Can we trust what humans report? – myths and realities

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ABSTRACT

Human information is crucial for efforts in the field of buildings, health and experiences. Despite this, there is strikingly little focus on how it is created and may be understood. Division between e.g. "subjective"/ "feelings" vs. "objective"/ "facts" and thinking that e.g. questionnaires produce "facts" are examples of popular ideas more based on cultural myths than science. Traditionally, the brain is thought to register what happens in- and outside the body. Emerging knowledge indicates that the brain instead should be seen as creating all conscious experiences. In principle, the creation is an "integration" of (a) our previous experiences (i.e. acting as a model to generate predictions on future events) and (b) what actually happens (i.e. the inputs the brain gets, e.g. from our senses); (a) and (b) themselves not being consciously experienced. In this "integration", factors (a) vs. (b) may have any distribution. If (b) dominates, the traditional model may fit, i.e. experience is rather equivalent to what actually happens. If (a) dominates, the traditional model fails, experience has limited relevance to what actually happens and may be understood as a "copy" based on previous experiences; e.g. still getting symptoms in a building long time after proper renovation of a water-damage. The new knowledge has several important implications, like: (1) Talking, questionnaires etc. "only" give the experience of each person, in principle no "objective" data on causal mechanisms, buildings etc.; (2) As all experiences are "subjective", no persons report "wrong" data; (3) Cultural misconstructions like "psyche"/"feelings" vs. "soma"/"real" are invalid, misleading and may be destructive. Taking the emerging knowledge into account may be of substantial help for all professions working in the field of buildings, health and experiences.

INTRODUCTION

In the field of buildings, health and human experiences reports from humans are crucial. In fact, one may see satisfaction among the users of the buildings as the most important goal of all efforts. Given the paramount importance of such human data, there is strikingly little focus on how they are created, and may be understood; i.e. why people report, experience and feel as they do. However, some ideas are circulating, like a division between e.g. "subjective"/"feelings" vs. "objective"/"facts" and thinking that e.g. questionnaires produce "facts". As will be sought explored in this paper, such ideas are more based on culturally mediated myths than science. Emerging knowledge of fundamental functions of the nervous system may be of substantial help for practice and science in the broad field of buildings, not only with focus on health, but also when addressing more general and technical issues relevant for humans.

NEW PERSPECTIVES ON THE NERVOUS SYSTEM

Traditionally, the brain is thought to just passively register what happens in- and outside the body. The idea is that experiences, e.g. those labelled as symptoms, generally are preceded by biological stimuli, i.e. changes somehow affecting the body (Kolk et al., 2003, p. 2344). If this is the case, it is possible to access "objective" descriptions of the in- and outside world of individuals, based on what they experience and report. In reality, this is far from always the case, e.g. some may get substantial symptoms visiting a certain building while others experience it as spotless. In traditional views, such mismatches are sought explained in several ways. One is to distinguish between medically (a) "explained" and (b) "unexplained" symptoms (MUS), the latter including labels like "psychosomatic symptoms" and "functional symptoms" (Van den Bergh et al., 2017). The (b) terms are used when the traditional model does not fit. Popular models like the somatosensory amplification model (Barsky & Wyshak, 1990) are hypothesized to explain this issue. Illness concerns of threat-sensitive persons may lead to stress-related physiological arousal and misattribution of normal sensations to be caused by abnormal conditions like diseases (Barsky & Wyshak, 1990; Kolk et al., 2003). Physiological arousal may also elevate attention to signals of the body, lowering the threshold for feeling symptoms (Barsky & Wyshak, 1990). These processes are proposed to end up in creating a vicious cycle. However, there is limited scientific support for these kind of models (Van den Bergh et al., 2017). Indeed, correlation between symptom reports and objective indicators of physiological arousal (e.g. due to stress) are typically absent. More generally, correlations between symptom reports and objective disease indicators are often low to moderate. Making a schism between "psyche"/"mental" and "soma"/"physical" is another widely accepted idea, both in- and outside health care. However, the scientific support for this is clearly limited. What symptoms perceived to be caused by building-related problems belongs to which part of the schism?, based on which rationale? E.g. experiencing breathlessness in a building may be caused by hyperventilation, asthma attack, other health conditions, previous experiences of breathlessness stored in the brain or, as often, a combination of such factors – in any case the experienced symptoms are created by the brain and objective investigations of the person may produce results only partly indicative of the bodily processes involved. In addition, the schism often causes unnecessary controversies, e.g. persons experiencing symptoms labelled as "psychogenic" may not accept such characteristics (Rief & Martin, 2014; Haanes et al., 2020).

