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1. CHANGING SOCIAL NORMS

1.1. INTRODUCTION

Social norms are "unwritten rules that are collectively understood, prescribe what people ought (not) to do, and motivate people to engage in individually costly but socially beneficial behaviour" (Andrighetto et al 2024 p1). Changing social norms can be seen as an intervention to change behaviours related to health, and the environment, say.

"Yet whether or not interventions work and how remain a black box unless underlying norm dynamics are understood" (Andrighetto et al 2024 p1). With this in mind, Andrighetto et al (2024) introduced an interdisciplinary special issue of the "Philosophical Transactions of the Royal Society B" on understanding norms and norm change. They highlighted three themes:

i) "Identification of norms, norm change and their effect on behaviour".

ii) "Drivers and consequences of spontaneous norm change".

iii) "Engineering norm change for behavioural change" (Andrighetto et al 2024).

1.2. NORMS

"In social sciences, most definitions of social norms involve beliefs about what others do and about what they should or should not do. The former are called descriptive norms, empirical expectations or folkways (emerging out of routines, such as waiting in line). The latter are termed injunctive norms, normative expectations, mores (specifying what is moral or unethical), taboos (prohibition of behaviours so strict it results in disgust), prescriptive norms (encouraging

positive behaviour), and proscriptive norms (discouraging negative behaviour)" (Gavrilets et al 2024 p1). These authors continued: "Norms vary among families, cultural, ethnic or religious groups, regions and countries, and are influenced by exposure to different situations, leading to different degrees of adherence often described in terms of societal tightness-looseness. Specifically, 'tight' cultures display strong norms, low tolerance for deviance, resistance to innovations and uniform social conduct, while 'loose' cultures demonstrate more relaxed norms, are more tolerant, and exhibit more diverse conducts" (Gavrilets et al 2024 p1).

There are also personal norms (or normative beliefs), which "can be shaped by an individual's moral values, often stemming from considerations about the welfare of others, or from their sense of what actions and beliefs are most appropriate. These norms can also evolve from internalised social norms" (Gavrilets et al 2024 p2).

The modelling of social norms and their changes involve a number of factors (Gavrilets et al 2024):

i) Beliefs - "Changes in social norms occur simultaneously with changes in our beliefs about what others do, what others think and what is right or wrong in different situations. Some changes occur gradually over generations, such as the norm regarding gender roles in many societies. Other norms can change relatively quickly. Norm change velocity can also be influenced by the level of consensus about a norm and the connectivity in a society or group" (Gavrilets et al 2024 p2).

ii) Cognitive and psychological processes - eg: mental discomfort of holding contradictory views (sometimes called "cognitive dissonance"); "theory of mind" (the ability to understand the mental state of others); "psychological reactance" (resisting threats to personal freedom).
"Importantly, people can incorrectly perceive others' beliefs, leading to pluralistic ignorance: people may believe their private thoughts and feelings differ from those of others when in fact they are not" (Gavrilets et al 2024 p1).

iii) Individual differences - eg: personality traits; emotional reactions.

iv) "Norm-utility" - eg: the benefits (material or

otherwise) that an individual gains from conformity or anti-conformity.

Norms have been studied experimentally with public good games. Each player in a group receives an amount of money, and they can place as much of that as they want in a pubic kitty, for instance. The amount in the kitty is doubled and shared equally between the players. "Free riders" are a risk in this game (ie: individuals who put in less than the others). For example, there are four players, of which three players each 25 units in the kitty, while the free rider puts in five units. The total is 80 units, which is doubled to 160 units, and each player receives 40 units back. Researchers are interested in the social norms that develop over a number of rounds to deal with free riders, and what becomes seen as the appropriate amount to put into the kitty.

Referring to the norms around the use of large language models, like "ChatGPT", Baronchelli (2024) outlined three main processes of norm creation and changes:

a) Formal institutions, like governments, that set regulations and laws.

b) Informal institutions that influence social norms, but cannot enforce them like formal institutions (eg: "gatekeepers" in society; religious leaders).

c) Spontaneous norms - "Universally accepted norms are the unintended consequence of individuals' efforts to co-ordinate locally with one another. Similar to other emergent phenomena observed in complex systems, global co-ordination in this context results from self-organisation within a network of locally interacting individuals. This spontaneous process interacts with the activity of formal and informal institutions in complex ways that range from complementing existing regulations to countering them in ways that can result in conflict and legislative change. More importantly, spontaneous norms tend to occupy a much wider space than regulations" (Baronchelli 2024 p3).

1.3. IDENTIFICATION OF NORMS

Andrews et al (2024) noted: "Nearly every aspect of human life is shaped by social norms, the 'often informal

rules that structure human behaviour, regulating what is appropriate, required, prohibited or permitted' [Kelly 2020]" (p1). These researchers proposed that social norms are not unique to humans, however. They stated: "While there is currently only suggestive evidence for norms in non-human communities, we argue that human social norms are likely produced by a wide range of mechanisms, many of which we share with non-human animals" (Andrews et al 2024 p1).

Because of the association of social norms with humans, the term "normative regularities" (defined as "socially maintained patterns of behavioural conformity within a community" by Westra and Anderson 2022) was used. This involves three aspects (Andrews et al 2024): "patterns of behavioural conformity" (ie: how things are done in a given community), "social maintenance" (ie: incentives and punishments for conformity and non-conformity) (appendix 1A), and "community" (ie: "the target group").

