of time for which we could run the adverts.

When placing adverts on third-party websites, such as via Outbrain, there is further reduction in control over where the advert is seen. As such, if using these online channels, then spill-over of the intervention message to non-targeted individuals is likely, and may need to be mitigated to meet research needs.

Due to these platform specific intricacies, it is necessary for implementers to budget time for them to familiarise themselves with the advertising platform they wish to use before they implement an intervention. Each platform offers guidelines or tutorials on how to carry out adverts on their platform, including information on how to select audiences or keywords, how the pricing works,

and tips for maximising audience engagement, among other lessons. Facebook, for example, offers Facebook Blueprint courses which are an extensive set of free online ‘courses’ that detail most every aspect of advertising on Facebook including how to use the Facebook Ads Manager interface.

Additionally, timing itself can affect online interventions. For example, the turn-around time for advert approval and the minimum time required for adverts to run need to be accounted for when using time-sensitive, or time-scaled, materials. In our trial, Outbrain’s lengthy approval time, and suggested multi-week run-time, impaired our ability to publish adverts on that platform. Similarly, when partnering with media/news outlets (as we did), researchers may be at the mercy of the outlet’s sometimes unpredictable timelines.

Related to this, working with news outlets, in most instances, will mean that articles are written and directed by journalists and editors who ultimately have the final say in the article’s text and framing. It is thus imperative to have discussions early and often with the news outlet to better ensure that the published content is in line with intervention goals – recognising that even with open communication, some variability in article content or framing is likely.

Regarding evaluation, online platforms for both paid and organic content can only provide a select set of analytics. These can be informative concerning intervention reach and audience response in a way typically unavailable for traditional message dissemination methods, but in almost all circumstances they do not detail actual behaviour change. Exceptions include when the goal is to increase donations [1] or purchases of a desired alternative product, and CTR is linked to on-page actions of donating or buying.

Cost and availability of message dissemination are critical factors overall. When compared to traditional marketing channels, online strategies can often be much cheaper [2], but they are not without cost. Our trial cost 27,700 USD for online advertising (not including researcher time costs or the baseline research), and in order to plan out a tentative advertisement budget, we had to use the tools on the platforms themselves. This allowed us to gauge what size of audience and length of time we would be able to run adverts given various daily budget allotments. This was especially important for Google, given that often-searched-for-keywords (e.g. ‘paracetamol’) cost the advertiser more money than less popular keywords (e.g. ‘saiga’). Overall, paid adverts can be expensive depending on the target audience, target topic, and dissemination approach, and organic content may not reach the audience or be perceived in a desired way. Researchers may

have to rely, at least in part, on opportunistic channels for online interventions due to constraints like funding. For example, we had to rely on a journalist at the Straits Times being interested enough in our research to write a piece about it. As such, online channels could be strewn with bias and limitations, and so researchers should think critically about available options and whether other off-line methods would be a better use of their resources and efforts.

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Appendix 4.5 Content Engagements Feature Categories

Table A4.5.1 Features included in content engagements (engagements with text, emojis, images, or stickers). Engagements could have multiple features within their content (i.e. a comment could have a general pro statement, as well as a personal call out).

Content Feature	Examples of content engagements that contain a given feature
<p>General Pro Statement (found in 50% of content engagements)</p> <p>Expressing/commenting</p> <ul style="list-style-type: none"> -sadness -anger/shock -disgust -guilt -agreement with intervention message 	<p>"So upset 🥺" "😭" "😞😞" "😞"</p> <p>"LITERALLY WHAT THE FUCK I THOUGHT IT WAS A HERB" "Omg nooo. 🤢"</p> <p>"Just saw this in a well-known TCM chain a few days back when I was getting ginseng water and was disgusted."</p> <p>"Oh No... i am guilty of drinking this. And i actually super love the taste of Ling Yang. Will stop from now on. 🙄"</p> <p>Sorry."</p> <p>"Nice article for a read!" "❌"</p>
<p>Commenting/giving opinions</p> <ul style="list-style-type: none"> -in support of nature/animals/environmental awareness -about the composition of saiga horn -about additional reasons to not use saiga horn (bad taste, price, saiga not proven biomedically effective) 	<p>"yes i support tcm, i support herbal tea. but i DOn'T drink ling yang, friends."</p> <p>"How about having label on food with ingredients from endangered species? At least the consumers are make aware of what they are consuming."</p> <p>"Your TCM is made of thr same stuff if fingernails and hair. Know what keratine is and what it does. Check the active principle of every single meds you take - whether western of chinese."</p> <p>"what!? i really hate this taste anyway" "This shit Tastes bad anyway. Good for me and the antelopes"</p> <p>"Now this is stupid. It doesn't really cure anything please." "tbh this is smelly af"</p>
<p>Suggesting alternatives</p>	<p>"There're at least 20 plant-based herbs for replacement, they're super cheap with the same efficiency and efficacy."</p> <p>😞😞😞 There are other alternatives..."</p>
<p>Stating info/quotes from the article or in support of the article</p>	<p>"Ever walked into a TCM shop to buy "antelope water"? The horn comes from the Saiga, a critically endangered species of antelope."</p>
<p>Spiritual comments or prayers in response</p>	<p>"Amitabha [repeated 47 times]" "🙏🙏🙏🙏🙏"</p> <p>"Namo Amitabha Namo Amitabha [repeated 54 times] 🙏🙏🙏"</p>

General Con Statement (found in 13% of content engagements)	
Commenting/promoting the efficacy of saiga horn	"Do you rather children/babies go extinct because of brain damaging fever?" "Damn, going to become even more ex... the medicinal use is really good to cool heatiness"
Stating that they will continue to use	"I still gg to drink it"
Believing the message is promoting saiga horn	"Where can buy?"
Commenting against product bans/regulation	"Now do business are not so easy here ban there ban" "@JohnDoe no need ban la, what works for one might not work for another. No need ban this and that."
Giving misinformation about saigas/ling yang, and other endangered species -saigas are farmed -the horns fall off or regrow -all products are now fake/goat/herb	"We can't tell for sure whether the animals are being farmed for this purpose (antlers and horns grow back so it's sustainable)" "Don't worry uh. This horn is a protected animal and only license personnel can retrieve the horn. And the horn will regrow." "Please lah the tcm is using the goat horn these days. Where got so much antelope horn to sell for the cheap cooling water in sg. Kindly get the facts right leh. Real 1 are too x." "Liar, there is no relation between fake products and antelopes."
Perceptions of small personal impact	"Nv always drink sometimes only 😊"
General Neutral or Undefined Statement (found in 12% of content engagements)	
Content was not determined to be pro or con statements and/or was irrelevant	"Well" "!!!" "Good morning, my friend." "OK I'm in toilet"
Self-Pledge (found in 3% of content engagements)	
Pledging a behaviour, or behaviour change of not using saiga -stopping/decreasing saiga horn use -speaking to others	"I didn't know they kill the animal for the horns 😞 no more cooling water for me." "I'm never ever gonna drink 羚羊水 anymore." "Oh god no!!!! Im nvr drinking this again 🙏" "Now then I know I will stop it hope this will stop it" "Must tell my grandma cannot buy liao"

Call to Action (found in 13% of content engagements)	
Asking/pleading/demanding for others to do something	"Please stop they don't have to die.... 😞 ..." "Ive shared this...Keep on resharing this articles to educate others."
-to general audience/social network	"Another endangered. Stop it la" "Stop drinking "Ling yang"" "Stop buying and the killing will stop!!!" "DONT KILL THE ANTELOPES"
-to specific entity out of their social network TCM company, the government	"Pls stop drinking ling yang cooling water.. there are other alternatives.." "Government can stop all this" "🙏 ok have never drunk this but ?!?!?? ZTP stop this pls" "Hope the TCM big boys can start practising CSR by stopping the sale of this drink and promoting plant alternatives. #savetheenvironment #CSR #TCM #foodsg #sgfood"
Telling them to use alternatives	"Try chrysanthemum tea instead." "Drink barley instead 🙏"
Personal Call-Out (found in 16% of content engagements – 17% of these included pro messages in line with the intervention)	
@ing a specific individual in their social network to share the material with them (not counting @ing in response to earlier comments or the sharer)	"Omg @JeffDoe .. don't buy this smelly thing any more and save them !! 😞" "@JaneDoe" "@JuneDoe Don't drink much"
Response to Personal Call-Out (included 4% of content engagements – linked to 25% of personal call-outs)	
First instance response of an individual who was the target of a personal call-out (@ing)	"Oh no....." "Later I go buy 羚羊水" "@JoelDoe yes. This one" "@JeanDoe 🙏🙏❤️🙏"

Appendix 5.1 Additional Survey Methodology Details

Consumer Surveys

Survey Approach

Post-intervention (2019) consumer survey methodology heavily followed the same protocols detailed in the pre-intervention (2017) consumer surveys (Chapter 2), so that the pre- and post-intervention surveys would be comparable.