Based on knowledge originating from the late 19th century (von Helmholtz), the last years of developments in neuroscience have opened up for a paradigm shift, based on new understandings of functions of the nervous system, including the brain. Like the traditional view, the new one starts out with the brain obtaining information from in- and outside the body. The perception of signals originating from the organs of the body (e.g. heart and stomach) and other internal functions (e.g. glucose balance) is often described as interoception. Exteroception includes the information gathered from the external world, e.g. vision and audition and senses like taste and touch (Quadt et al., 2018). All these inputs are communicated through a sophisticated set of distinct pathways, via the nervous or humoral (e.g. hormones) systems. In principle, the information is directed to the brain. However, there is more to the picture. The signals propagating towards the brain meets signals going the opposite direction, generated by the brain itself and across several hierarchical levels of the brain. This means that there are two counterflowing streams of information, mainly mediated as unconscious neural activation; i.e. top-down and bottom-up processes. The top-down flow is based on neural representations in the brain that are produced from stored previous experiences, pre-existing information ("priors"). The brain anticipates inputs and activates prior information stored in the brain regions actually receiving stimuli from intero- and exteroception, i.e. through the bottom-up stream (Barrett & Simmons, 2015). At each hierarchical level from bottom to top of the nervous system, including the brain, stimuli that are predicted tends to be cancelled out, as there are "no news". If the inputs do not correspond to the predictions, prediction errors (i.e. non-predicted input) are formed. The process continues further on the way to the top meeting new predictions all the way, bottom-up, accumulating the prediction errors generated through the process. In the final step the least overall prediction errors constitutes basis for a "posterior" evaluation, i.e. the fundament for a possible final conscious perception. According to the model, predictions represent hypotheses describing our internal and external world. These hypotheses are tested against the actual inputs, originating from the real world. The "posterior" evaluation is the generative result that overall fits best to this testing, i.e. may be seen as the best the brain is capable of doing and that brings the best possible order among all the overwhelming and complex stimuli we have to deal with. Posterior perceptions are subsequently added to the priors, i.e. the processes are interactive (Barrett & Simmons, 2015; Pezzulo et al., 2019). Information has important influence on shaping priors, e.g. information and social relations may have substantial impact on perception of building-related factors. The described processes may be seen as the general biological core for all learning processes.

Reduced prediction errors may be obtained by actions modifying priors to become closer to the world (internal and external) or by changing the world to fit the priors. This indicates that actions and planning can contribute to reduce prediction errors (Pezzulo et al., 2018). For example, in order to produce input consistent with the priors, the nervous system may initiate behaviour, e.g. change posture of the body or strategies for sampling information. In addition, prediction errors are modified not only from the outside world and priors, e.g. affective responses may contribute to imprecise prediction errors that allow prior beliefs to dominate the conscious experience of symptoms (Van den Bergh et al., 2017).

Priors, stimuli, corresponding prediction errors and posteriors may be understood as probability distributions of neural activity in the actual parts of the neural system, i.e. an expected range of values for a given input and associated likelihood. The distributions may have any degree of precision, i.e. act as an account of reliability. Priors with low precision combined with high precision prediction errors/ high precision stimuli will generate a posterior evaluation closer to the original input, while high precision priors combined with low precision prediction errors/ low precision stimuli will shift the posterior towards the prior (Pezzulo et al., 2019). If these precisions are in the same range, the posterior evaluation ends up somewhere in-between the prior and what is accounted for by the stimuli. In principle, the processes described above are unconscious, except for the posterior perception, that rely heavily on the posterior evaluation. The latter may technically be understood as a neural probability distribution. In general, acute events are more likely to be dominated by the stimuli than priors, while the opposite is more probable in chronic ones (Van den Bergh et al., 2017). Fig. 1 illustrates two random, different patterns of distributions of prior, observation (stimulus) and posterior.