Andrews et al (2024) defended themselves: "Some critics might object that our characterisation of normative regularities is overly broad and that too many non-human behaviours would fall within its scope. For instance, Mormon crickets demonstrate a kind of social maintenance during swarming events when they gather and march, eating all the nutrients in their way. Insects that deviate from this pattern are cannibalised by their swarm-mates, placing them in a march-or-die situation. Since swarming is a kind of normative regularity, one might worry that the construct is too permissive, especially given that such self-organising regularities are common — in insect behaviour in particular. However, the permissiveness of our definition is intentional" (p3).

Andrews et al (2024) proposed a six-dimensional model of psychological and social factors that lead to differences in norms between humans and non-humans:

a) Rule-following.

- Level 1: Emergent regularities - rule-following with little mental representation of rules (eg: Mormon crickets).
- Level 2: Implicit representations - relatively simple cognitive processes behind the rule-following.
- Level 3: Non-propositional representations (eg: cognitive maps).
- Level 4: Propositional representations of rules -

rule-following based on distinct propositions.
- Level 5: Public linguistic representations of rules - rule-following supported by language.

b) Behavioural understanding - understanding of others' mental state.

- Level 1: Sub-mentalistic behaviour understanding - little or no mental state understanding. "Processes of habituation might support the gradual automatisation of norm-conforming behaviours over time. Processes like these are widely distributed among non-human animal species" (Andrews et al 2024 p5).
- Level 2: Minimal mentalising - basic abilities.
- Level 3: Meta-representational mentalising - an understanding of how others' beliefs influence their behaviour.
- Level 4: Recursive mentalising - eg: "Person A believes that Person B believes that Person C believes X".

c) Collective agency - rule-follower's understanding of collective group membership.

- Level 1: Individual intentionality - individuals acting for themselves.
- Level 2: Co-ordinated intentionality - individuals aware that co-ordination with others is necessary to achieve individual goals (eg: group hunts by chimpanzees).
- Level 3: Shared intentionality - "Individual representations of shared agency and the motivation to pursue joint goals together" (Andrews et al 2024 p6). A shared "we-mode" (Tomasello 2016).
- Level 4: Social identity - a shared social identity.

d) Motivation - for conforming.

- Level 1: Basic motivation - conformity because it benefits an individual's immediate self-interest (eg: capuchin monkey alarm calls when spotting an approaching predator in order to gather others to mob the predator).
- Level 2: Reciprocal motivation - conformity as part of a reciprocal relationship with others.
- Level 3: Reputational motivation - conformity

because it benefits an individual's reputation in the group.

- Level 4: Intrinsic motivation - conformity not based on external benefits, and manifest as doing the behaviour even when there is no audience.

    e) Punishment - rule-following is maintained by the punishment of rule-breakers.

- Level 1: Second-party punishment - "Violations are met with a negatively valenced response from the individuals directly impacted/harmed by the violation. Responses can include physical retaliation, a communicative signal of displeasure, a negative affective response, withdrawal from the violator etc" (Andrews et al 2024 p8).
- Level 2: Third-party punishment - those not directly impacted by the rule violation ("bystanders") impose punishment.
- Level 3: Institutionalised punishment - a structured response for violators maintained by institutions (eg: police force).

    f) Pedagogy - positive social maintenance that help individuals to learn norms.

- Level 1: Selective social toleration - naive individuals are allowed to violate norms initially or sometimes during the process of learning.
- Level 2: Active feedback - clear rewards for rule-following (eg: female vervet monkeys grooming males that participate in inter-group fights).
- Level 3: Active teaching/correction.
- Level 4: Institutionalised teaching - eg: schools.

    The purpose of Andrews et al's (2024) framework was to show that non-human animals can have social norms based on Levels 1 and
2, say, whereas human societies are usually the higher levels.

    Individuals form expectations about norms in a large society from a number of sources, including others around them, and statistics (eg: opinion polls), but also from government policies. In two similar experiments Syropoulos et al (2024) showed that when a government passes a new law, it is perceived that the majority of people support it (ie: there is a social norm).

Government policies are "institutional signals" of norms (Syropoulos et al 2024), and Tankard and Paluck (2016) saw them as one of three sources of information about new norms (along with observation of others, and summary statistics).

Syropoulos et al's (2024) studies involved over 11000 US adults recruited online. During the completion of a survey, they read about a new policy (or not), like generating 100% of electricity using renewable sources. Then they were asked to estimate what percentage of people supported this policy.

The estimation of how many people supported the policy was significantly higher after reading the statement compared to the control group with no statement.

Syropoulos et al (2024) concluded: "We find that signals by formal, democratic institutions — specifically information about the passage of a policy — influences perceptions of social norms around related issues. This is true of state- and national-level policies, for policies attributed to the legislative branch, executive branch, or to the government, and for policies that introduce restrictions and incentives. We also find that the expressive function of policy signals — that is, their signalling of social norms — depends critically on the belief that the institution in question is accountable to public preferences in its legislative decision-making" (p11).

Social norms can have functions other than "herding" behaviour, like signalling group membership. Macanovic et al (2024) asserted: "Mechanisms of social control reinforce norms that appear harmful or wasteful, such as mutilation practises or extensive body tattoos. We suggest such norms arise to serve as signals that distinguish between ingroup 'friends' and outgroup 'foes', facilitating parochial co-operation" (p1). So, where co-operation with members of one's own group (parochial co-operation) is important, costly norms will emerge. "These signals are reliable if only co-operators can afford to send them, either because co-operators incur lower signalling costs or gain higher co-operation benefits compared to untrustworthy defectors" (Macanovic et al 2024 p1).

