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Seeing is believing? The pivotal role of personal experience in contemporary health behaviour: A narrative review

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REVIEW ARTICLE

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ABSTRACT

In the age of people aspiring after sense experiences, encouraging long-term health behaviour changes to prevent future disorders that are, without previous personal experiences, unimaginable threats for the public, maybe one of the greatest challenges preventive medicine has to face. In order to become trusted sources, and influence public health behaviour in an experience-oriented manner, we need to formulate strategies offering emotionally evocative sense inputs that elicit self-relatedness. The current narrative review discusses the relevance of personal experiences in contemporary health behaviour by focusing on three major areas: 1) the importance of personal sources of health-related information, 2) cognitive and neurobiological background of personal experiences, 3) potential strategies to induce health behaviour changes through personal experiences. Based on the reviewed body of knowledge, three potential "rules" are proposed to increase the effectiveness of health promotion programs through sense or personal experiences: 1) Rule of Senses (stressing the importance of multisensory learning); 2) Rule of Affect (emphasizing the motivational significance of evoking positive emotions); and 3) Rule of Self-relatedness (highlighting the role of the self-referential composition of human experiences).

KEYWORDS

personal experiences, sense inputs, health behaviour, health decisions, serious game

INTRODUCTION

As we forthwith witness the large-scale spreading of coronavirus-sceptic movements, mainstream and social media disseminate news about virus sceptics who - after being infected or hospitalized with COVID-19 - either shift their attitude toward the risk of infection or, on the contrary, reinforce their initial incredulity. And while organized virus scepticism can be explained by many reasonable assumptions – including, but not limited to, inconsistencies in government policies, conflicting pandemic narratives, the restriction or violation of basic human rights, and simply the depletion of self-regulatory resources due to prolonged stress [1], – the fact that personal experience often challenges or overrides the existence of scientific consensus might convey a principal message regarding our contemporary health behaviour and the accountability of scientific communities. For many, *personal* messages and *practical* experiences prevail over *professional* insights when it comes to their health. Personal stories are much easier to relate to, just as they better aid future recall of the core matter, or induce prosocial or health behaviour [2], even if the story happens to be fictional [3]. One might be susceptible to cognitive biases due to common sources of error, also labelled as heuristics [4], such as "anchoring"; that is, we tend to rely too much on initial observations, or deeply held sentiments during decision making. Some will, for instance, remember reading something about the potential association between the measles-mumps-rubella vaccine and autism, but won't take the trouble to further check whether or not that particular paper was retracted or

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its posited link refuted by more recent empirical findings [5]. The original sensation disseminated by word of mouth might be too powerful and emotionally coloured to be diminished by reason, as it represents an almost unflinching anchor point in the formation of anti-vaccination attitudes. Some might even become a member of the anti-vaxxer community, which provides a strong identity in an era of value crisis and creates a sense of belonging in a time of social isolation [6]. However, it potentially undermines any future vaccine against COVID-19 [7], or other infectious diseases.

The current paper seeks to provide an overview on the relevance and consequences of personal experiences in health-related decisions, focusing on the following areas: 1) the relevance of personal sources of health-related information (influencers vs. professional health advocates), 2) cognitive and neurobiological characteristics of information processing as related to personal and practical experiences, and 3) potential strategies to induce health behaviour changes through personal experiences.

MATERIALS AND METHODS

A form and methodology of a narrative review were chosen over a systematic one because – as Greenhalgh et al. [8] also pointed out – narrative reviews are more appropriate choices for providing a personal interpretation of existing evidence that may deepen the understanding of a given topic. Three literature databases were selected as primary sources of the reviewed articles: Embase, MEDLINE and Google Scholar. The following terms (appearing in publication titles) were applied during the literature search: "*personal experience**" OR "*practical experience**" AND "*influencer*" OR "*cognitive*" OR "*neuro**" AND "*health behavior*", OR "*health decision*". The search was conducted in February 2021, without any further restrictions considering the publication date.

RESULTS

Embase (49) and MEDLINE (114) altogether yielded 290 search results for selected search terms with 124 articles appearing in both databases, while Google Scholar yielded 153 search results. After the exclusion of duplicative results and irrelevant publications, 51 remained for review. These 51 selected articles formed the basis of the present narrative review, with additional references from the grey literature assisting in the interpretation of the results.