Surveys were conducted in five Planning Areas (i.e. neighbourhood districts) in Singapore with the largest population of Chinese Singaporeans [1]. Chinese Singaporeans were targeted for this intervention because they are the largest consumers of complementary and alternative medicines (including TCM) in Singapore [2]. Within each Planning Area, we surveyed at four locations that would span patrons of varying socio-economic levels (Table A5.1.1). Survey collection was also stratified across day of week and time of day (weekday/weekend and morning-afternoon/afternoon-evening shifts).

Table A5.1.1 Consumer survey Planning Area and survey location.

Planning Area	Locations			
Bedok	Siglap Centre	Bedok Mall	Bedok South Food Centre	The Market Place @58
Jurong West	Jurong Point	Gek Poh Shopping Centre	Boon Lay Shopping Centre	Taman Jurong Shopping Centre
Hougang	Heartland Mall	Hougang Mall	Hougang Green Shopping Mall	Hougang 105 Hainanese Village Centre
Tampines	Tampines Mall	Eastpoint Mall	Hawker Centre 201	Prime Supermarket (Tampines Street 81)
Sengkang	Rivervale Mall	Compass One	The Seletar Mall	Kopitiam @ Block 275 D Compassvale Link

Surveyors wore red Nanyang Technological University (NTU) logo shirts and stated to potential respondents that the survey was asking heatiness and fever treatment preferences. There was no mention of saiga, TCM, wildlife, or the intervention. Surveyors also carried with them a letter of support detailing what the survey was about and indicating that it had ethics approval from both NTU and the University of Oxford. For respondents who elected to participate, the surveyor obtained informed consent as detailed by the ethics committees, prior to beginning the survey.

Surveyors asked every third person who passed them (while they were not with another respondent) to take the survey. If a group approached: surveyors asked the person on the right (for a group of two) or the third person to the right (for groups larger than two). The surveyor held the tablet the entire time, but stood next to the respondent so that the screen was clearly visible to them. The surveyor walked through each question orally in either English or Chinese, depending on the respondent's preference. The survey was also written in either English or Chinese. See Chapter 2 for more details.

Data Analyses

Statistical analyses followed the same approach as Doughty et al. (2019) where appropriate. For pre- and post-intervention comparisons we used the MatchIt package to match the 2017 and 2019 datasets, in order to account for possible sampling variances between years [3]. Specifically, we performed an 'optimal' match, with a 'mahalanobis' distance measure, and a 1:1 ratio. We chose optimal matching over the common 'nearest neighbour' matching, because optimal matching aims for the smallest average absolute distance across all the matched pairs, and has been found to be better than 'nearest neighbour' matching at minimising the distance within each pair [4]. Variables matched included Chinese dialect, education, generation Singaporean, religion, and Target Audience (for the total sample comparisons). Comparisons of regressions (see below) between matched datasets and unmatched datasets did not yield any difference in variable significance, confirming that the characteristics of our post-intervention survey were quite similar to those of our pre-intervention survey.

We used General Linear Model regressions (GLMs) with sum contrasts applied [5], to assess differences between: pre- and post-intervention datasets, post-intervention target audience and other respondents, and post-intervention high-fidelity users and other respondents within the target audience. See Table 5.1 for GLM questions and variables used. We chose GLMs because they account for differences between the datasets, as well as variance caused by other demographic factors when comparing across groups. And we applied sum-contrasts to the GLMs because this allows the researcher to compare the mean of one variable level to the mean of all means across the levels within a variable [5]. In contrast, a default GLM output compares each variable's level to only one other 'reference' level within the variable.

All variables used in GLMs throughout this study can be seen in Table A5.1.2. Prior to running any GLMs, variable levels with less than 10 respondents were combined. The variable of 'Income' was

omitted for the pre-post intervention comparisons as there was a 21% increase in number of respondents willing to disclose their income post-intervention, and we felt this discrepancy may inaccurately skew outputs. For our post-intervention specific comparisons, variable levels with less than 10 respondents for the target audience were omitted so they did not disproportionately skew results: 'Education Unknown', 'Religion Unknown', 'Religion Other', 'Dialect Unknown'.

Lastly, we used 2-sample z-tests for equality of proportions with a continuity correction to assess intervention message exposure sources, and reasons for behaviour change. This test was chosen because the respondent's answers on these questions were not mutually exclusive

Table A5.1.2. Dependent variables used in regression analyses throughout this study.

Variable	Type	Levels	Description
Target Audience	Binary	Yes No	Respondent is, or is not, a female aged 35-59 years old
High-fidelity saiga user	Binary	Yes No	Respondent did, or did not, state that saiga horn is a product they use 'most often' when treating fever/heatiness
Chinese Dialect	Categorical	Hokkiens Teochews Cantonese Hakkas Hainanese Other Prefer not to say	The Chinese dialect of the respondent's family
Education	Ordinal	Pre-primary or primary school Secondary school ITE Polytechnic Junior college Accredited diploma University Masters or PhD Prefer not to say	Respondent's highest level of education
Generation Singaporean	Ordinal	First Second Third More than third Prefer not to say	Generation Singaporean is the number of generations a respondent's family has lived in Singapore
Income	Ordinal	Income 1 - Less than \$5000 Income 2 - \$5001 to \$15,000 Income 3 - \$15,001 to \$25,000 Income 4 - \$25,001 to \$35,000 Income 5 - \$35,001 and higher Prefer not to say	Respondent's household average monthly income
Religion	Categorical	Buddhist Muslim Taoist Catholic Hindu Christian (other) Other I do not identify with a religion Prefer not to say	Respondent's religion

Shopkeepers Surveys

Survey Approach

Shopkeeper surveys were conducted in and around the same Planning Areas where the consumer surveys were conducted to allow for a rough comparability between the two (Table A5.1.4). There were five common shop types that we surveyed, as these sold saiga horn-like products (Table A5.1.3).

Table A5.1.3. Planning Areas and shop types visited in the shopkeeper surveys.

Planning Areas	Shop Types
Bedok +	TCM chain store
Geylang	Family-owned TCM store
Hougang +	TCM practitioner (some practitioners also sell TCM products)
Jurong East	Provision store (i.e. a store that sells a mix of food and home products)
Jurong West +	
Sengkang +	
Serangoon	
Tampines +	

+ Planning Area also used in the consumer surveys.

To begin the survey process, we identified possible TCM shops using a Search.insing.com business directory search, as well as Google Maps. We first visited shops in the five Planning Areas used in the consumer surveys, and as shops declined our surveys, we expanded this search to the surrounding Planning Areas.

The surveyor wore a red NTU logo shirt, and stated to the individual working behind the counter that they were conducting a study about which traditional fever and heatiness products customers purchase. There was no mention of saiga, TCM, wildlife, or the intervention. The surveyor also carried a letter of support detailing what the survey was about and indicating that it had ethics approval from both NTU and the University of Oxford. For shopkeepers who elected to participate, the surveyor obtained informed consent as detailed by the ethics committees, prior to beginning the survey.

Question phrasing was particularly important for the shopkeeper survey, and we carefully piloted and revised this survey in order to make shopkeepers feel as comfortable as possible. To ensure this comfort, and not prompt the shopkeeper into thinking we were for or against the intervention, the respondent gave the following statement prior to asking about the intervention?

“There are many factors that can influence or change a customer's choice of health products, such as their family's recommendations, media they see, price, and convenience. To

understand the role of media better, for the next set of questions I am asking about the media reports from the past four months around ling yang, and your thoughts on how it may have affected your customer's choices.”

Data Analyses

Due to the sample size of our shopkeeper survey, and the emphases on more qualitative answers, we chose to only do descriptive analyses. This was especially useful for the intervention-specific questions (e.g. assessing behaviour change following accurate intervention recall) when the sample size was below 10 respondents.

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Appendix 5.4 Supplementary Consumer Results

Consumer Demographics and Saiga Use

Pre- and Post-Intervention Sample Demographics

The post-intervention (2019) sample yielded a gender balance of 55% female, 45% male, and an age balance of 31% aged 18-34 years old, 35% aged 35-59 years old, and 34% aged 60+ years old. There were differences from 2017 to 2019 in the amount of demographic information respondents chose to share (Table A5.4.1). In 2019 about 5% more people chose to disclose their religion, dialect, education, and generation; and a stark 21% more people shared their income.