The investment in the costly signal will become more important where the outgroup is frequently encountered. Macanovic et al (2024) offered this example from human history: "Imagine two large hunter-gatherer bands that are in conflict over limited resources in their shared

habitat. A group that has spent a very long time hunting away from their band is coming home and approaching one of the settlements. Others in this band might want to welcome the hunters, hoping for a share in the kill. Yet, as the group has been away for so long, the band cannot as easily recognise which band this particular group belongs to. If they are from the same band, the incoming hunters will be co-operative; if they are from another band, the group might have come to raid the settlement instead. To prevent being mistaken for members of an enemy group and win the trust of their band, the approaching group of hunters can display a reliable sign of band belonging, such as a difficult to fake local dialect or a tattoo with group-specific features. Once the band members recognise that this signal corresponds to their own group, they can rest assured and welcome the arrivals; otherwise, they can play safe and stay away from interacting with the group of strangers that is approaching their settlement" (p2).

1.4. EXAMPLES OF SPONTANEOUS NORM CHANGE

It is predicted that in the mid-21st century White Americans will no longer be the numerical minority in the USA. Amalia et al (2024) investigated the changing demographics and the social norm controlling anti-White prejudice. It is possible that "when Whites feel threatened and discriminated against, and they perceive more strongly that they share a 'common fate' with other Whites, conditions may be ripe for a social norm against anti-White prejudice to emerge" (Amalia et al 2024 p1).

Data from a survey measuring reactions to racially-offensive speech were analysed. It was found that "White Americans (in comparison to non-Whites) are indeed more likely to profess a social norm governing anti-White prejudice" (Amalia et al 2024 p1), and this was particularly so among White Republicans.

The online survey was completed in early 2020 by around 5000 US respondents. Anti-White prejudice was measured by the response to statements like, "The world could get by just fine with zero White people", and "White people have everything handed to them on a silver platter from birth" (p4). Each statement was rated "not at all offensive" (1) to "extremely offensive" (4).

He et al (2024) investigated the adoption of standard Mandarin Chinese (over local dialect), and denim jeans (over traditional clothing) by two groups (the

Mosuo and the Han [1]) in rural southwest China in the 21st century. These were outgroup cultural traits. The data were collected via surveys from over 2400 adults in 2017.

The adopting of the outgroup traits came from contact with outsiders in economic activities, education, and kin networks. "Males are more likely to adopt outgroup values than females in both groups. Females of the two groups are no different in speaking Mandarin and wearing jeans, whereas males do differ, with Mosuo males being keener to adopt them than Han males" (He et al 2024 p1).

The researchers offered an evolution-based explanation: "The reason might be that Mosuo men experience more reproductive competition over mates, as Mosuo men have larger reproductive skew than others. Moreover, Mosuo men but not others gain fitness benefits from the adoption of Mandarin (they start reproducing earlier than non-speakers)" (He et al 2024 p1). They expanded this explanation later: "Speaking Mandarin might act as an honest signal for Mosuo men, which indicates their ability to manage new knowledge. Surprisingly, wearing jeans does not affect one's reproductive success. The explanation might lie in the fact that learning a language is more costly and serves as a better signal of mate quality than wearing jeans" (He et al 2024 p9).

This fits with the "frequency-dependent selection theory" which explains the adoption of traits in relation to reproductive success. There are times when having the common trait is an advantage (ie: conformity or positive frequency-dependent selection), while at other times having the uncommon trait is an advantage (ie: innovation or negative frequency-dependent selection) (He et al 2024).

"Social norm messaging" is a strategy to change behaviour for the better in a population (eg: reduce consumption of unhealthy foods). The language in which such messages are framed is important (eg: normative expressions like "should" or "it is appropriate").

Kuang and Bicchieri (2024) investigated this in two online studies. In the first study over 1400 participants played a donation game, where they were given ten tokens and asked to donate them to a charity. Participants saw a message beforehand (or not) with a normative injunction (eg: "people should donate all ten tokens") [2], or one

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[1] The Mosuo are a small ethnic group in China as a whole, while the Han are the dominant ethnicity (He et al 2024).
[2] Seven variations in words were used.

based on social norms (or not) (eg: "most people think one should donate ten tokens"). More tokens on average were donated in the injunctive conditions (eg: 29% of participants donated all 10 tokens with "should" injunctive vs 12% in social norm version). Subsequent questioning of the participants found that words like "should", and "desirable" in the injunctive were important.

Study 2 involved a trust game and over 1400 more participants. Player A has a sum of money (10 tokens) and can give as much as they want to Player B. The amount given is tripled by the experimenter, and Player B decides how much to return to Player A. Injunctive messages or social norm messages were presented before the game. No difference was found in the amount given based on the type of message.

The researchers explained the difference in findings between the two studies. They argued that the existing norm was weak in Study 1 and strong in Study 2. The norm of Player B in Study 2 returning half the money was strong, for example (a reciprocity norm), but the norm of how much to donate to charity in Study 1 was weak (a giving norm). So, the conclusion was that "norm compliance can be strongly influenced by normative language, particularly when the norm is weak" (Kuang and Bicchieri 2024 p7).