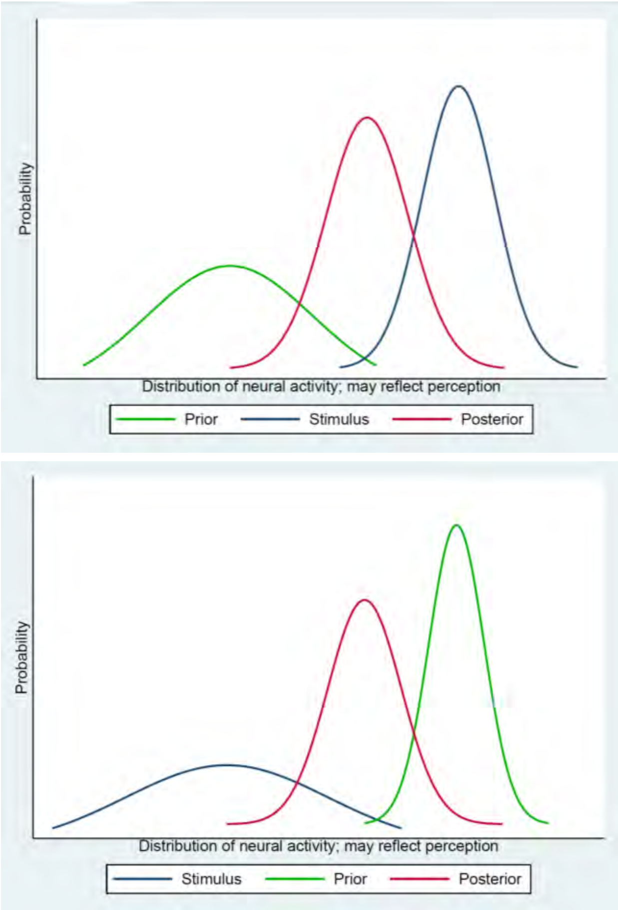

Figure 1. There are numerous possible patterns for how prior and stimulus generate a posterior. The graphs give two examples illustrating the distribution of neural activity (probability for a given pattern), that may reflect the final perception (distribution if possibilities based on the posterior). Upper panel: A low precision prior will have less impact on the formation of a posterior interpretation than a high precision stimulus, i.e. what is consciously perceived is closer to the actual stimulus. Lower panel: A low precision stimulus will have less impact on the formation of a posterior interpretation than a high precision prior, i.e. what is consciously perceived is closer to the prior (based on accumulated experiences) and with limited impact from the actual stimuli.

Using statistical models may also help to understand the actual neural processes. Bayes' theorem describes the probability of an event, based on prior knowledge of conditions that might be related to the event. (Joyce, 2003). Bayesian inference is a method of statistical inference in which Bayes' theorem is used to update the probability for a hypothesis as more evidence or information becomes available (Wikipedia, retrieved 20.02.2021). The described functions of the neural system may be understood in accordance with Bayesian inference and generative models, i.e. models that generate new data instances (Parr & Friston, 2018). Based on past experiences (priors), the nervous system generates new probabilities/hypothesis of the internal and external world as new information arrives in the form intero- and exteroception (Barrett & Simmons, 2015). Predictive processing and predictive coding are terms frequently used to describe these neural phenomena (Pezzulo et al., 2019).

The described models are based on emerging understanding of (a) anatomic structures and physiologic functions of the nervous system, and (b) phenomenon descriptions like placebo, nocebo, conditioning and other learning processes. Despite quite substantial scientific support for the models, clearly there is need for more documentation. However, the scientific support for alternative, e.g. more commonly used, models is though more limited (Barrett & Simmons, 2015; Van den Bergh et al., 2017). Hence, a possible conclusion is that in the lack of anything better, and based on the available documentation, models like predictive coding (PC) should be used to understand human experiences, including e.g. perception of symptoms and associated causes.

Summary of new perspectives on the nervous system

All conscious experiences are in principle “integrations” of (a) our previous experiences (i.e. acting as models to generate predictions on future events by the brain) and (b) what actually happens (i.e. the inputs the brain gets, e.g. from our senses). Only the “end-product” is consciously experienced, not (a) and (b) themselves. In this “integration”, factors (a) and (b) may be of equal importance, one factor may dominate or even constitute the total. If (b) dominates, the traditional model may be acceptable, i.e. what is experienced is rather equivalent to what actually happens, e.g. reporting an unpleasant smell in a newly water damaged building. If (a) dominates, the traditional model fails, what is experienced in the actual situation has limited relevance to what actually happens. Instead, the experiences may be understood as “copies” based on previous experiences; e.g. still getting symptoms in a building long time after proper renovation of water-damages.

POSSIBLE IMPLICATIONS FOR THE FIELD OF BUILDINGS AND HUMANS

The possible underlying mechanisms, elaborated above, describing conscious perceptions in general, may be applicated more specific to issues relevant for the field that may be labelled as building-related factors and its effects on humans, e.g. levels of satisfaction and symptoms. Using the term building-related factors (BRF) implies that a broad range of technical issues, exposures and other kinds of factors may be of importance for buildings and their effects on occupants. Effects of BRF on human perceptions, e.g. generation of experiences, symptoms, hypothesized causes and behavioural responses, are of substantial relevance for most research and practice in the field. Despite this fact, the literature addressing these issues, based on models like PC, seems to be almost non-existent, although mentioned in Nordin, 2020. However, the literature on how symptoms perceived linked to BRF may be explained is abundant. Parts of the literature deal with exposures and related effects on health with established biological causal mechanisms (e.g. exacerbation of asthma in water-damaged buildings; Mendell et al., 2011; Kanchongkittiphon et al., 2015), while others focus on conditions where such causal mechanisms are less likely or uncertain (e.g. perception of headache and dizziness associated with BRF). For a review of the latter, see Nordin 2020. Proposed underlying mechanisms, like neurogenic inflammation and neural sensitization, have some elements in common with models like PC. Learning phenomena, e.g. conditioning and nocebo, are also frequently discussed in this literature. As discussed earlier, such phenomena are fundaments for PC as well. None of the models have a robust scientific base. However, it may be argued that models like PC have the broadest and most convincing grounding for understanding why we perceive as we do (Van den Bergh et al., 2017; van den Broeke et al., 2018).