Table A5.4.1: Comparing Pre- and Post-Intervention (2017 and 2019) sample demographic proportions for the respondents used in analyses on saiga consumers.

Age							
	<i>Young</i>	<i>Mid-age</i>	<i>Old</i>				
2017	34%	34%	31%				
2019	31%	35%	34%				
Sex							
	<i>Female</i>	<i>Male</i>					
2017	51%	49%					
2019	55%	45%					
Dialect							
	<i>Teochews</i>	<i>Cantonese</i>	<i>Hainanese</i>	<i>Hakkas</i>	<i>Hokkiens</i>	<i>Other dialect</i>	<i>Did not say</i>
2017	21%	15%	5%	8%	41%	4%	6%
2019	20%	17%	6%	8%	42%	6%	1%
Education							
	<i>Primary</i>	<i>Secondary/ITE</i>	<i>Pre-uni/Post-sec</i>	<i>Uni/Grad</i>	<i>Did not say</i>		
2017	15%	27%	25%	25%	7%		
2019	13%	26%	28%	31%	2%		
Generation Singaporean							
	<i>First</i>	<i>Second</i>	<i>Third</i>	<i>More than third</i>	<i>Did not say</i>		
2017	22%	40%	23%	6%	9%		
2019	17%	30%	38%	11%	4%		
Religion							
	<i>Buddhist</i>	<i>Taoist</i>	<i>Catholic</i>	<i>Christian</i>	<i>No religion</i>	<i>Other religion</i>	<i>Did not say</i>
2017	42%	5%	6%	15%	25%	1%	5%
2019	40%	8%	6%	19%	25%	1%	1%
Income							
	<i>Income one</i>	<i>Income two</i>	<i>Income three</i>	<i>Income four</i>	<i>Income five</i>	<i>Did not say</i>	
2017	31%	20%	5%	2%	3%	39%	
2019	40%	26%	7%	3%	6%	18%	

Pre- and Post-Intervention High-Fidelity Frequency

Sample year (2017 versus 2019) was not significantly associated with high-fidelity saiga horn use across the total sample or the target audience (Tables A5.4.2 and A5.4.3). In other words, high-fidelity use was *not* more likely to occur in a given year.

Table A5.4.2. GLM Output for profiles of respondents indicating high-fidelity saiga use pre- and post-intervention, across the total sample.

Did high-fidelity saiga horn use, across the total samples, change from 2017 to 2019?					
No - Not Significant					
High-fidelity saiga use = year - target-audience + Chinese dialect + education + generation Singaporean + religion					
((the variable 'income' was omitted because 20% more people disclosed their income in 2019 than in 2017 and we felt this discrepancy may disproportionately impact outputs))					
Coefficients:	Estimate	Standard Error	Z-Value	Pr(> z)	
(Intercept)	-1.614	0.104	-15.523	0.000	**
Year 2019	-0.088	0.093	-0.938	0.348	*
Target Audience	0.325	0.135	2.405	0.016	*
Year - Target Audience Interaction	0.042	0.190	0.221	0.825	
Dialect Cantonese	0.011	0.109	0.096	0.923	
Dialect Hainanese	-0.060	0.173	-0.347	0.729	
Dialect Hakkas	0.421	0.130	3.236	0.001	**
Dialect Hokkiens	0.237	0.084	2.806	0.005	**
Dialect Teochews	0.102	0.101	1.013	0.311	
Dialect Other	-0.301	0.198	-1.523	0.128	
Dialect Unknown	-0.409	0.265	-1.547	0.122	
Education Primary School (and Under)	0.282	0.093	3.014	0.003	**
Education Secondary School / ITE	-0.101	0.080	-1.258	0.208	
Education Pre-University / Post-Secondary School	-0.259	0.084	-3.094	0.002	**
Education University / Graduate School	-0.111	0.083	-1.336	0.182	
Education Unknown	0.189	0.167	1.132	0.258	
Generation First	-0.147	0.090	-1.642	0.101	
Generation Second	-0.099	0.075	-1.323	0.186	
Generation Third	-0.027	0.079	-0.339	0.735	
Generation More than Third	0.255	0.117	2.184	0.029	*
Generation Unknown	0.018	0.148	0.119	0.905	
Religion Buddhist	0.354	0.101	3.516	0.000	**
Religion Catholic	-0.311	0.181	-1.720	0.085	.
Religion Christian	-0.024	0.123	-0.197	0.843	
Religion Taoist	0.347	0.149	2.329	0.020	*
Religion None	-0.253	0.116	-2.181	0.029	*
Religion Other	-0.296	0.382	-0.775	0.438	

Religion Unknown	0.184	0.268	0.687	0.492

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1				
Null deviance: 4093.4 on 4207 degrees of freedom				
Residual deviance: 3975.6 on 4184 degrees of freedom				
AIC: 4023.6				
Number of Fisher Scoring iterations: 4				

Table A5.4.3. GLM Output for profiles of respondents indicating high-fidelity saiga use pre- and post-intervention, within the target audience.

Did high-fidelity saiga horn use, in the target audience, change from 2017 to 2019?					
No - Not Significant					
High-fidelity saiga use = year + Chinese dialect + education + generation Singaporean + religion					
((the variable 'income' was omitted because 20% more people disclosed their income in 2019 than in 2017 and we felt this discrepancy may disproportionately impact outputs))					
Coefficients:	Estimate	Standard Error	Z-Value	Pr(> z)	
(Intercept)	-1.272	0.237	-5.371	0.000	***
Year 2019	-0.106	0.171	-0.617	0.537	
Dialect Cantonese	0.102	0.219	0.464	0.643	
Dialect Hainanese	0.006	0.367	0.016	0.987	
Dialect Hakkas	-0.396	0.324	-1.224	0.221	
Dialect Hokkiens	0.368	0.176	2.097	0.036	*
Dialect Teochews	0.056	0.210	0.269	0.788	
Dialect Other	0.263	0.374	0.703	0.482	
Dialect Unknown	-0.399	0.560	-0.713	0.476	
Education Primary School (and Under)	0.433	0.234	1.847	0.065	.
Education Secondary School / ITE	-0.035	0.172	-0.207	0.836	
Education Pre-University / Post-Secondary School	-0.104	0.180	-0.580	0.562	
Education University / Graduate School	-0.239	0.183	-1.308	0.191	
Education Unknown	-0.054	0.425	-0.127	0.899	
Generation First	-0.188	0.198	-0.948	0.343	
Generation Second	-0.127	0.155	-0.818	0.413	
Generation Third	-0.194	0.158	-1.231	0.218	
Generation More than Third	0.134	0.243	0.549	0.583	
Generation Unknown	0.375	0.317	1.182	0.237	
Religion Buddhist	0.213	0.243	0.877	0.381	
Religion Catholic	0.248	0.347	0.713	0.476	
Religion Christian	0.156	0.269	0.580	0.562	
Religion Taoist	0.043	0.367	0.116	0.908	
Religion None	0.182	0.262	0.693	0.488	
Religion Other	0.027	0.983	0.028	0.978	

Religion Unknown	-0.869	0.695	-1.251	0.211

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1				
Null deviance: 955.60 on 875 degrees of freedom				
Residual deviance: 932.96 on 854 degrees of freedom				
AIC: 976.96				
Number of Fisher Scoring iterations: 4				

Perceptions of the Saiga's Conservation Status

Respondents were asked which animals (out of a list of animals used often in TCM) were common in the wild. Responses pre- and post-intervention are shown in Table A5.4.4. Sample year (2017 versus 2019) was significantly associated with misidentifying saiga antelope as common, for both the total sample and the target audience (Tables A5.4.5 and A5.4.6). In other words, misperceptions that saiga antelopes are a common species in the wild decreased significantly from 2017 to 2019.

Table A5.4.4. Wild Animals perceived as common in the wild. Frequencies and percentages out of total respondents for each sample (2,294 pre-intervention; 2,116 post-intervention) are shown.

	2017		2019	
	Frequency	Percentage	Frequency	Percentage
Sea cucumber (hai shen)	844	(37%)	879	(42%)
Goat (shan yang)	871	(38%)	722	(34%)
Turtle (hai gui)	649	(28%)	606	(29%)
Saiga antelope (ling yang)	641	(28%)	452	(21%)
Sea horse (hai ma)	621	(27%)	556	(26%)
Rhino (xi niu)	343	(15%)	313	(15%)
None -- N/A in 2017	(0	(0%)	349	(16%)
I don't know	632	(28%)	449	(21%)

Table A5.4.5: GLM output for profiles of respondents who misidentified saiga antelopes as being common in the wild, pre- and post-intervention.