1.5. CHANGING NORMS TO CHANGE BEHAVIOUR

In terms of social learning of norms, Efferson et al (2024) observed: "We pay attention to some people and ignore others. Sometimes we follow the majority, and sometimes we do not. Some people provide examples of how to behave, and some people provide examples of how not to behave. Some behaviours we simply like, and others we do not" (p1). These facts are important when trying to change behaviour for the good.

Efferson et al (2024) described this situation: "In the simplest case with two behaviours, one locally stable steady state has everyone choosing one behaviour, and another locally stable steady state has everyone choosing the other behaviour. The population has converged on one of these equilibria, but the two states may not be equally good for society. One can be relatively harmful and the other relatively beneficial. Because both are locally stable, the population can get stuck in the harmful equilibrium. Happily, however, the same conformity and co-ordination incentives that trap the

population in the harmful equilibrium can create the potential for a rapid transition to the beneficial equilibrium. A sufficiently large shock — a social planner's intervention, for example — can dislodge the population from the harmful equilibrium and tip it into the basin of attraction for the beneficial alternative. Once this happens, cultural evolutionary forces finish the job. Conformity and co-ordination incentives ensure that the population completes the transition to the new socially beneficial norm without further inputs from the social planner" (p2). This is the "social tipping" model.

If everyone is the same (a homogeneous population), then the initial shock can be estimated to change behaviour (ie: what proportion of people must change for conformity to encourage all to change). But, in reality, people are different (a heterogeneous population). In this situation, Efferson et al (2024) argued that targeting the most amenable segment of the population with a behaviour change intervention can create misco-ordination (the opposite of tipping), but lead to the greatest social welfare. This "paradoxical outcome readily occurs in situations where, perhaps typically, some people want society to transition to a new norm, but others do not" (Efferson et al 2024 p2). For example, encouraging occasional meat-eaters and omnivores (amenable segement) to eat plant-based foods, but leaving "hardcore" meat-eaters produces the greatest overall benefit for society (Efferson et al 2024).

Changing behaviour (for the good) by appealing to social norms has been tried, both perceived injunctive norms (PIN) (ie: what is perceived as socially approved), and perceived descriptive norms (PDN) (ie: what is perceived as commonly done by others) (Liu and Lapinski 2024).

Liu and Lapinski (2024) reported an experiment to reduce food waste involving US and Chinese students (563 in the MidWest and 886 in Yunnan province respectively). The participants read about a proposed (fictional) on-campus food waste prevention programme. The message included descriptive norms (high- or low-prevalence) or injunctive norms (strong or weak social approval) (table 1.1). The independent variable was the nature of the message. Technically, there were two independent variables (descriptive norm level, and injunctive norm level), which produced four independent conditions. The dependent variable was measured by six items about behavioural intention to engage in future food waste prevention activities (eg: "I have it in my mind to start

meal planning to reduce unnecessary food waste";
"strongly disagree" (1) to "strongly agree" (5)).

TYPE OF NORM	CONDITION	STATEMENT
Descriptive Norm	High-prevalence	"the results showed that most of the students at XX university, about 80%, have taken actions to help reduce food waste" (p6).
	Low-prevalence	"... a few students... about 20%...".
Injunctive Norm	Strong social approval	"the majority of students have indicated that they believe preventing food waste is very important and that wasting food is definitely an unacceptable and despicable behaviour for XX University students" (p6).
	Weak social approval	"only a small number of students...".

Table 1.1 - Norm statements used by Liu and Lapinski (2024).

Overall, "with the same message exposure, Chinese participants perceived food waste prevention as more prevalent and socially approved compared to US participants" (Liu and Lapinski 2024 p1). Chinese participants had a stronger intention to prevent food waste than US participants after both PIN and PDN messages.

The study showed the cultural differences in using social norm appeals to change behaviour. The researchers concluded that "social norm appeals — either descriptive or injunctive norms — may be most effective when being implemented in cultural contexts where there has been an existing norm or evolving social environment aligned with the message exposure. The cultural backdrop magnifies the potency of norm appeals and norm perceptions in steering behaviours" (Liu and Lapinski 2024 p13).

Note that the Chinese participants completed the study in a face-to-face group setting, while the US students completed it individually online. So, Liu and Lapinski (2024) stated, "the differences in survey administration modes may have impacted the salience of social norms and contributed to the observed cultural variations in susceptibility to those norms. Therefore, while our findings offer valuable insights into the behaviours of students within the context of food waste

prevention, extending these conclusions to diverse demographic groups necessitates further research involving a more representative sample" (p13).

The study measured only stated future behavioural intentions, not actual behaviours. "While intentions are strong predictors of subsequent actions, they do not always translate into real-world practices" (Liu and Lapinski 2024 p13).

The changing of norms was studied in the real world during covid-19 with social distancing, for example. Vriens et al (2024) collected data in Rome in June-August 2021 and October 2021-February 2022. Nearly 2000 adults were surveyed online at the different times. A scenario of the distance in line at the checkout of a supermarket was used. An onscreen slider could be moved between 40 and 160 cm apart.

Generally, norms about social distancing were linked to risk of covid-19, while sanctioning of violators increased as a new norm developed, but decreased when a clear norm of distance was established. Put another way, as a norm became strengthened, so the tolerance of violation increased. If people feel that violators are uncommon, then they may be less willing to sanction violators. "These results put some limits to social norms as solutions to guide behaviour under risk" (Vriens et al 2024 p1).