Health-related information sources

Throughout the history of mankind, practical and theoretical knowledge have always diverged, with certain information being derived from practices for privileged or professional groups, while the same practices seemed to be hardly verifiable theories for the masses. From our first footsteps on the planet, everyone could inspect human anatomy, including the seemingly predetermined arrangements of the internal organs (all too often made visible after severe accidents, war injuries, public dissections, etc.); but it was the discovery of the microscope (in 1595 by Zacharias Janssen), the x-ray (in 1895 by Wilhelm Röntgen), the ultrasonic testing method (in 1940 by Floyd Firestone), and magnetic resonance imaging (in 1971 by Paul C. Lauterbur) that deepened the gap between lay and professional experiences. These technological advancements (microscope, x-ray, ultrasonic testing, MRI, and so on. . .) made it possible for "anointed" minorities to see the undiscernible and experience the unexperienceable by augmenting their vision with mechanical devices. What was only an unconfirmed concept before, suddenly became a testable reality for those who were able to handle these devices and interpret their results. For those "profane" outsiders who were unable to use them or understand their mechanism, technological sciences – and especially medicine, the science of life and death – started to transform into a nontheistic religion, established on their trust in science. However, it was a religion without a guiding hand. The first mass-produced English translation of the Bible dates back as early as the 16th century. In 1535 Miles Coverdale published a supplemented version of William Tyndale's original translation, helping believers to recognize the words of God, to experience them first hand. Medical records and case reports, on the contrary, are still crowded with Latin phrases and abbreviations [9], baffling to the patient. According to the epistemological views of Ockham, our perceptions provide the basis for our abstract concepts and knowledge of the world, yet some beliefs (e.g. belief in God) are matters of faith and not knowledge, as we cannot confirm or reject their validity through experience. In a way, and from a lay perspective, the same goes for medical technologies and records. In this mindset, medical compliance and religious devotion originate from the same roots. But do we have faith and trust in medicine? Recent findings emphasize the public's need for transparency and shared knowledge, with open access to scientific results reported to be interrelated with public trust in scientific experts [10].

Although technology has grown exponentially in recent decades [11], the deepening of the gap between lay individuals and professionals was moderated by a trend that fundamentally changed the distribution of health-related information. This was the rapid increase in the availability of ICT equipment and home internet connections, along with the emergence of eHealth/mHealth technologies, which turned laptops, tablets, smartphones, and related devices into portable or wearable labs [12] for self-testing, symptom monitoring [13], and self-diagnostics [14]. One of the most beneficial consequences of these personal technologies is that they allow self-directed, experience-based learning about our own mental and somatic health. We have finally become informed insiders in the management of our well-being, and what's more, we have the option to gather almost all necessary information first hand. eHealth technologies have brought the age of health-related self-knowledge through personal experience. In the past decades, the World

Wide Web established the basis of self-directed learning and information retrieval, and without question became one of the most important health-related information sources. Web searches, however, are also characterized by several biases. Those who rely solely on web-based health-related information may, for instance, discover only what suits their suppositions the best. Girded by the external memory of the web, some people are no longer able to recollect the information itself, only the source and where to access it [15]. It is the *practice* that becomes important, not the *body of knowledge*. The unambiguous truth has been long lost among a million accessible theories and countless online data resources. Such an enormous set of coexisting opinions would necessarily support the emergence of relativism, whether ethical or noetic. Hence, at some point, the person who is looking for web-based health-related information is forced to choose between trust and an infinite search, since – as Simon [16] also argues – trust and knowledge are often entangled in contemporary epistemic practices. Assuming the importance of personal experience remains, at least as important as the personal source of information: that is, who will make it a truly reliable source of information? Professionals or lay opinion leaders?

When scientists are perceived as inhabitants of a remote and inbred community beyond reach, inducing increasing doubts about whether these strange outlanders would share the general population's interests [17] and life experiences, trust in science might be reduced – and not necessarily because the scientists' expertise would be questioned. The problem is that scientific knowledge, when imparted in its full complexity, might not make any sense to a layperson, in contrast to the simplified message of an influencer "selling happiness" [18], while giving health advice that is not scientifically sound [19]. To whom does the lay individual listen? Recent studies indicate the growing impact of social media influencers on a diverse spectrum of health behaviours, including dieting, exercise [18, 20], vaccination [21], health care decisions [22], such as decisions about irrational or controversial remedies for cancer [23], and HIV and syphilis testing behaviour [24]. We cannot overlook the fact that user-generated content – such as Facebook posts, tweets, blogs, and online discussion groups – significantly shapes contemporary health decisions [25].

To better understand this trend, we need to address some major differences between lay influencers and professional public health advocates. Influencers often 1) reduce the level of abstraction in their formula for health, 2) promise the illusion of a yellow-brick road leading to guaranteed well-being, and – perhaps most importantly – 3) they do this while offering a glimpse into their private life, portraying themselves as an approachable, *regular person*, who uses everyday language, mass cultural references, and the signs of consumerism as a modern religion.

The influencer seems to come from a social context similar to the one in which a lay individual - potentially representing the majority society - may engage, and therefore most likely share similar experiences. It does not matter that the genuine aims of the influencer are often narcissistic and materialistic: e.g. publicity, positive feedback, and payment for collaborating to sell the products of various companies. Our world is indeed narcissistic and materialistic [26] and influencers just encapsulate the zeitgeist of the present. Against this background, Lou and Kim [27] pointed out that the materialistic views and purchase intentions of adolescent followers, their parasocial relationship and perceived similarity with the influencer, and the trustworthiness or attractiveness of the same are all in relation.