Did misconceptions of saigas being common in the wild, across the total samples, change from 2017 to 2019?					
Yes - Significant					
Misidentifying saiga as common in the wild = year - target-audience + Chinese dialect + education + generation Singaporean + religion					
((the variable 'income' was omitted because 20% more people disclosed their income in 2019 than in 2017 and we felt this discrepancy may disproportionately impact outputs))					
Coefficients:	Estimate	Standard Error	Z-Value	Pr(> z)	
(Intercept)	-1.170	0.092	12.669	0.000	***
Year 2019	-0.439	0.084	-5.224	0.000	***

Target Audience	0.188	0.122	1.545	0.123	
Year - Target Audience Interaction	0.117	0.175	0.669	0.504	
Dialect Cantonese	0.132	0.094	1.401	0.161	
Dialect Hainanese	-0.323	0.161	-2.008	0.045	*
Dialect Hakkas	0.288	0.120	2.407	0.016	*
Dialect Hokkiens	0.117	0.075	1.549	0.121	
Dialect Teochews	0.165	0.089	1.862	0.063	.
Dialect Other	0.168	0.149	1.126	0.260	
Dialect Unknown	-0.547	0.232	-2.355	0.019	*
Education Primary School (and Under)	-0.063	0.095	-0.667	0.505	
Education Secondary School / ITE	-0.023	0.075	-0.302	0.762	
Education Pre-University / Post-Secondary School	0.158	0.074	2.146	0.032	*
Education University / Graduate School	0.084	0.076	1.105	0.269	
Education Unknown	-0.156	0.164	-0.954	0.340	
Generation First	-0.213	0.084	-2.553	0.011	*
Generation Second	-0.004	0.068	-0.059	0.953	
Generation Third	0.057	0.071	0.794	0.427	
Generation More than Third	-0.150	0.115	-1.311	0.190	
Generation Unknown	0.311	0.132	2.360	0.018	*
Religion Buddhist	0.094	0.091	1.037	0.300	
Religion Catholic	0.009	0.145	0.065	0.949	
Religion Christian	0.079	0.107	0.740	0.460	
Religion Taoist	0.284	0.138	2.059	0.040	*
Religion None	0.066	0.098	0.673	0.501	
Religion Other	-0.212	0.324	-0.655	0.513	
Religion Unknown	-0.321	0.257	-1.247	0.212	

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1					
Null deviance: 4710.5 on 4207 degrees of freedom					
Residual deviance: 4633.2 on 4184 degrees of freedom					
AIC: 4681.2					
Number of Fisher Scoring iterations: 4					

Table A5.4.6. GLM output for profiles of respondents who misidentified saiga antelopes as being common in the wild, pre- and post-intervention, within the target audience.

Did misconceptions of saigas being common in the wild, in the target audience, change from 2017 to 2019?
Yes - Significant
Misidentifying saiga as common in the wild = year + Chinese dialect + education + generation Singaporean + religion
((the variable 'income' was omitted because 20% more people disclosed their income in 2019 than in 2017 and we felt this discrepancy may disproportionately impact outputs))

Coefficients:	Estimate	Standard Error	Z-Value	Pr(> z)	
(Intercept)	-0.774	0.205	-3.785	0.000	***
Year 2019	-0.363	0.161	-2.250	0.024	*
Dialect Cantonese	0.168	0.197	0.851	0.395	
Dialect Hainanese	-0.299	0.362	-0.825	0.410	
Dialect Hakkas	0.266	0.256	1.036	0.300	
Dialect Hokkiens	0.070	0.164	0.425	0.671	
Dialect Teochews	0.074	0.190	0.392	0.695	
Dialect Other	0.343	0.341	1.005	0.315	
Dialect Unknown	-0.622	0.490	-1.269	0.204	
Education Primary School (and Under)	-0.184	0.242	-0.761	0.447	
Education Secondary School / ITE	-0.225	0.166	-1.357	0.175	
Education Pre-University / Post-Secondary School	0.213	0.165	1.292	0.197	
Education University / Graduate School	0.115	0.168	0.684	0.494	
Education Unknown	0.081	0.390	0.209	0.835	
Generation First	-0.400	0.198	-2.024	0.043	*
Generation Second	0.104	0.149	0.699	0.485	
Generation Third	0.053	0.151	0.355	0.723	
Generation More than Third	-0.136	0.250	-0.544	0.586	
Generation Unknown	0.379	0.315	1.202	0.229	
Religion Buddhist	0.000	0.211	0.001	0.999	
Religion Catholic	-0.257	0.316	-0.813	0.416	
Religion Christian	0.031	0.231	0.136	0.892	
Religion Taoist	0.353	0.315	1.119	0.263	
Religion None	-0.222	0.233	-0.952	0.341	
Religion Other	0.681	0.812	0.838	0.402	
Religion Unknown	-0.586	0.561	-1.044	0.296	

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1					
Null deviance: 1054.9 on 875 degrees of freedom					
Residual deviance: 1028.9 on 854 degrees of freedom					
AIC: 1080.5					
Number of Fisher Scoring iterations: 4					

Consumer Treatment Preferences

Reasons, Recommenders, and Locations

Post-intervention (in 2019) we saw a number of statistically significant trends among high-fidelity saiga horn consumers using saiga horn on themselves, which were mainly in keeping with our Pre-intervention (2017) results (Figure A5.4.1). Firstly, *it works* and *someone recommended it to me*

remained the top two stated reasons for using saiga horn, and *family* remained the top recommender of saiga horn (though the second recommender shifted from *TCM shopkeeper* in 2017 to *friend* in 2019). Next, *TCM stores* remained the top location to buy saiga horn products (however the order flipped between *family-owned stores* and *chain stores*). Finally, high-fidelity saiga horn users were still less likely to also use biomedical products to treat heatiness and fever, and more likely to also use traditional herbal products. Statistical outputs shown below.