It is not clear how the responses to the (realistic) hypothetical scenario related to actual behaviour. The researchers also accepted that the data were collected at two different periods - "seasons with different characteristics, namely summer and winter. Seasonal variation and climate-related aspects might have influenced changes in risk perception and norms" (Vriens et al 2024 p10).

The sharing of misinformation online via social media platforms is a growing concern. Developing norms about accuracy of information is one way to counter this phenomenon, based on experiments by Pretus et al (2024). Generally, norms of the ingroup (versus general population) to share accurate information was found to reduce sharing of inaccurate information by around one quarter (compared to controls).

Pretus et al (2024) used political party affiliations - Democrat or Republican in the USA, and Labour or Conservative in the UK. Nearly 3000 adults were recruited online in these two countries for three experiments. Fictitious social media posts were created

that looked like "Tweets" about political issues (table 1.2). The willingness to share the post was the main outcome measure. Norms about accuracy of information were created by showing the number of ingroup members or general population individuals who had tagged the post as "misleading".

Overall, likelihood of sharing the post was reduced by the presence of a "misleading" count by any group compared to no "misleading" count (control condition). Specifically, "the 'misleading' count was more effective when it reflected ingroup norms (ie: the number of fellow Republicans/Democrats who had tagged the post as misleading), as compared with the norms of general users" (Pretus et al 2024 p5).

- "Thanks to the Trump administration, there are almost 600 000 people sleeping out on the streets of the wealthiest country in the world".

- "Labour MPs are 73% in favour of re-writing the school curriculum to paint the English as conquerors and oppressors. Simply unacceptable".

Table 1.2 - Example of fictitious "Tweets" used by Pretus et al (2024).

1.6. APPENDIX 1A - NORM ENFORCEMENT

Norm enforcement is key in the establishing of social norms (ie: the punishment of norm violators or non-conformists). However, the willingness to punish norm violators can vary between societies (Molho et al 2024).

Molho et al (2024) performed a literature review of 28 empirical studies using experimental games that recorded punishment of norm violators and compared different societies, as well as real life situations.

Across all societies studied, "at least some individuals in each of these populations were willing to punish unfairness" (Molho et al 2024 p6). The researchers suggested factors that might explain the cross-societal differences in norm enforcement, including:

i) Socio-ecological factors (eg: community size) - There was mixed evidence for the view that the importance of punishment of norm violators increases with community size.

ii) Cultural factors (eg: individualism vs

collectivism) - "Researchers have argued that, in individualistic societies, people place more value on individual freedom and feel more loosely tied with their group members, which may result in weaker motivations to punish norm breakers. By contrast, in collectivistic societies, people place more value on social cohesion, feel more strongly connected in extended families and ingroup networks, and may thus be more motivated to punish norm breakers" (Molho et al 2024 p8). Studies varied in their support for this view.

The problem for Molho et al (2024) was the the studies in the review varied greatly in their methodology, which limited clear generalisations. For example: "Several studies have relied on vignette experiments, which provide participants with rich contextual information, but have the drawback of assessing only hypothetical, non-consequential reactions to norm violations. Another common methodology that addresses this limitation involves economic decision-making experiments with standardised procedures across sites. These paradigms allow researchers to study consequential punishment decisions across societies, but have limitations in terms of ecological validity" (Molho et al 2024 p10).

The type of offence was also important. "Specifically, different cultures and communities might prescribe and condone punishment in response to some types of offences but not others" (Molho et al 2024 p10).

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2. SICKNESS COMMUNICATION

2.1. INTRODUCTION

Sensations, signs and symptoms of sickness "can lead to self-treatment and small changes in behaviour to minimise contact with others. They also encompass overt internal and external signs and symptoms that are obvious to others and diagnosable" (Shattuck and Boyle 2024 p71). This is "sickness behaviour", which is the "evolved behavioural manifestations of sickness", and it is also linked to a "behavioural immune system" - "a suite of psychological capabilities for recognising and responding to disease cues in the environment and in others" (Shattuck and Boyle 2024 p72).

Put another way, "human sickness is a social phenomenon awash with internal and external signals, each of which can elicit changes in behaviour and immune activity in both the sender and receiver" (Shattuck and Boyle 2024 p72). In the "evolutionary arms race", however, pathogens will evolve to avoid or delay activating these signals, so that carriers continue to interact with others.

Shattuck and Boyle (2024) introduced a virtual special issue of the journal "Evolution, Medicine, and Public Health" on "sickness communication.

2.2. SPOTTING SICK INDIVIDUALS

Concentrating on the evolved ability to spot infected individuals (in order to avoid them), Bressan (2023) focused on the face: "pale skin and lips, red eyes, droopy eyelids and mouth corners, a tired and sad expression tend to be interpreted as cues of sickliness" (p309). Specifically, Bressan (2023) tested this in relation to first impressions of faces.

Bressan (2023) reanalysed data from van Leeuwen and Petersen (2018) from over 3500 individuals publicly available online used in an experiment. The photographs used (and participants) came from the USA (classed as a

"low pathogen country") and India (viewed as a "high pathogen country"). Half of the photographs of neutral facial expressions had a severe facial rash added digitally as the pathogen cue. The first impression was measured by fourteen adjectives (half positive/half negative) (eg: "dirty", "intelligent", "clean", "likeable"). Other measures were willingness to shake hands with the person in the photograph (a measure of disgust sensitivity), their perceived health, perceived ethnic similarity to self, and self-rated health at time of experiment. The independent variables were same/different ethnicity as participant, and pathogen cue absent or present.