Scientific experts, on the other hand, do not represent "common people." They never did. Scientific workforces have always shown gender inequalities, with the over-representation of males [28] – a trend particularly increasing with seniority [29] – and a higher-than-average socioeconomic status [30]. Coming from such a privileged social milieu, they might induce unpleasant feelings of inferiority and revulsion [31] in a layperson. Existing stereotypes about scientists [32] imply that they somehow differ from the perceived average. Moreover, science, by its nature, cannot grant full testimony. Most branches of science – including medicine – are not exact in the sense that they cannot reach absolute precision in their findings. A responsible professional health advocate therefore cannot have the luxury of talking about a miraculous pathway heading towards guaranteed well-being. Let us realize the underlying paradox here: the more profound someone gets, the less convincing he/she may become in the eyes of a lay individual. An accountable professional will most likely talk about odds instead of absolute truth while trying to demonstrate the fairness of his/her message with scientific facts. Unfortunately, there is a good chance that lay individuals won't change their health-related habits just by gaining comprehension. Such information is usually not enough, for it does not drive behaviour changes [33]. Health-related decisions are often not rational at all, but rather the results of emotion-laden processes [34].

Cognitive background of health-related decisions. When health-related decisions are put into the context of the cognitive decision-making systems described by Stanovich and West [35], the influencer exerts an impact by activating System 1 processes (i.e. fast, habit-based, emotion-laden choices with a higher probability of bias and cognitive illusions), whereas health professionals try to appeal to their target group by activating System 2 processes (i.e. slower, rational, information-based, more reliable and maintainable mental processing). Concerning contemporary health behaviour, some [36] consider System 1 the dominant system in modern societies for making decisions about health and fitness. When potential differences between practice and theory come into the picture, we might, once again, want to take into account the observations of Tversky and Kahneman [4] about heuristics – namely, that one of our most common heuristics (trial and error) is related to experience-based problem solving, not reliance on theory. But health-related decision making is truly a complex procedure involving further heuristics and biases, as people do not necessarily want to receive information about their

present or future health. Recently, Sharot and Sunstein [37] proposed a framework with three aspects that might influence such decisions about information seeking: 1) information can facilitate *action* (instrumental value) leading to either positive or negative outcomes, that is, knowledge may have negative instrumental value as well, 2) information can evoke both positive and negative *feelings* (hedonic value), and humans tend to avoid any information that provokes negative affects, and 3) information might modify our *cognition* (cognitive value), more specifically, our internal mental model of the world, while humans would rather seek information related to their frequently activated concepts and inter-connected with further nodes in their mental models.

In the end, personal experience and practice are nothing but personally collected, first-hand data about the world, whereas theory is the integration of second-hand insights by mostly unknown, unseen individuals. Theory is only the essence of another person's experience, only the concentration of a lengthy personal process. For the receiver, it is impersonal data. Without the human factor (without the opportunity to relive the same experiences), it is harder to relate to. Practice is acting, a process in which we are self-starters; listening to theories is receiving, a symbolically passive act. Practice is perceived autonomy ("I only believe what I see") while listening to theories is self-imposed compliance ("I believe your truth without personal reassurance"). Trust is not a necessary condition for practice, but it is for the acceptance of theories. Practice may invoke self-relatedness (the self-referential composition of human experiences), increasing the valence and intensity of emotion [38], and thus lead to emotional memories with personal significance. These memories are not only easier to recollect; they also enhance the formation of memories of further, unrelated information [39]. The same does not apply to theory-based learning. Practice additionally teaches us *the best way* to do something by mastering an act. Theory teaches us *all possible ways*. Now, let's assume that lay individuals unwittingly follow Occam's razor – an important logical principle applying to sensorimotor learning [40], and causal explanations [41] – saying "all things being equal. . ." (i.e. all health-related information provided by lay influencers and professionals are perceived coequal) ". . .the simplest solution tends to be the best one." In this case, the simplest solution is what the influencer offers, not the scientist.

Senses and abstract concepts: a neurobiological viewpoint. What generated heated arguments between representatives of rationalism and empiricism (the latter, with exponents like the Hindu sage Kanada/Kashyapa, ancient Greek Stoics and Epicureans, medieval scholastics, such as St. Thomas Aquinas, and William of Ockham, Persian polyhistor, Ibn Sina/Avicenna, or representatives of British empiricism: Francis Bacon, John Locke, John Stuart Mill, and Bertrand Russell, all arguing for the epistemological superiority of senses), seems to have been found within the territory of neural substrates. As demonstrated by the experiments of Deglin and Kinsbourne [42], in which they used transitory hemisphere suppression during the task of solving syllogisms, differences between theoretical and empirical reasoning may be explained by divergent thinking styles of the right and left hemispheres, with the activated right hemisphere being responsible for context-bound empirical cognition and incapable of abstraction, and the left being responsible for decontextualized, deductive patterns of thinking. Nevertheless, abstract thinking and sensory experiences are not entirely set apart from each other. To name but one example, action words – as abstract manifestations of human behaviour – activate the motor cortex, while form-related words activate the prefrontal region [43], implying the interconnection of sensory experiences and higher-order cognitive processes related to abstract concepts. This connectivity between basic experiences and abstraction is especially pronounced in professional practitioners of particular behaviours. For instance, visual recognition of musical instruments activates the right pSTG/MTG in professional musicians, but not in lay individuals [44], suggesting neuroplasticity in common neuroanatomical substrates for perceptual and conceptual processes. Certain sensory experiences may alter abstraction ability. Digital-native millennials, and most likely this will be true of further generations to come, during their exposure to increased screen-time, receive ready-made mental images that impair multimodal mental image generation, higher-order representation, and interpretation of visual and haptic inputs [45].