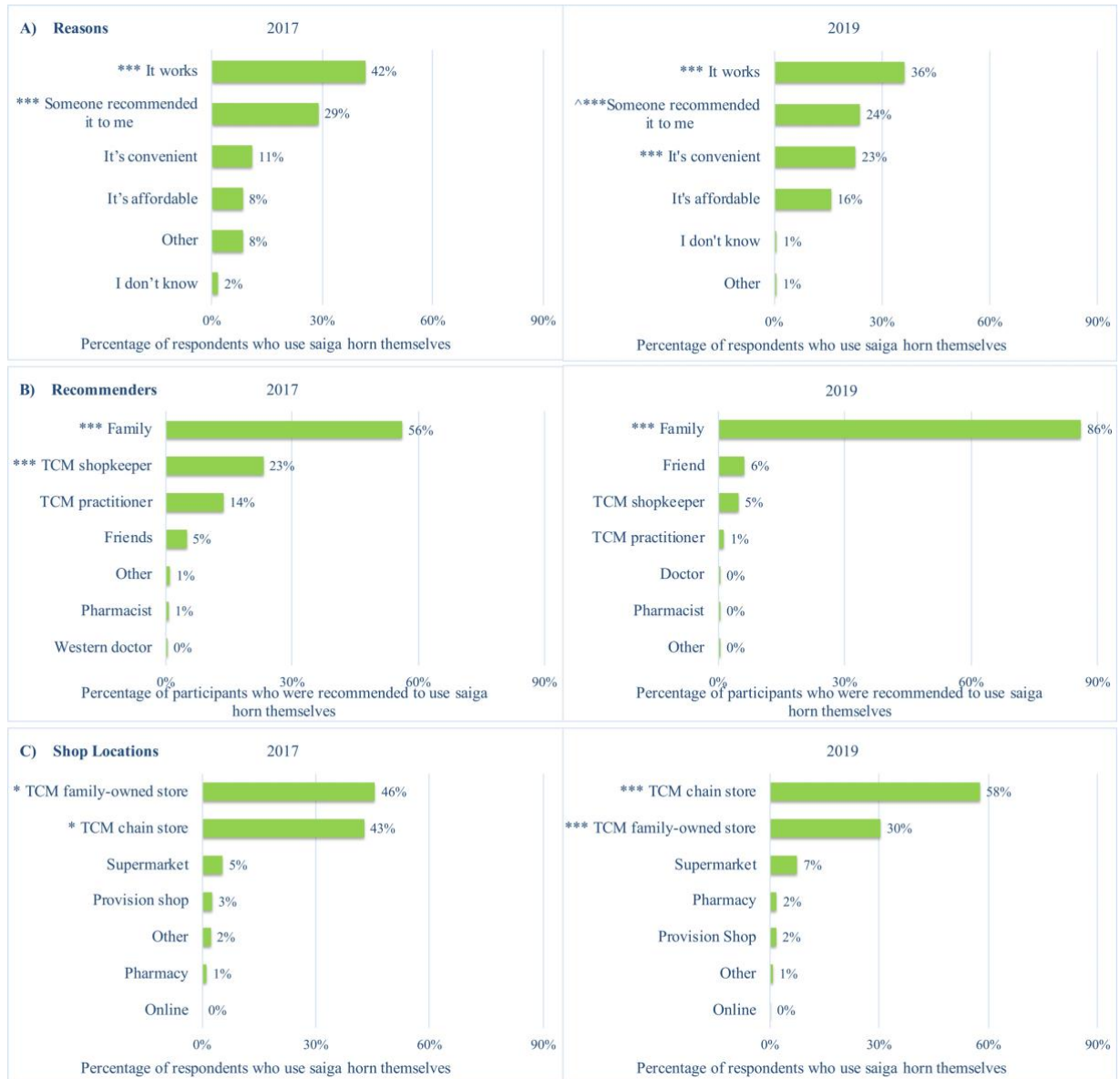


Figure A5.4.1. Trends for those using saiga horn to treat fever/heatiness in themselves Pre- and post-intervention (2017 and 2019). **A)** Reasons for using saiga horn stated by respondents. **B)** Recommenders for using saiga horn stated by respondents. **C)** Shop locations for purchasing saiga horn stated by respondents. Astride indicate: * is $p < 0.05$, ** is $p < 0.01$, *** $p < 0.001$. See Doughty et al. (2019) for 2017 statistics.

2-sample test for equality of proportions with continuity correction:

Reasons for Using Saiga

“It works” vs “Someone recommended it to me”

data: c(286, 188) out of c(343, 343)
 X-squared = 64.232, df = 1, p-value = 5.529e-16

“Someone recommended it to me” vs “It’s Convenient”
 data: c(188, 178) out of c(343, 343)
 X-squared = 0.47444, df = 1, p-value = 0.2455

“It’s Convenient” vs “It’s Affordable”
 data: c(178, 124) out of c(343, 343)
 X-squared = 16.616, df = 1, p-value = 2.288e-05

Recommenders of Saiga Horn
“Family” vs “Friend”

data: c(178, 13) out of c(188, 188)
 X-squared = 286.2, df = 1, p-value < 2.2e-16

Locations for Purchasing Saiga Horn

“TCM Chain Store” vs “TCM Family Store”
 data: c(277, 146) out of c(343, 343)
 X-squared = 104.21, df = 1, p-value < 2.2e-16

“TCM Family Store” vs “Supermarket”
 data: c(146, 36) out of c(343, 343)
 X-squared = 88.854, df = 1, p-value < 2.2e-16

Additional Treatment Types

Different from our pre-intervention sample (2017), in our post-intervention sample (2019): among those using saiga horn on themselves, respondents were significantly more likely to also use traditional herbal medicine, and significantly less likely to also use western or other medicine (Table A5.4.7).

Table A5.4.7. Comparing the additional treatment types that those who saiga horn on themselves, Pre- and post-intervention (2017 and 2019).

	2017				2019			
	β	Std. Error	Z-value	P-value ^	β	Std. Error	Z-value	P-value
Intercept	0.08621	0.19248	0.448		Intercept	-1.298	0.248	-5.239 ***
Western Med	-1.3304	0.14983	-	***	Western Med	-0.906	0.187	-4.856 ***
Herbal Trad Med	-0.1913	0.13378	-1.43		Herbal Trad Med	0.794	0.168	4.741 ***
Other	-	0.16556	-	***	Other	-0.904	0.202	-4.480 ***
	1.51281		9.138					

Intervention-Specific Analyses

Accurate Intervention Recall

Respondents mentioned a number of topics of when describing what they thought the “recent media attention about ling yang” was about (Table A5.4.8). The target audience, and high fidelity

saiga horn users within this audience, were significantly more likely to describe content generally in-line with the intervention recall (and thus to be identified as having ‘accurate intervention recall’) (Tables A5.4.9 and A5.4.10).

Table A5.4.8. Stated recall, and the “media attention” content described by respondents. ‘Saiga as an Animal’ content refers to generally accurate descriptions of the intervention message. Frequencies and percentages out of the non-target and target audience (1678 and 438 people respectively) are shown.

	Non target audience		Target audience	
Stated recall	126	(8%)	69	16%
<i>Saiga as an Animal (accurate)</i>	74	(4%)	50	(11%)
Saiga horn not effective	16	(1%)	7	(2%)
Saiga horn effective	35	(2%)	12	(3%)
Saiga horn products are fake/diluted	4	(0%)	2	(0%)
Saiga horn Seizures	2	(0%)	2	(0%)
Generically negative towards saiga horn	2	(0%)	5	(1%)
I don’t know	6	(0%)	0	(0%)

Table A5.4.9. GLM output for profiles of respondents who accurately recalled the intervention message.

Did the 2019 target audience accurately recall the intervention more than the non-target audience?					
Yes - Significant					
Accurate intervention message recall = target-audience + Chinese dialect + education + generation Singaporean + religion + income					
((variable levels with less than 10 participants for the target audience were omitted so they did not disproportionately skew results: ‘Education Unknown’, ‘Religion Unknown’, ‘Religion Other’, ‘Dialect Unknown’))					
Coefficients:	Estimate	Standard Error	Z-Value	Pr(> z)	
(Intercept)	-3.513	0.254	13.854	< 2.00E-16	***
Target Audience	0.943	0.201	4.688	0.000	***
Dialect Cantonese	0.127	0.228	0.556	0.578	
Dialect Hainanese	-0.399	0.402	-0.992	0.321	
Dialect Hakkas	0.114	0.301	0.377	0.706	
Dialect Hokkiens	0.030	0.178	0.167	0.868	
Dialect Teochews	-0.159	0.231	-0.689	0.491	
Dialect Other	0.288	0.318	0.904	0.366	
Education Primary School (and Under)	-0.843	0.398	-2.118	0.034	*
Education Secondary School / ITE	0.078	0.206	0.379	0.705	
Education Pre-University / Post-Secondary School	0.027	0.214	0.124	0.901	
Education University / Graduate School	0.738	0.192	3.847	0.000	***
Generation First	-0.171	0.252	-0.677	0.499	
Generation Second	-0.264	0.211	-1.247	0.212	

Generation Third	0.213	0.176	1.209	0.226
Generation More than Third	0.034	0.273	0.126	0.900
Generation Unknown	0.187	0.390	0.479	0.632
Religion Buddhist	0.279	0.183	1.524	0.127
Religion Catholic	-0.125	0.341	-0.367	0.714
Religion Christian	-0.356	0.239	-1.488	0.137
Religion Taoist	-0.223	0.389	-0.575	0.565
Religion None	0.425	0.195	2.179	0.029 *
Income One	-0.110	0.216	-0.508	0.611
Income Two	0.247	0.190	1.296	0.195
Income Three	0.327	0.272	1.205	0.228
Income Four	-0.293	0.510	-0.575	0.565
Income Five	0.236	0.292	0.806	0.420
Income Unknown	-0.407	0.272	-1.497	0.134

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1				
Null deviance: 908.49 on 2004 degrees of freedom				
Residual deviance: 833.71 on 1982 degrees of freedom				
AIC: 879.71				
Number of Fisher Scoring iterations: 16				

Table A5.4.10. GLM output for profiles of respondents who accurately recalled the intervention message, within the target audience.