Positive qualities were associated with faces with no pathogen cues (ie: higher facial health), and same ethnicity, while negative qualities with lower facial health, and viewer's self-rated health, and disgust sensitivity. The negative qualities were stronger in the Indian sample.

There is a view that first impressions of faces are based on three fundamental dimensions - attractiveness, trustworthiness, and dominance (Todorov 2017), but this is superseded by assessment of sickness or health. Bressan (2023) explained: "Impressions of attractiveness, in short, may serve to assess others' suitability as interaction partners. Impressions of trustworthiness may serve to figure out others' good or bad intentions; impressions of dominance, others' ability to put intentions into practice. Yet no matter how attractive, trustworthy, or submissive they are, others remain capable of harming us — even killing us — if they are infectious. It makes a whole lot of sense that this vital concern helps shape our first impressions of them" (p314).

Individuals with higher perceived vulnerability to disease (PVD) are more alert to sickness cues, and women too. In the latter case, there is "evidence from (mostly) natural fertility populations suggests that while the presence of a mother is pivotal for child survival, fathers have little effect on child survival. Hence, women may be more likely to avoid sick conspecifics than men, because they have a more central role in protecting themselves and offspring from disease. Moreover, as women are more susceptible to sexually transmitted infections, heightened perception and response to sickness cues may be advantageous, in reducing their infection risk" (Tognetti et al 2023b p388).
Tognetti et al (2023b) studied gender differences in

perception of sick and healthy faces. Volunteers were injected with an endotoxin (lipopolysaccharide; LPS) which induces the facial appearance of sickness. The faces were photographed before (healthy appearance) and after (sickness appearance) the injection. Over 600 online volunteers were presented with pairs of composites of the faces and asked to name the healthy and the sick one. This is the forced-choice method. PVD of the participants was also measured with statements like, "I avoid using public telephones because of the risk that I may catch something from the previous user" (p390).

There was a 50% chance of being correct when presented with a pair of faces, so the accuracy must be statistically significant above this figure to be seen as a true effect. On average, participants correctly identified 60% of the faces as sick or healthy (and this was statistically significant). Women were more accurate than men (61% vs 59% on average; a statistically significant difference), and faster at discriminating between the faces. PVD had no effect on accuracy.

The study involved a large sample of Swedish volunteers recruited online. Tognetti et al (2023b) admitted that "it remained difficult to assess participants' motivation to succeed at the task, as well as their honesty when completing the questionnaires" (p394). The researchers focused only on visual (2D) cues, whereas in everyday life, multiple cues of sickness would be used (eg: visual, odour, behaviour, movement).

Tognetti et al (2023a) performed a similar study using the forced-choice method with body odours. Body odour samples were collected from 20 volunteers, once while healthy and once while sick with an acute respiratory infection (on the first day of sickness symptoms). T-shirts worn during sleep were the means to collect the odours.

Eighty participants at a Swedish university were presented with odours (one from a healthy person and one from a sick person). Correct detection of the odour from a sick person was significantly above chance (which was 50%), but low (average 57%). An interesting finding was that "greater change in donor body temperature, but not sickness symptoms, between sick and healthy conditions improved sickness detection accuracy" (Tognetti et al 2023a p219).

2.3. PATHOGEN AVOIDANCE

"Upon detection of disgusting objects, a repertoire of autonomic and involuntary behavioural responses is initiated to avoid pathogen-rich objects like faeces and rotten food, and to prepare for the possibility of contact. Pathogen avoidance offers a considerable evolutionary advantage by reducing the probability for disease contagion when compared with the exhaustive and cost-intensive mechanisms of pathogen elimination in form of a fully developed immune response" (Juran et al 2023 p8).

Juran et al (2023) concentrated on disgusting odours specifically. Thirty-six volunteers in Sweden were presented with sixteen odours, of which twelve were disgust-triggering (eg: rotten yeast; artificial urine). For each odour disgust was rated on a 100-point scale, facial muscle activity was recorded, and two salivary immune markers were measured. Odours rated as high disgust showed the muscle activity in the face as well (ie: a "disgust face"), and there was an increase in immune markers. This suggested that "disease cues [eg: odours] can trigger a preparatory response in the oral cavity" (Juran et al 2023 p8).

Pathogen avoidance and disgust can have a darker side in that "people react also to heuristic cues that are indirectly related (if at all) to disease. Indeed, heightened pathogen avoidance is associated with bias against people who are elderly, obese, physically atypical or who are perceived as foreign" (Makhanova et al 2023 p439).

Prejudice against outgroup members is an upshot of the over-sensitive pathogen avoidance. For example, Faulkner et al (2004) found that "Krasnees" (fictional African migrants) were rated negatively by individuals with higher trait pathogen avoidance. Trait pathogen avoidance is seen as an individual difference ("personality characteristic"), as opposed to pathogen avoidance related to a situation, which can vary depending on the environment. "Decreased pathogen disgust has been observed in military cadets after exposure to the harsh conditions of a 10-day military camp [Batres and Perrett 2020], suggesting attenuated pathogen avoidance in those circumstances" (Makhanova et al 2023 p439).