Taylor et al. [46], using a geometry-based method to analyze fMRI databases, drew attention to the hierarchical aggregation of human cortical networks and cognition in general, which start from sensory experiences, and progress toward abstract symbolic tasks deeper into the cortex. Their pyramid model of cognition illustrates a region-wise, bottom-up progression of the degree of connectivity of sensory inputs, where basic somatosensory sensations form the foundation, and going upwards, functions become more abstract and show weakened connections to the original inputs. Symbolic representations of sense experiences (e.g. reasoning, imagination, and concepts) are at the pinnacle of the pyramid but are structurally deepest in the cortical network. With respect to informed health-behaviour changes (e.g. in response to targeted health messages from an influencer or a professional health advocate), top-down pathways may exert likewise important impacts. Greater activity in the ventral medial prefrontal cortex seems to play a relevant role, as it might mediate behaviour changes as a result of persuasive messages, particularly when these messages are tailored [47]. In the posterior medial prefrontal cortex, on the other hand, reduced neural sensitivity to the strength of other people's disconfirming opinions was recently demonstrated [48], revealing that our initial judgments modify the neural representation of information relevance and thereby decrease the odds of changing our opinions when we face disagreement.

Potential strategies to induce health behaviour changes through personal experiences. In his masterpiece, *Measuring the world* [49], Daniel Kehlmann re-envisions the lives of Carl Friedrich Gauss and Alexander von Humboldt.

While doing so, he metaphorically presents two prototypical ways humans construct their worldview: Humboldt through sense experiences when he explores the heights and the depths of South America on the spot, and Gauss through abstract concepts when he measures and interprets the world by self-constructed mathematical models. To put the key message of this paper differently: we live increasingly in an age of Humboldts, not Gausses – an age of people aspiring after sense experiences, and as virtuality gradually swallows reality, a thirst for lifelike experiences constantly grows. The same tendency may apply to the target populations of health promotion and education campaigns. It is the nature of preventive medicine to try to persuade our fellow human beings to take all sorts of precautionary measures to avoid future disorders. They are often unpleasant (such as regular gynaecological controls, or prostate tests), or at least uncomfortable (such as wearing a mask). Without previous experience, these disorders may be unimaginable threats. To effectively distribute the information we aim to transfer through personal experience, we need to formulate strategies that offer emotionally evocative sense inputs that elicit self-relatedness.

How can we encourage health-behaviour changes if we go on with the assumption that a considerable number of people relies on personal experiences when making decisions about their health? In other words – while noticing that health literacy, by definition [50], includes the individual's ability to actively *use* health information that supports self-management instead of passively receiving second-hand knowledge – what are the experience-oriented possibilities of health communication, promotion, or education? Based on the review of health-related information sources, five primary sources of reliable information linked to personal experiences can be mentioned, with empirical evidences supporting their efficacy: 1) health professionals may work together with expert patients (i.e. individuals who become experts of a disorder or disease by their personal experience of living and coping with it on a daily basis) [51], establishing the means of personalized medicine alongside with the presentation of personal stories; 2) the scientific community may increase public interest in health-related scientific findings by open access dissemination and data visualization, creating e.g. video abstracts and using plain language to summarize scientific results in an understandable way to transform scientific data into comprehensible information [52]; 3) trained e-mavens are social influencers with health-related expertise who can potentially be involved in health information acquisition and transmission [53, 54]; 4) virtual and augmented reality interventions provide simulation-based learning opportunities, and can be used in both professional medical and patient education by presenting, for instance, interactive and easily observable 3D models [55]; 5) web- and/or app-based projects can maximize the potential of gamification by creating online interfaces enriched by visual and auditory stimuli, targeting all age groups, promoting a wide-spectrum of health behaviors, and may even involve lay individuals in the process of achieving health-related scientific breakthroughs [56].

Furthermore, based on the cognitive and neuropsychological background of health-related information processing and decision making, health promotion programs that aim to change health behaviours through personal experiences might increase their effectiveness by applying the following "rules":

1. *Rule of Senses*: to simulate lifelike experiences, the program may provide sense data covering as many modalities as possible. Multisensory learning support all aspects – cognitive, affective, and psychomotor domains - of learning [57, 58], while, compared to unimodal data, better guides equivalence learning [59] and incidental learning [60] as well. Multisensory processes additionally enhance later recognition memory of unisensory objects and improve working memory among both adults and school-aged children [61], in the case of health promotion interventions as well.
2. *Rule of Affect*: to facilitate behaviour changes, health promotion programs should induce positive emotional responses. Through implicit processes, positive affect may facilitate long-term adherence to desired health behaviour changes, creating an upward spiral [62], supported by self-rewarding experiences. The link between positive emotions and behavioural changes is most likely mediated by brain structures receiving VTA direct projections, playing crucial roles in both reward and motivation [63].
3. *Rule of Self-relatedness*: to enhance memory formation, the program needs to invoke self-relatedness by offering personalized, tailored data. Self-relatedness is further associated with a wide spectrum of emotion dimensions, and neural activity in certain brain regions (and especially in subcortical areas, such as the tectum, right amygdala, hypothalamus) is similarly modulated by both emotional states and the subjective experience of self-relatedness [38]. The enhancement of positive self-referential processing might improve mental health [64], fostering engagement in health behaviour change.