Did 2019 high-fidelity users in the target audience accurately recall the intervention more than others in the target audience?					
Yes - Significant					
Accurate intervention message recall = high-fidelity saiga user + Chinese dialect + education + generation Singaporean + religion + income					
((variable levels with less than 10 participants for the target audience were omitted so they did not disproportionately skew results: 'Education Unknown', 'Religion Unknown', 'Religion Other', 'Dialect Unknown'))					
Coefficients:	Estimate	Standard Error	Z-Value	Pr(> z)	
(Intercept)	-3.355	0.248	13.504	< 2.00E-16	***
High-Fidelity Saiga User	0.456	0.226	2.023	0.043	*
Dialect Cantonese	0.104	0.226	0.459	0.646	
Dialect Hainanese	-0.354	0.400	-0.885	0.376	
Dialect Hakkas	0.078	0.301	0.258	0.797	
Dialect Hokkiens	0.021	0.176	0.122	0.903	
Dialect Teochews	-0.159	0.230	-0.692	0.489	
Dialect Other	0.310	0.317	0.978	0.328	
Education Primary School (and Under)	-0.934	0.398	-2.347	0.019	*
Education Secondary School / ITE	0.129	0.205	0.631	0.528	

Education Pre-University / Post-Secondary School	0.046	0.213	0.217	0.828	
Education University / Graduate School	0.758	0.192	3.954	0.000	***
Generation First	-0.108	0.251	-0.430	0.667	
Generation Second	-0.248	0.211	-1.176	0.240	
Generation Third	0.251	0.175	1.437	0.151	
Generation More than Third	-0.026	0.272	-0.096	0.924	
Generation Unknown	0.131	0.389	0.336	0.737	
Religion Buddhist	0.273	0.182	1.502	0.133	
Religion Catholic	-0.142	0.339	-0.418	0.676	
Religion Christian	-0.268	0.236	-1.136	0.256	
Religion Taoist	-0.257	0.386	-0.665	0.506	
Religion None	0.394	0.194	2.029	0.043	*
Income One	-0.141	0.215	-0.655	0.512	
Income Two	0.232	0.190	1.226	0.220	
Income Three	0.415	0.269	1.543	0.123	
Income Four	-0.309	0.510	-0.605	0.545	
Income Five	0.223	0.291	0.768	0.443	
Income Unknown	-0.422	0.271	-1.556	0.120	

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1					
Null deviance: 908.49 on 2004 degrees of freedom					
Residual deviance: 850.50 on 1982 degrees of freedom					
AIC: 896.5					
Number of Fisher Scoring iterations: 6					

Sources of Exposure

Respondents were asked where they heard about the “recent media attention on ling yang” (Figure A5.4.2). Those with accurate intervention recall were significantly more likely to cite the news and social media, while those with inaccurate intervention recall were significantly more likely to cite family and friends. Statistical outputs shown below.

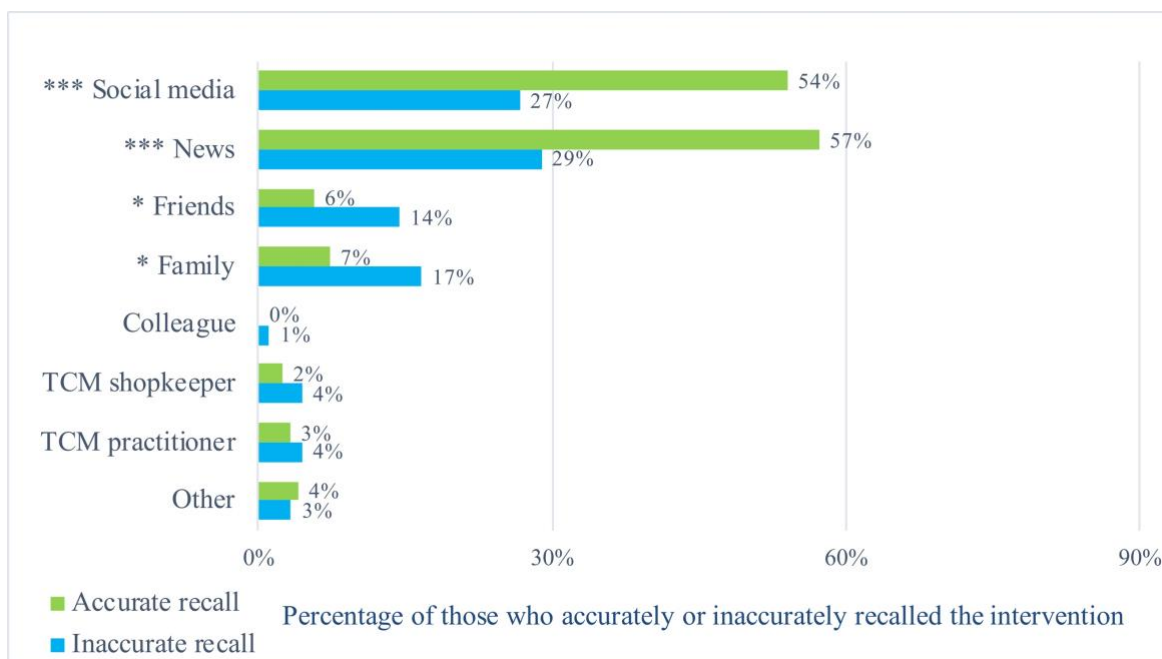


Figure A5.4.2. Sources of exposure to the intervention message. Percentages out of all respondents with accurate or inaccurate intervention message recall.

2-sample test for equality of proportions with continuity correction:

News

"Accurate recall" vs "Inaccurate recall"

data: c(71, 26) out of c(124, 90)

X-squared = 15.811, df = 1, p-value = 3.5e-05

Social Media

"Accurate recall" vs "Inaccurate recall"

data: c(67, 24) out of c(124, 90)

X-squared = 14.879, df = 1, p-value = 5.733e-05

Family

"Inaccurate recall" vs "Accurate recall"

data: c(15, 9) out of c(90, 124)

X-squared = 3.7395, df = 1, p-value = 0.02657

Friends

"Inaccurate recall" vs "Accurate recall"

data: c(13, 7) out of c(90, 124)

X-squared = 3.7839, df = 1, p-value = 0.02587

Behaviour Change

There were two ways that we assessed behaviour change following the intervention message. Firstly, we asked respondents if their fever/heatiness treatment preferences had changed in the last four months for any reason, with no mention of the intervention. Nine people who selected saiga as a product they purchase most often (and thus were categorised as high-fidelity saiga users), when next asked if their preferences changed for any reason in the last three months, said yes and either referenced herbal alternatives they are switching to or specifically referenced the news/Facebook posts (Table A5.4.11). Secondly, after asking respondents whether they recalled

recent media attention around ling yang (saiga horn), we asked them if they had changed their usage of saiga horn. Among those with accurate intervention recall, target audience respondents were significantly more likely than non-target audience respondents to state they had decreased their saiga horn usage (Table A5.4.12). And within the target audience, high-fidelity saiga horn users were significantly more likely than presumably lower-fidelity users to state they had decreased their saiga horn usage (Table A5.4.13).

Table A5.4.11. Responses given by respondents who indicated high-fidelity saiga horn use, but then stated they had in fact changed their preference in the last four months.

Heatiness or Fever	Target Audience	Responses as they were recorded by the research surveyors
H		"Use more herbal product instead because it's more convenient"
H		"News"
H	Y	"Last used ling yang last year, will opt for herbal alternatives like barley if heaty now"
H		"There is other options like food and fruits"
H & F	Y	"Found ling yang so cooling that respondent has leg pain. Also read a Facebook post on how ling yang is harmed for their horns, feel pity towards them so haven't drink or buy ling yang this year. So now use more of herbal alternatives like barley water"
H		"If there is no need, I purchase water instead of ling yang if heaviness occurs."
F		"Became vegan in the last 2 months but haven't fallen sick during this period; would probably not use ling yang anymore if still maintaining diet the next time she gets fever"
F		"If ling yang doesn't work, respondent will take Panadol."
F	Y	"If these three methods does not work, the respondent will eat lots of fruits and drink plenty of water."

Table A5.4.12. GLM output for profiles of respondents with accurate intervention recall, who stated they had fully stopped, or heavily decreased, their saiga horn usage following the intervention.

Did the 2019 target audience change their behaviour more than the non-target audience?				
Yes - Significant				
Decrease saiga horn usage = target-audience + Chinese dialect + education + generation Singaporean + religion + income				
((variable levels with less than 10 participants for the target audience were omitted so they did not disproportionately skew results: 'Education Unknown', 'Religion Unknown', 'Religion Other', 'Dialect Unknown'))				
Coefficients:	Estimate	Standard Error	Z-Value	Pr(> z)
(Intercept)	-7.407	153.798	-0.048	0.962
Target Audience	1.186	0.347	3.421	0.001 ***
Dialect Cantonese	2.749	153.798	0.018	0.986
Dialect Hainanese	2.255	153.799	0.015	0.988
Dialect Hakkas	3.036	153.798	0.020	0.984
Dialect Hokkiens	2.197	153.798	0.014	0.989
Dialect Teochews	2.542	153.798	0.017	0.987

Dialect Other	-12.778	768.988	-0.017	0.987
Education Primary School (and Under)	-0.474	0.573	-0.827	0.408
Education Secondary School / ITE	0.250	0.312	0.801	0.423
Education Pre-University / Post-Secondary School	-0.122	0.347	-0.351	0.725
Education University / Graduate School	0.346	0.315	1.098	0.272
Generation First	-1.301	0.837	-1.554	0.120
Generation Second	0.213	0.392	0.543	0.587
Generation Third	0.687	0.351	1.960	0.050
Generation More than Third	-0.326	0.635	-0.513	0.608
Generation Unknown	0.727	0.645	1.128	0.259
Religion Buddhist	-0.064	0.359	-0.178	0.859
Religion Catholic	-0.657	0.834	-0.788	0.431
Religion Christian	-0.162	0.431	-0.376	0.707
Religion Taoist	0.026	0.627	0.042	0.966
Religion None	0.857	0.342	2.508	0.012 *
Income One	0.040	0.344	0.117	0.907
Income Two	0.028	0.326	0.086	0.932
Income Three	-0.136	0.538	-0.252	0.801
Income Four	0.927	0.552	1.680	0.093
Income Five	-0.383	0.633	-0.605	0.545
Income Unknown	-0.477	0.471	-1.013	0.311

Signif. codes: 0 '****' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1				
Null deviance: 368.76 on 2004 degrees of freedom				
Residual deviance: 327.51 on 1982 degrees of freedom				
AIC: 373.51				
Number of Fisher Scoring iterations: 18				

Table A5.4.13. GLM output for profiles of respondents (within the target audience) with accurate intervention recall, who stated they had fully stopped, or heavily decreased, their saiga horn usage following the intervention.