Makhanova et al (2023) examined pathogen avoidance among healthcare professionals, who have high contact with pathogens. The researchers recruited online 210 US

healthcare professionals along with 107 non-healthcare
professionals as controls. The participants completed the
"Three Domain Disgust Scale" (Tyber et al 2009), which
measures three dimensions of disgust - pathogen (eg:
"Stepping on dog poop"), sexual (eg: "Hearing two
strangers have sex"), and moral (eg: "Stealing from a
neighbour"). Each of the 21 items was rated from "not
disgusting at all" (1) to "extremely disgusting" (7).
This measured trait pathogen avoidance and disgust.

Next the participants read about the "Krasnees", and
the desire of 100 of them to immigrate to the USA. The
perceptions and attitudes towards these fictional
Africans were measured (eg: "likeable"; "trustworthy";
"unclean").

Overall, higher pathogen disgust scores on the Three
Domain Disgust Scale was associated with negative
perceptions of Krasnees. However, healthcare
professionals had lower pathogen disgust scores than
controls (figure 2.1). There was no difference between
the two groups on sexual and moral disgust.

The researchers summed up that "healthcare
professionals demonstrate the same relationship between
pathogen disgust and bias as in people working in other
professions, even though healthcare professionals have
lower pathogen disgust overall" (Makhanova et al 2023
p445).
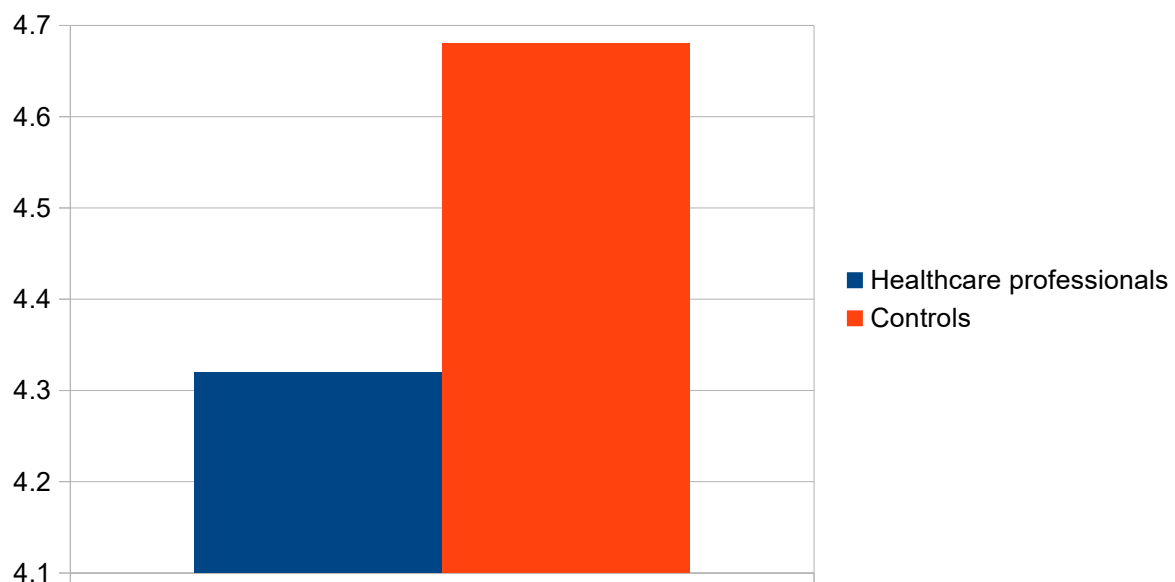
(Data from Makhanova et al 2023 table 3 p443)

Figure 2.1 - Mean pathogen disgust scores on the Three
Domain Disgust Scale (out of seven).

2.4. MEDICAL TREATMENT AND CARE

Sickness behaviour can also be a signal that the individual needs care and treatment. But there is the question of these signals being honest. A dishonest signal would be a healthy person showing signs of sickness without the actual illness in order to gain care from others. Providing care is costly, and so caregivers need to be sure that the signals are honest.

de Barra et al (2023) studied how the honesty of sickness signs is established by sender and receiver using vignettes. Participants were recruited online (n = 248) mostly in the UK and the USA for the first experiment. In Study 1 (divided into two versions), a vignette presents a co-worker who claims to be unable to work due to back pain, acute respiratory infection (ARI), or stomach pain (Study 1a). Study 1b added the response of the ill person in the vignette as either no treatment, treatment based on a doctor's recommendations, or self-administered treatment. The treatment either varied in no or aversive consequences (table 2.1). Study 1b used back pain, irritable bowel syndrome, and shoulder injury.

- "(No treatment) Your co-worker keeps complaining about back pain lately. The pain does not have any obvious cause and he seems to be able to walk without difficulty. Although it is an important week at work, he has been late to work every day due to the back problem. You keep having to stay till 9 pm at night to finish the work that he is not doing. Today, you overhear that your co-worker went to the doctor and no medication was prescribed.

- (Treatment) As above, but last clause reads:...they were prescribed strong prescription painkillers to take every night before bed.

- (Aversive treatment) As above, but last clause reads:...they were prescribed strong prescription painkillers to take every night before bed. An unpleasant side-effect of the medicine is that he feels very nauseous and dizzy for a couple of hours after taking them".

(Source: de Barras et al 2023 table 1 p366)

Table 2.1 - Example of vignette in Study 1a.

A "caregiving index" was created from seven questions and a five-point Likert scale (eg: "This co-worker is definitely ill; My team and I should take over all their work-related responsibilities until they

recover fully; and It was fully acceptable for them to be late/absent"; p365). A higher score indicated a greater willingness to care for the individual. Participants were also asked if they would donate money to a charity related to the vignettes.