Figure 1 additionally presents tips and good practices exemplifying the implementation of each rule.

These "rules" may also serve as mediator variables in future efficacy studies measuring the extent or direction of health behaviour changes as primary outcomes of the given program. In terms of the applied methodology of health promotion programs, a wide variety of techniques, tools and platforms may give us the opportunity to provide multisensory sense inputs, evoke positive affect or catharsis, and create personalized experiences for the target groups, including but not limited to e.g. utilizing augmented reality or virtual reality technologies, organizing interactive exhibitions, collaborating with trained e-mavens, or expert patients, etc. In each case, it is important that program participants go through a lifelike, emotional, and personalized experience. Such experience increases the odds of prolonged health behaviour changes.

Concluding remarks. Providing personal or lifelike experiences can therefore be a key condition for effective health

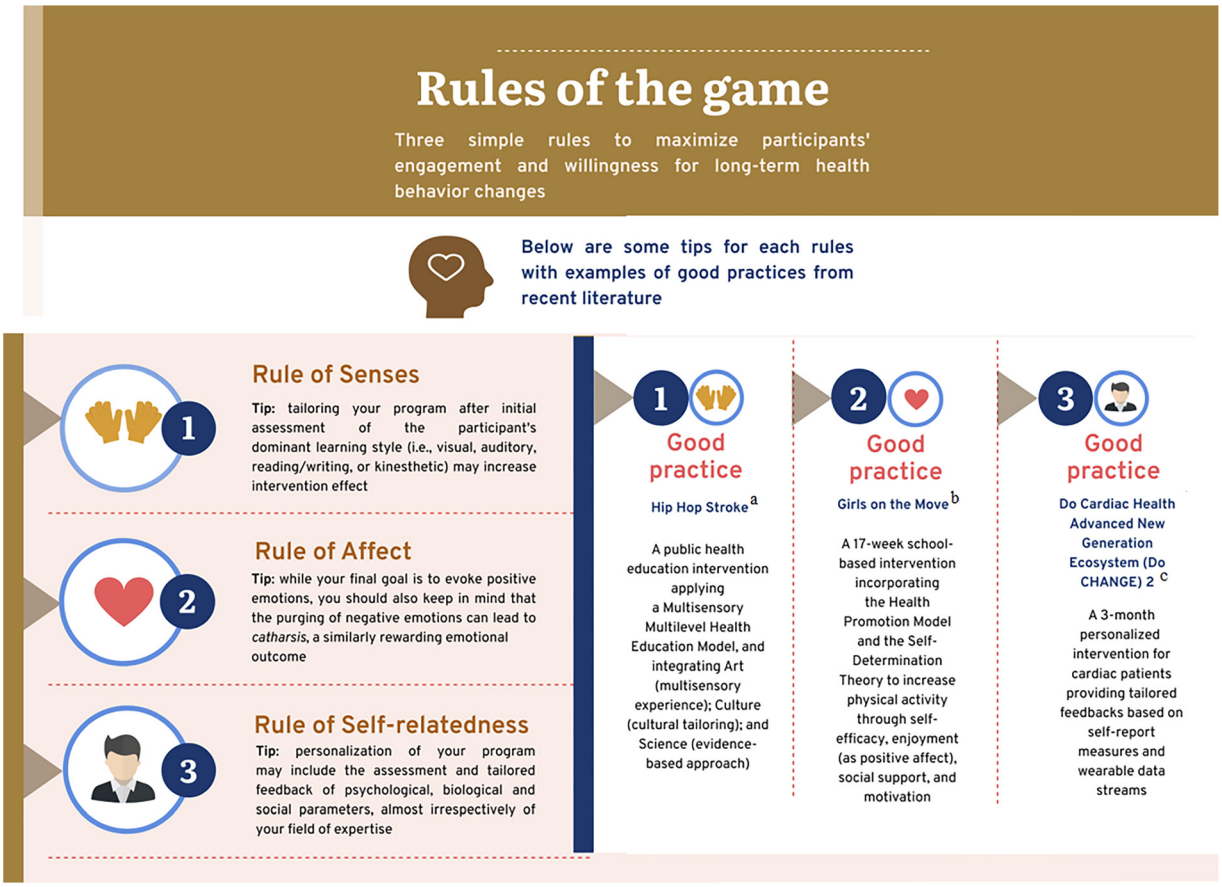

Fig. 1. Tips and good practices for health promotion programs targeting health behaviour changes through personal experiences
Notes. a) Hip Hop Stroke [65], b) Girls on the Move [66], c) Do CHANGE 2 [67].

education. Even so, many programs still try to influence society's health beliefs and health decisions through the mere transfer of information. As Kelly and Barker [33] have pointed out, many health promotion campaigns build their strategies on misconceptions. Such misconceptions encompass the expectation that people usually act rationally, that information alone is an effective driver of behaviour change, or that behaviour can be predicted accurately. None of these assumptions is true. In human evolution, basic sensory-based cognition has existed for much longer than theory-based scientific persuasion, thus the vague transmission of concepts unknown to the population is an insufficient means of health promotion. The scientific community needs to recognize that a significant portion of the population defines or interprets certain health-related concepts differently and that emotions need to be targeted during health education at least as much as rationality. Scientific insights should eventually become common knowledge that can be translated into everyday language and that, if only in the form of simulations, can be experienced by all.