Did 2019 high-fidelity users in the target audience change their behaviour more than others in the target audience?				
Yes - Significant				
Decrease saiga horn usage = high-fidelity saiga user + Chinese dialect + education + generation Singaporean + religion + income				
((variable levels with less than 10 participants for the target audience were omitted so they did not disproportionately skew results: 'Education Unknown', 'Religion Unknown', 'Religion Other', 'Dialect Unknown'))				
Coefficients:	Estimate	Standard Error	Z-Value	Pr(> z)
(Intercept)	-7.328	155.313	-0.047	0.962
High-Fidelity Saiga User	1.113	0.359	3.106	0.002 **
Dialect Cantonese	2.706	155.313	0.017	0.986

Dialect Hainanese	2.392	155.314	0.015	0.988
Dialect Hakkas	2.902	155.313	0.019	0.985
Dialect Hokkiens	2.158	155.313	0.014	0.989
Dialect Teochews	2.553	155.313	0.016	0.987
Dialect Other	-12.712	776.562	-0.016	0.987
Education Primary School (and Under)	-0.580	0.574	-1.011	0.312
Education Secondary School / ITE	0.314	0.310	1.013	0.311
Education Pre-University / Post-Secondary School	-0.102	0.347	-0.295	0.768
Education University / Graduate School	0.368	0.319	1.155	0.248
Generation First	-1.181	0.838	-1.409	0.159
Generation Second	0.257	0.394	0.652	0.514
Generation Third	0.741	0.350	2.115	0.034 *
Generation More than Third	-0.461	0.642	-0.718	0.473
Generation Unknown	0.644	0.643	1.001	0.317
Income One	0.001	0.343	0.003	0.997
Income Two	-0.008	0.327	-0.024	0.981
Income Three	-0.100	0.541	-0.185	0.853
Income Four	1.040	0.552	1.882	0.060 .
Income Five	-0.456	0.634	-0.720	0.472
Income Unknown	-0.477	0.471	-1.012	0.312
Religion Buddhist	-0.113	0.360	-0.315	0.753
Religion Catholic	-0.650	0.834	-0.779	0.436
Religion Christian	-0.053	0.428	-0.124	0.901
Religion Taoist	-0.039	0.627	-0.063	0.950
Religion None	0.855	0.342	2.499	0.012 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1				
Null deviance: 368.76 on 2004 degrees of freedom				
Residual deviance: 329.76 on 1982 degrees of freedom				
AIC: 375.76				
Number of Fisher Scoring iterations: 18				

Reasons for Behaviour Change

When asked why respondents did or did not decrease their saiga horn usage following the intervention, respondents with accurate intervention recall who changed their behaviour were significantly more likely to mention reasons related to the intervention message (i.e. 'Saiga as an Animal'), whereas those who did not change their behaviour mentioned the effectiveness of saiga horn the most often (Table A5.4.14). Statistical analyses shown below.

Table A5.4.14. Reasons given for changing or not changing behaviour. Among all respondents who decreased their saiga horn usage (38 people) and among all respondents who did not decrease their saiga horn usage (22 people)

Did decrease saiga horn usage	
Saiga as an Animal (e.g. endangered species)	29
Respondent prefers alternatives	9
Saiga horn not effective	4
Saiga horn effective	2
No longer need saiga horn	1
Taste of saiga horn is undesirable	1
Don't use it often	1
Tradition	1
Did not decrease saiga horn usage	
Saiga horn effective	10
Don't use it often	5
Not big impact/Don't Care	4
Tradition	2
Respondent prefers alternatives	2
Reason Unknown	1
Saiga horn is expensive	1

2-sample test for equality of proportions with continuity correction

Those who decreased saiga horn usage

"Saiga as an Animal" vs "Respondent prefers alternatives"

data: c(29, 9) out of c(38, 38)

X-squared = 19, df = 1, p-value = 6.536e-06

Those who did not decrease saiga horn usage

"Saiga horn effective" vs "Tradition"

data: c(10, 5) out of c(22, 22)

X-squared = 1.6184, df = 1, p-value = 0.1017

Appendix 5.5 Supplementary Shopkeeper Results

Shopkeeper and Shop Demographics

Out of shopkeepers who completed the survey: 51% were female and 49% were male. Shopkeepers 35-59 years old composed 51%, followed by 18-34 year olds (27%), and 60+ year olds (23%). Shopkeepers were predominately first- and second-generation Singaporean (both at 38%). Shopkeepers who completed the survey came from chain and family-owned TCM shops the most often (Figure A5.5.1). Additionally, the Planning Areas (i.e. neighbourhood districts) of Bedok, Jurong West, and Tampines yielded the largest number of completed surveys. To protect the anonymity of our shopkeepers, their Planning Area location has been withheld.

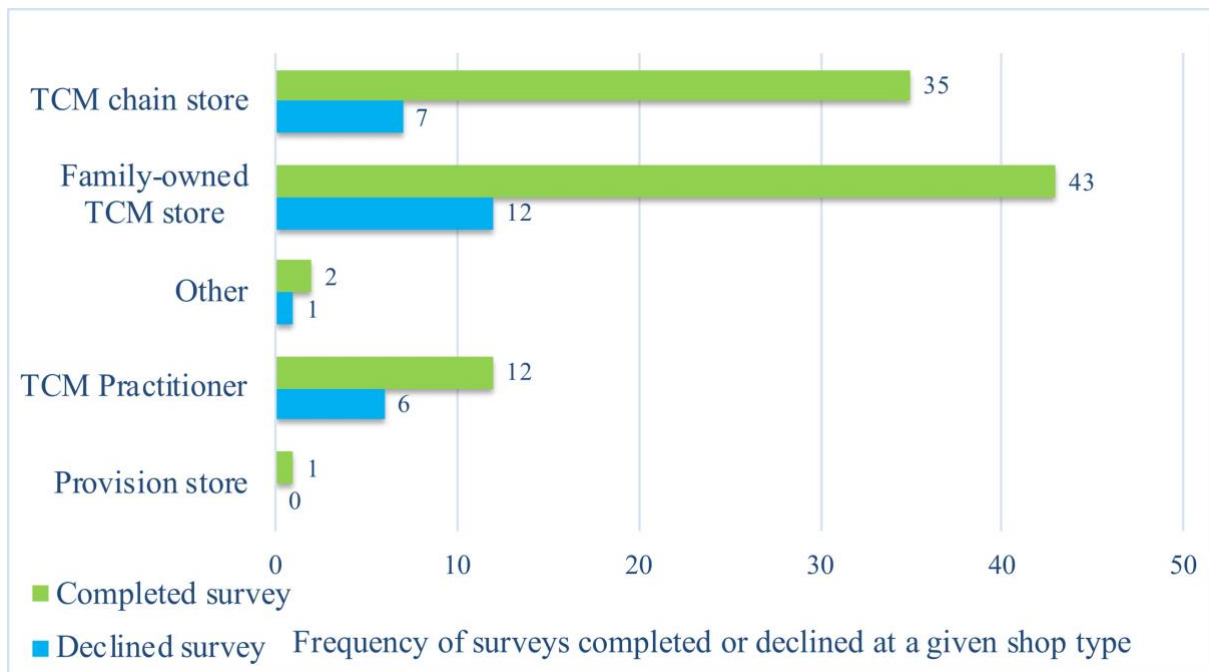


Figure A5.5.1. Frequencies of completed surveys broken down by shop type.