Overall, participants were more likely to provide care if the sufferer was undergoing medical treatment, especially aversive treatment. This showed that receivers perceived sickness signals as honest when the sender was willing to suffer to get better.

Study 2 (also divided into two versions) used vignettes to further investigate what was perceived as signs of honest signalling. The vignettes of illness were anxiety, depression or chronic fatigue syndrome in Study 2a, and cough, urinary tract infection, or throat infection in Study 2b (table 2.2), while the treatment offered was sub-optimal (eg: anti-biotics for a cough). In Study 2a, psychological treatment was compared to pharmacological treatment for mental health problems.

- "(No anti-biotics) Your co-worker was due to give an important presentation to a group of clients. None of your team like giving these presentations, but it was his turn. Now, on the day of his presentation, he emails to say he has a cough and cannot give the presentation. He went to the doctor who did not prescribe anything. You will need to take over the presentation.

- (Delayed anti-biotics) As above but: He went to the doctor who told him that he should come back for anti-biotics in a few days if he felt substantially worse.

- (Anti-biotics) As above but: He went to the doctor who prescribed a course of anti-biotics".

(Source: de Barra et al 2023 table 6 p372)

Table 2.2 - Example of vignette in Study 2b.

Overall, "the participants [n = 204] were more likely to provide care when the vignette protagonist underwent a drug treatment. There was no evidence that psychological treatments had signalling value. This suggests that some patients experience an incentive to reject psychological treatments and accept pharmacological treatments. Participants perceived that an illness was more legitimate when the sick person received immediate or delayed anti-biotics, supporting the hypothesis that anti-biotic treatments have

signalling value" (de Barra et al 2023 p371).

In Study 3 (which had three versions), 835 participants who had experienced chronic pain, were asked about their willingness to undergo different treatments, which varied in aversiveness (eg: "undergo a minor surgery which will result in some visible scarring"). These studies investigated the sender's perception of honest signalling. The perceived legitimacy of an illness was manipulated. Generally, participants were more willing to undergo aversive treatment if they believed others did not see the illness as legitimate.

de Barra et al (2023) concluded: "These experiments show consistent support for the hypothesis that would-be caregivers use medical treatments — especially aversive treatments — as evidence of illness authenticity" (p375). This has implications for ill individuals who feel the need to get treatment, whether helpful or not, to justify their sickness behaviour as "real".

Humans provide care for sick individuals beyond that of other species. Gilbert and Kessler (2024) outlined the key consequences of such behaviour: "First, care would have generated substantial immune costs for carers. Many (but not all) forms of care require the care-giver to be exposed to the socially transmittable pathogens from which the recipient may be suffering. Thus, as care evolved, it would have exerted pressures on the immune system to withstand the exposures experienced by care-givers. Second, care would have potentially shielded sick individuals from some of the selective pressures exerted by pathogens either directly or indirectly, for example, poor nutrition due to reduced foraging abilities, increased predation risk due to reduced mobility, and so on" (p34). McDade et al (2016) predicted the evolution of a "slow pace of life" (eg: long lifespan, long developmental period after birth, and substantial parental investment) based on "life history theory" for the Homo species, and increased investment in acquired immunity related to innate immunity. Acquired immunity is the immune system's ability to recognise pathogens after contact with them.

2.5. PAIN

Pain and pain-related behaviours are signals to both the sufferer and others. The function of pain includes reflex withdrawal from noxious stimulus, memorising of context and cues that cause pain, minimising further

damage and protect wound, suppressing competing responses, and behaviours to promote healing (Walters 1994).

"Pain can persist, failing to recover or to respond to analgesics and other interventions effective for acute pain. Although conventionally described as maladaptive and dysfunctional, the prolonged hypervigilance conferred by persistent pain may, in fact, be adaptive in an environment estimated to be dangerous. However, the associated demotivation, suppression of appetitive behaviours and immobility also carry risks, particularly when prolonged. Many animals cannot go long without foraging or hunting and are more at risk when separated from their social or family group or herd. There is thus a trade-off between the pain-and-recovery inactive state and the activities required for survival" (Williams 2021 pp430-431).

A "mismatch hypothesis" has been applied to chronic or prolonged pain in humans. In modern societies others can provide food and so the pain sufferer can remain inactive, but this "lack of activity itself may serve to prolong pain" (Williams 2021 p431).

Pain as signalled to others through facial expressions, olfactory means, and behaviours like limping have been studied in many mammals. For example, experiments with mice inducing pain are common. "Pain shown behaviourally by one mouse sensitises cagemates that can see the mouse in pain, while the mouse in pain shows more pain-related behaviour with a littermate present than with a strange mouse. Olfactory cues between mice can also confer hyperalgesia [increased sensitivity to pain]. If a mouse in pain is in a 'jail', a free female mouse observing the mouse in pain will choose to stay close to it, appearing to reduce its pain by doing so" (Williams 2021 pp431-432). These are "onlooker responses".

As much as humans show caring behaviour and such onlooker responses to those in pain, there are times when sufferers can feel disbelief from others, "not feeling understood even by those close to them, being viewed with suspicion and being stigmatised. This makes sense in terms of human pro-sociality and a tendency to co-operation that is balanced by alertness to possible exploitation. Invisible disabilities such as chronic pain are easily subject to such suspicion" (Williams 2021 p433). This is "cheater detection - alertness to free riders that underpins the capacity for pro-social behaviours" (Williams 2021 p429).

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