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REFERENCES

1. Evans DR, Boggero IA, Segerstrom SC. The nature of self-regulatory fatigue and "ego depletion": lessons from physical fatigue. Pers Soc Psychol Rev 2016;20:291–310. https://doi.org/10.1177/1088868315597841.
2. Hawthornthwaite L, Roebotham T, Lee L, O'dowda M, Lingard L. Three sides to every story: preparing patient and family storytellers, facilitators, and audiences. Perm J 2018;22:17–119. https://doi.org/10.7812/TPP/17-119.
3. Barraza JA, Alexander V, Beavin LE, Terris ET, Zak PJ. The heart of the story: peripheral physiology during narrative exposure predicts charitable giving. Biol Psychol 2015;105:138–43. https://doi.org/10.1016/j.biopsycho.2015.01.008.

4. Tversky A, Kahneman D. Judgment under uncertainty: heuristics and biases. Science 1974;185:1124–31. https://doi.org/10.1126/science.185.4157.1124.
5. Hviid A, Hansen JV, Frisch M, Melbye M. Measles, mumps, rubella vaccination and autism: a nationwide cohort study. Ann Intern Med 2019;170:513–20. https://doi.org/10.7326/M18-2101.
6. Banerjee D, Rai M. Social isolation in Covid-19: the impact of loneliness. Int J Soc Psychiatry 2020;66:525–7. https://doi.org/10.1177/0020764020922269.
7. Burki T. The online anti-vaccine movement in the age of COVID-19. Lancet Digit Health 2020;2:e504–5. https://doi.org/10.1016/S2589-7500(20)30227-2.
8. Greenhalgh T, Thorne S, Malterud K. Time to challenge the spurious hierarchy of systematic over narrative reviews? Eur J Clin Invest 2018;48:e12931. https://doi.org/10.1111/eci.12931.
9. Lysanets YV, Bieliaieva OM. The use of Latin terminology in medical case reports: quantitative, structural, and thematic analysis. J Med Case Rep 2018;12:45. https://doi.org/10.1186/s13256-018-1562-x.
10. Crew B. Confidence in scientists is on the rise in the US, Pew survey finds [Internet]. Nature Index, Spinger Nature; 2019 [cited 2020 Oct 16]. Available from: https://www.natureindex.com/news-blog/confidence-trust-scientists-increase-united-states-pew-report.
11. Butler, D. A world where everyone has a robot: why 2040 could blow your mind. Nature 2016;530:398–401. https://doi.org/10.1038/530398a.
12. Christodouleas DC, Kaur B, Chorti P. From point-of-care testing to eHealth diagnostic devices (eDiagnostics). ACS Cent Sci 2018;4:1600–16. https://doi.org/10.1021/acscentsci.8b00625.
13. Timmers T, Janssen L, Stohr J, Murk JL, Berrevoets M. Using eHealth to support COVID-19 education, self-assessment, and symptom monitoring in The Netherlands: observational study. JMIR Mhealth Uhealth 2020;8:e19822. https://doi.org/10.2196/19822.
14. Yeung WK, Dawes P, Pye A, et al. eHealth tools for the self-testing of visual acuity: a scoping review. NPJ Digit Med 2019;2:82. Available from: https://doi.org/10.1038/s41746-019-0154-5.
15. Sparrow B, Liu J, Wegner DM. Google effects on memory: cognitive consequences of having information at our fingertips. Science 2011;333:776–78. https://doi.org/10.1126/science.1207745.
16. Simon J. The entanglement of trust and knowledge on the Web. Ethics Inf Technol 2010;12:343–55. https://doi.org/10.1007/s10676-010-9243-5.
17. Cardew G. People will not trust unkind science. Nature 2020;578:9. https://doi.org/10.1038/d41586-020-00269-0.
18. Pilgrim K, Bohnet-Joschko S. Selling health and happiness how influencers communicate on Instagram about dieting and exercise: mixed methods research. BMC Public Health 2019;19:1054. https://doi.org/10.1186/s12889-019-7387-8.
19. Smyth RSD, Amlani M, Fulton A, Sharif MO. The availability and characteristics of patient-focused YouTube videos related to oral hygiene instruction. Br Dent J 2020;228:773–81. https://doi.org/10.1038/s41415-020-1527-5.