If models like PC are used to understand important aspects of perception regarding BRF, this may have substantial implications. This paper discusses some more general implications, while a separate conference paper elaborates on conditions characterized by symptoms associated with buildings (Haanes, 2021).

Do human perceptions deliver objective or subjective data?

As mentioned, according to traditional ideas, the brain may be thought to just passively register what happens in- and outside the body. If this was the case, human reports would give access to objective data of the status of the body and the outside world, e.g. an accurate account of the status of in principle any BRF affecting humans. The latter may be what is sought for when collecting information using questionnaires etc. As individual factors determine all experiences (i.e. posteriors in the models), what we really get may be seen as subjective in its nature, but at the same time, also as an objective account for the perception of the actual person. To this comes that there may be a huge variation in experiences between and within individuals over time (Van den Bergh et al., 2017). However, this does not mean that we should stop to obtain information from humans. In many situations data indicating perceptions, opinions and feelings are just what is wanted, e.g. the users' degree of satisfaction related to different parameters of a building. When objective information on e.g. BRF is sought, in some cases questionnaires etc. may be close enough to be useful; sometimes supported or supplemented by objective data, e.g. measurements.

All human perceptions are true

As all human perceptions are generated based on prior experiences and other factors specific for each individual, there is only one version of the truth; the one of each person. This explains that one person may report different from other persons and independently of objective data, e.g. from measurements. On the contrary, this also indicates caution taking actions regarding BRF based on human reports only, as they represent individual experiences and may not be in line with actual BRF facts, e.g. indoor climate may be evaluated as technically perfect despite occupants reporting severe symptoms or diseases like cancer, that they attribute to indoor climate. As mentioned earlier, the culturally generated idea of a schism between "psyche"/"mental" and "soma"/"physical" has limited support, and gets no support from models like PC (Haanes et al., 2020). In addition, labels like "psyche" and "mental" are often interpreted negative, i.e. associated with stigma. Thus, a lot of unnecessary controversies and miscommunications may be avoided if refraining from terms indicative of this schism.

Some interventions may be more effective than others

In the field of BRF, the goal often is changes for the better. Sometimes this can be achieved by entirely technical interventions. However, frequently, changed human perception may be necessary. Models like PC can guide on which interventions that may be effective (Van den Bergh et al., 2020). Traditional (passive) information gets better "through" in cases with limited earlier experiences (priors) than cases abundant in such experiences. Especially in the latter kind of cases, priors containing the "wrong messages" have to be overridden (they may not be erased) by priors that are more beneficial. In general, this is better achieved with active than passive methods, e.g. two-way communication vs. passive information. If possible, getting new embodied experiences are even more effective, e.g. giving opportunities to obtain neutral/positive experiences when attending a building usually giving unpleasant symptoms. The downsides of how human experiences are generated, is that it may be very hard to change strong unbeneficial priors and that heavy loads of "wrong" messages (e.g. undocumented statements in social media or negative experiences spread among occupants of a building) may produce strong priors. In addition, there is a tendency to pay more attention to information that fits the priors than not, i.e. conformation bias. This calls for realism regarding what are possible to achieve in cases of the practice field that are perceived difficult or stuck, e.g. despite little progression in a building related case, try to avoid frustrations among professionals and those afflicted.

Taking the described emerging knowledge into account may be of substantial help for all professions working in the field of buildings, health and experiences.

CONCLUSION, TAKE HOME MESSAGES

1. All data originating from human perception reflect personal experiences.
2. All human experiences are true, but not necessarily in accordance with technical assessments etc.
3. Questionnaires and other inputs from humans must be interpreted accordingly.
4. Cultural misconstructions like "psyche"/ feelings" vs. "soma"/"real" should be avoided.
5. Active approaches are more effective than passive for changing human experiences.

ACKNOWLEDGMENTS

Many thanks to Martin Tondel, Sweden and Omer Van den Bergh, Belgium for valuable inputs and interesting discussions; and Tove Linda Haanes, Norway for useful comments on language issues.

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