Customer Treatment Preferences

When asked what heatiness/fever treatments that a shopkeeper's customers preferred to purchase the most, shopkeepers stated differences in the perceived preferences of their overall customer base and their target audience (middle-aged female) specific customer base (Figure A5.5.2).

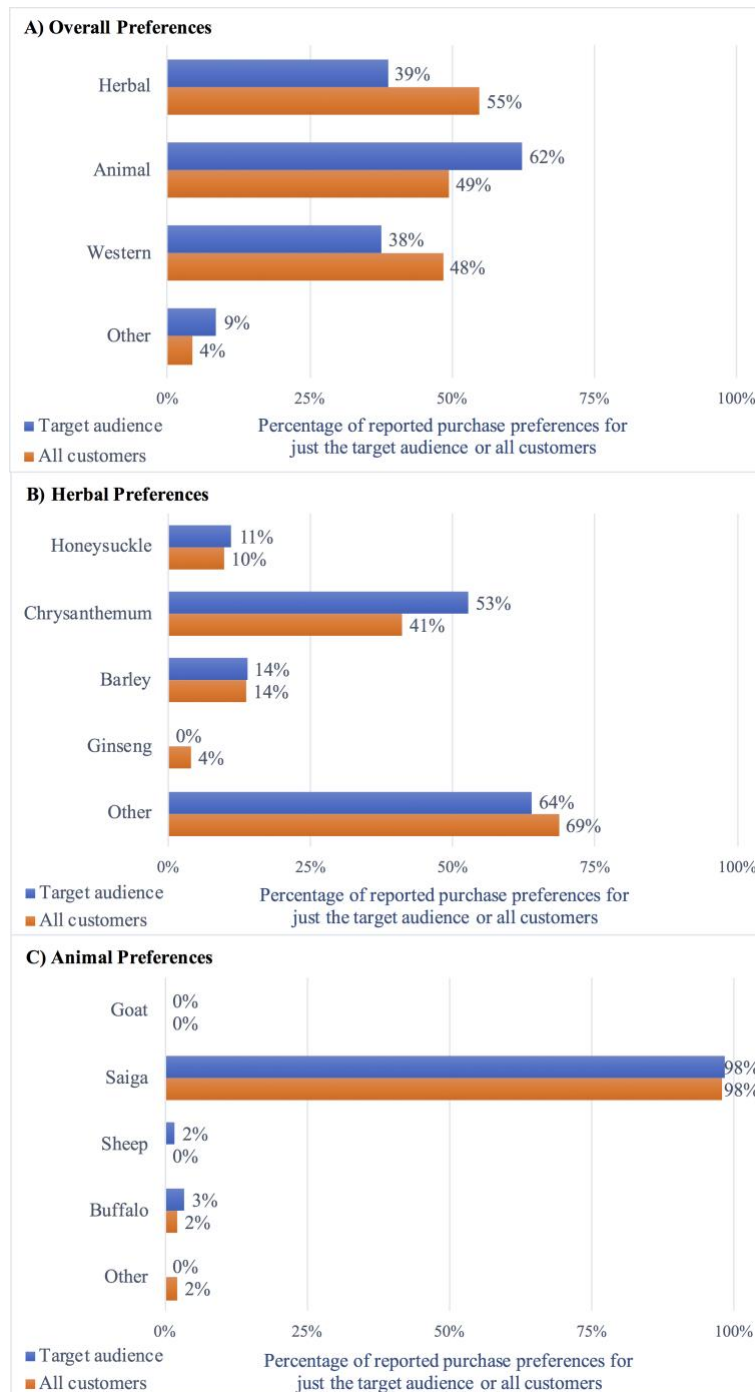


Figure A5.5.2. Trends in shopkeeper perceived customer preferences for heatiness and fever treatments. **A)** Overall customer preferences. **B)** Herbal treatment preferences. **C)** Animal treatment preferences. Percentages out of responses given by 93 shopkeepers for their target audience (middle-aged female) customer base, and their overall customer base. Preference selections were not mutually exclusive.

Perceptions of Wild Animals' Conservation Status

Shopkeepers were asked which animals (out of a list of animals used often in TCM) were common in the wild (Table A5.5.1). Sea cucumbers were most often mentioned as common in the wild. Turtles were never mentioned as common in the wild. Shopkeepers were also asked to elaborate on their answers if they wanted. The content of their responses was then coded (Table A5.5.2).

Table A5.5.1: Wild Animals perceived as common in the wild. Each animal's frequencies and percentages are shown out of total shopkeeper respondents (93 people).

Sea cucumber (hai shen)	42	(45%)
Goat (shan yang)	32	(34%)
Turtle (hai gui)	0	(0%)
Saiga antelope (ling yang)	15	(16%)
Sea horse (hai ma)	13	(14%)
Rhino (xi niu)	1	(1%)
None -- N/A in 2017	21	(23%)
I don't know	18	(19%)

Table A5.5.2: Content stated by respondents when discussing which of the given animals used in TCM a respondent thought were common in the wild. Frequencies out of total 93 shopkeepers' responses. Content were not mutually exclusive.

Saigas being protected/endangered	16
Other species' populations are doing OK	16
Saigas are restricted/Saiga's restrictions	14
Other species' farming	13
Saiga populations are decreasing	11
Saiga horn alternatives	11
Saiga horn stockpile	11
Saiga horn cost	11
Other species' populations are decreasing	9
Saiga populations are doing OK	9
Saiga hunting	8
Respondent stated they are 'not informed'	7
Saiga farming	7
Other species' protections	6
Others species' restrictions	6
Saiga horn reports from the government	3
Saiga horn imports are decreasing	2
Saigas are not killed for their horn	2
Saiga horn supply is decreasing	1
Other species' product supplies are decreasing	1
Other species' product imports are decreasing	1

ACRES non-profit stickers in TCM shopkeeper windows	1
Shopkeeper indicated they were uncomfortable to discuss details	2
Shopkeeper did not elaborate	33

Intervention-Specific Analyses

Accurate Intervention Recall

Shopkeepers mentioned a number of topics when describing what they thought the “recent media attention about ling yang” was about (Table A5.5.3). Eight shopkeepers gave a generally accurate description of the intervention message and thus were labelled as having ‘accurate recall.’

Table A5.5.3: Stated intervention recall and the content of the intervention described by the shopkeepers. ‘Saiga endangered’ indicated a generally accurate description of the intervention message. Respondents could describe more than one type of content.

Those who stated intervention recall	23
Content described by shopkeepers:	
Saiga horn is effective	10
Saiga is endangered (accurate recall)	8
Saiga horn bans/restrictions	7
Saiga horn supplies are decreasing	2
Saiga horn is not effective	2
Saiga horn stockpiles	2
Saiga horn is losing popularity	2

Sources of Exposure

Shopkeepers were asked where they heard about the “recent media attention on ling yang” (Table A5.5.4). Those with accurate and inaccurate intervention recall mentioned the news most often. Given some of the ‘other’ sources though, such as “company training books”, or “personal experience”, it is clear that not all shopkeepers were talking about the intervention. Some of the ‘other’ descriptions could be accurate though, such as “google search” or “radio broadcast”.

Table A5.5.4: Sources where shopkeepers heard about the intervention message. Frequencies are given for number of shopkeepers indicating a given source. Sources were not mutually exclusive.

	Inaccurate Recall	Accurate Recall
News outlet/newspaper	9	4
Other	6	2
Social media	4	2
TCM association	3	0
Family	1	1
Friends	0	1
Colleague	0	0

I don't know	0	0
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Perceived Sales Changes

When asked whether sales for saiga horn had changed at all following the recent media attention around ling yang, five shopkeepers (one shopkeeper with accurate intervention recall) stated there had been a decrease in saiga horn sales (Table A5.5.5). Shopkeepers also described why they thought saiga horn sales had decreased or stayed the same (Table A5.5.5). No shopkeepers stated saiga horn had increased in sales.

Table A5.5.5: Perceived change (if any) in saiga sales following the intervention - encompassing sales to any customer, including the target audience. Reasons given by shopkeepers for these sales trends is also shown.

Perceived decrease in sales ^	5
No perceived change in sales	16
I don't know	2
Discussion content for perceived change/no change	
Decreased saiga horn sales	
Cost of saiga	3
Prefer alternatives	2
Doctor more convenient	1
Saiga losing popularity	1
Restrictions on saiga access	1
No change in saiga horn sales	
Effective	11
Customer choice	3
Tradition	3
Cost of saiga	2
Doctor more convenient	2
Impact apathy	2
Prefer alternatives	2
Stockpile decreasing	1

^ About 5% of shopkeepers perceived a decrease in saiga sales, and this sales change ranged from unknown, to 25%, to >70%.