20. Smit CR, Buijs L, van Woudenberg TJ, Bevelander KE, Buijzen M. The impact of social media influencers on children's dietary behaviors. Front Psychol 2020;10:2975. https://doi.org/10.3389/fpsyg.2019.02975.
21. Chan MS, Jamieson KH, Albarracin D. Prospective associations of regional social media messages with attitudes and actual vaccination: a big data and survey study of the influenza vaccine in the United States. Vaccine 2020;38:6236–47. https://doi.org/10.1016/j.vaccine.2020.07.054.
22. Iftikhar R, Abaalkhail B. Health-seeking influence reflected by online health-related messages received on social media: cross-sectional survey. JMIR 2017;19:e382. https://doi.org/10.2196/jmir.5989.
23. Delgado-López PD, Corrales-García EM. Influence of internet and social media in the promotion of alternative oncology, cancer quackery, and the predatory publishing phenomenon. Cureus 2018;10:e2617. https://doi.org/10.7759/cureus.2617.
24. Wu D, Tang W, Lu H, et al. Leading by example: web-based sexual health influencers among men who have sex with men have higher HIV and syphilis testing rates in China. JMIR 2019;21:e10171. https://doi.org/10.2196/10171.
25. Wegohealth. Authenticity: the value of user-generated content in healthcare. Boston, MA: Wegohealth; 2018.
26. Twenge JM, Campbell WK. The narcissism epidemic: living in the age of entitlement. New York: Free Press; 2010.
27. Lou C, Kim HK. Fancying the new rich and famous? Explicating the roles of influencer content, credibility, and parental mediation in adolescents' parasocial relationship, materialism, and purchase intentions. Front Psychol 2019;10:2567. https://doi.org/10.3389/fpsyg.2019.02567.
28. Huang J, Gates AJ, Sinatra R, Barabási AL. Historical comparison of gender inequality in scientific careers across countries and disciplines. PNAS 2020;117:4609–16. https://doi.org/10.1073/pnas.1914221117.
29. Kern CC, Kenefic LS, Stout SL. Bridging the gender gap: the demographics of scientists in the USDA forest service and academia. BioScience 2015;65:1165–72. https://doi.org/10.1093/biosci/biv144.
30. The Royal Society. A picture of the UK scientific workforce Diversity data analysis for the Royal Society Summary report [Internet]. The Royal Society: London; 2014 [cited 2020 Oct 18]. Available rom: https://royalsociety.org/-/media/Royal_Society_Content/policy/projects/leading-way-diversity/picture-uk-scientific-workforce/070314-diversity-report.pdf.
31. Leach CW, Spears R. "A vengefulness of the impotent": the pain of in-group inferiority and schadenfreude toward successful outgroups. J Pers Soc Psychol 2008;95:1383–96. https://doi.org/10.1037/a0012629.
32. Schinske J, Cardenas M, Kaliangara J. Uncovering scientist stereotypes and their relationships with student race and student success in a diverse, community college setting. CBE Life Sci Educ 2015;14:ar35. https://doi.org/10.1187/cbe.14-12-0231.
33. Kelly MP, Barker M. Why is changing health-related behaviour so difficult? Public Health 2016;136:109–16. https://doi.org/10.1016/j.puhe.2016.03.030.
34. Carpenter SM, Niedenthal PM. Emotional processes in risky and multiattribute health decisions. Psychol Health 2018;33:58–76. https://doi.org/10.1080/08870446.2017.1314478.
35. Stanovich KE, West RF. Individual differences in reasoning: implications for the rationality debate? Behav Brain Sci 2000;23:645–65. https://doi.org/10.1017/S0140525X00003435.
36. Maffetone PB, Laursen PB. Decision-making in health and fitness. Front Public Health 2019;7:6. https://doi.org/10.3389/fpubh.2019.00006.
37. Sharot T, Sunstein CR. How people decide what they want to know. Nat Hum Behav 2020;4:1–6. https://doi.org/10.1038/s41562-019-0793-1.

38. Northoff G, Schneider F, Rotte M, et al. Differential parametric modulation of self-relatedness and emotions in different brain regions. Hum Brain Mapp 2009;30:369–82. https://doi.org/10.1002/hbm.20510.
39. Tambini A, Rimmele U, Phelps EA, Davachi L. Emotional brain states carry over and enhance future memory formation. Nat Neurosci 2017;20:271–8. https://doi.org/10.1038/nn.4468.
40. Genewein T, Braun DA. Occam's Razor in sensorimotor learning. Proc Royal Soc B 2014;281:20132952. https://doi.org/10.1098/rspb.2013.2952.
41. Pacer M, Lombrozo T. Ockham's razor cuts to the root: simplicity in causal explanation. J Exp Psychol Gen 2017;146:1761–80. https://doi.org/10.1037/xge0000318.
42. Deglin VL, Kinsbourne M. Divergent thinking styles of the hemispheres: how syllogisms are solved during transitory hemisphere suppression. Brain Cogn 1996;31:285–307. https://doi.org/10.1006/brcg.1996.0048.
43. Pulvermüller F, Kherif F, Hauk O, Mohr B, Nimmo-Smith I. Distributed cell assemblies for general lexical and categoryspecific semantic processing as revealed by fMRI cluster analysis. Hum Brain Mapp 2009;30:3837–50. https://doi.org/10.1002/hbm.20811.
44. Hoenig K, Müller C, Herrnberger B, Spitzer M, Ehret G, Kiefer M. Neuroplasticity of semantic maps for musical instruments in professional musicians. NeuroImage 2011;56:1714–25. https://doi.org/10.1016/j.neuroimage.2011.02.065.
45. Suggate SP, Martzog P. Screen-time influences children's mental imagery performance. Dev Sci 2020;23:e12978. https://doi.org/10.1111/desc.12978.
46. Taylor P, Hobbs JN, Burroni J, Siegelmann HT. The global landscape of cognition: hierarchical aggregation as an organizational principle of human cortical networks and functions. Sci Rep 2015;5:18112. https://doi.org/10.1038/srep18112.
47. Tompson S, Lieberman MD, Falk EB. Grounding the neuroscience of behavior change in the sociocultural context. Curr Opin Behav Sci 2015;5:58–63. https://doi.org/10.1016/j.cobeha.2015.07.004.
48. Kappes A, Harvey AH, Lohrenz T, Montague PR, Sharot T. Confirmation bias in the utilization of others' opinion strength. Nat Neurosci 2020;23:130–7. https://doi.org/10.1038/s41593-019-0549-2.
49. Kehlmann D. Measuring the world. New York: Pantheon Books; 2006.
50. Liu C, Wang D, Liu C, et al. What is the meaning of health literacy? A systematic review and qualitative synthesis. Fam Med Community Health 2020;8:e000351. https://doi.org/10.1136/fmch-2020-000351.
51. Bolz-Johnson M, Meek J, Hoogerbrugge N. "Patient Journeys": improving care by patient involvement. Eur J Hum Genet 2020;28:141–3. https://doi.org/10.1038/s41431-019-0555-6.
52. Bredbenner K, Simon SM. Video abstracts and plain language summaries are more effective than graphical abstracts and published abstracts. PLoS One 2019;14:e0224697. https://doi.org/10.1371/journal.pone.0224697.
53. Sun Y, Liu M, Krakow M. Health e-mavens: identifying active online health information users. Health Expect 2016;19:1071–83. https://doi.org/10.1111/hex.12398.
54. World Health Organization. Risk communication and community engagement readiness and response to coronavirus disease (COVID-19): interim guidance [Internet]. World Health Organization; 2020 March 19 [cited 2020 Oct 20]. Available from: https://www.who.int/publications/i/item/risk-communication-and-community-engagement-readiness-and-initial-response-for-novel-coronaviruses-(-ncov).
55. Bric JD, Lumbard DC, Frelich MJ, Gould JC. Current state of virtual reality simulation in robotic surgery training: a review. Surg Endosc 2016;30:2169–78. https://doi.org/10.1007/s00464-015-4517-y.
56. Cooper S, Khatib F, Treuille A, et al. Predicting protein structures with a multiplayer online game. Nature 2010;466:756–60. https://doi.org/10.1038/nature09304.
57. Bloom BS, Englehart MB, Furst EJ, Hill WH, Krathwohl DR. Taxonomy of educational objectives: the classification of educational goal. Handbook I: cognitive domain. New York, NY, USA: David McKay; 1956.
58. Schneider J, Börner D, van Rosmalen P, Specht M. Augmenting the senses: a review on sensor-based learning support. Sensors 2015;15:4097–133. https://doi.org/10.3390/s150204097.
59. Eördegh G, Őze A, Bodosi B, et al. Multisensory guided associative learning in healthy humans. PLoS One 2019;14:e0213094. https://doi.org/10.1371/journal.pone.0213094.
60. Broadbent HJ, White H, Mareschal D, Kirkham NZ. Incidental learning in a multisensory environment across childhood. Dev Sci 2018;21:e12554. https://doi.org/10.1111/desc.12554.
61. Denervaud S, Gentaz E, Matusz PJ, Murray MM. Multisensory gains in simple detection predict global cognition in schoolchildren. Sci Rep 2020;10:1394. https://doi.org/10.1038/s41598-020-58329-4.
62. Van Cappellen P, Rice EL, Catalino LI, Fredrickson BL. Positive affective processes underlie positive health behaviour change. Psychol Health 2018;33:77–97. https://doi.org/10.1080/08870446.2017.1320798.
63. Yin J. Study on the progress of neural mechanism of positive emotions. Transl Neurosci 2019;10:93–8. https://doi.org/10.1515/tnsci-2019-0016.
64. Dainer-Best J, Shumake JD, Beevers CG. Positive imagery training increases positive self-referent cognition in depression. Behav Res Ther 2018;111:72–83. https://doi.org/10.1016/j.brat.2018.09.010.
65. Williams O, Swierad EM. A multisensory multilevel health education model for diverse communities. Int J Environ Res Public Health 2019;16:872. https://doi.org/10.3390/ijerph16050872.
66. Robbins LB, Wen F, Ling J. Mediators of physical activity behavior change in the "Girls on the Move" intervention. Nurs Res 2019;68:257–66. https://doi.org/10.1097/NNR.0000000000000359.
67. Broers ER, Widdershoven J, Denollet J, et al. Personalized eHealth program for life-style change: results from the "do cardiac health advanced new generated ecosystem (do CHANGE 2)" randomized controlled trial. Psychosom Med 2020;82:409–19. https://doi.org/10.1097/PSY.0000000000000802.