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Neuroscience and everyday life: Facing the translation problem

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ABSTRACT

To enable the impact of neuroscientific insights on our daily lives, careful translation of research findings is required. However, neuroscientific terminology and common-sense concepts are often hard to square. For example, when neuroscientists study lying to allow the use of brain scans for lie-detection purposes, the concept of lying in the scientific case differs considerably from the concept in court. Furthermore, lying and other cognitive concepts are used unsystematically and have an indirect and divergent mapping onto brain activity. Therefore, scientific findings cannot inform our practical concerns in a straightforward way. How then can neuroscience ultimately help determine if a defendant is legally responsible, or help someone understand their addiction better? Since the above-mentioned problems provide serious obstacles to move from science to common-sense, we call this the 'translation problem'. Here, we describe three promising approaches for neuroscience to face this translation problem. First, neuroscience could propose new 'folk-neuroscience' concepts, beyond the traditional folk-psychological array, which might inform and alter our phenomenology. Second, neuroscience can modify our current array of common-sense concepts by refining and validating scientific concepts. Third, neuroscience can change our views on the application criteria of concepts such as responsibility and consciousness. We believe that these strategies to deal with the translation problem should guide the practice of neuroscientific research to be able to contribute to our day-to-day life more effectively.

1. Introduction

Can brain scans read thoughts? If so, can they detect lies? Questions such as these are frequently being asked today, and jurors seriously consider the use of neuroimaging data in court (Costandi, 2013; McCabe, Castel, & Rhodes, 2011; Roskies, Schweitzer, & Saks, 2013). This example illustrates, on the one hand, the quick rise of the field of neuroscience. On the other hand, however, it highlights the demand for translation of scientific findings about the brain into language that is appropriate to improve practices outside of cognitive neuroscience. Usually this is the language of common-sense cognitive concepts (‘CCCs’, such as ‘lying’). The use of CCCs to report research findings suggests that these terms have the same meaning in scientific and non-scientific contexts, but this is often not the case (Figdor, 2013; Francken & Slors, 2014). In the lie-detection case, for instance, one might argue that neuroscientists are not really studying lying: fMRI studies investigate trivial lies with no consequences, which may not count as lies in an everyday context (Pardo & Patterson, 2013). The neuroscience of ‘love’ provides another example. In these studies, what is usually studied is a passive, emotional experience in response to seeing a picture of a beloved (Van Stee, 2017). Although this leaves out many aspects of the meaning of love in our day-to-day life, this nuance is lost as soon as scientific results are translated to popular statements such as ‘neuroscience now proves that love is addictive’.

Hence, quite apart from methodological questions (concerning e.g., reliability and generalizability) it is vital to study the use of common-sense cognitive concepts when reporting research findings. For there often exists a conceptual gap between neuroscientific findings and the concepts we are ultimately interested in. Only when we bridge this gap neuroscience will really be able to contribute to determine if someone lied during interrogation, or to help someone understand his addiction better.

If the CCCs of our everyday ‘folk-psychology’ could be operationalised unproblematically and unambiguously in neuroscientific experiments, the outcomes of these experiments would ideally directly inform CCC-based practices. Given the conceptual gap, however, we should be cautious in interpreting the outcomes of neuroscience experiments simply as, say, results about ‘lying’, ‘free will’, ‘love’, or any other folk-psychological category. How then can neuroscientific findings be translated in terms that speak to our practical concerns in a non-misleading, non-naive way? Let us call this the 'translation problem'.

After elaborating on the translation problem in Section 2, we will

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discuss three different solutions to it (Sections 3–5). These are not mutually exclusive, but highlight different ways in which neuroscience can impact on our CCC-based practices. The first solution to the translation problem is to allow neuroscience to go beyond the traditional folk-psychological array of CCCs and introduce what may be viewed as new CCCs. As is noted by an increasing number of researchers and journalists, it has become common to express feelings, thoughts and attitudes in terms of one's dopamine, serotonin or adrenaline levels. In Section 3 we will discuss the relation between this emerging 'folk-neuroscience' and folk-psychology. The next two solutions hinge on the idea that neuroscience can improve our current array of CCCs. In Section 4 we will discuss how neuroscience might influence the taxonomy of CCCs by refining and validating scientific concepts. In Section 5 we will discuss an illustrative case study - responsibility - that shows how neuroscience can alter the criteria of applicability of certain CCCs. Finally, in Section 6, we will discuss the question how neuroscience research practices can be amended to improve its contribution to our everyday life.

2. The translation problem

The 'translation problem' is the problem of drawing conclusions about CCCs from brain data. In a previous paper, we discussed the fact that CCCs need to be refined and operationalised into tasks before they can be connected to activity in the brain (Francken & Slors, 2014). This process, we argued, involves multiple, interpretive steps. As a consequence, brain data cannot inform us unambiguously about the nature of CCCs (see also Anderson, 2010; Burnston, 2016; Poldrack, 2006; Rathkopf, 2013). This is where the translation problem emerges: it is not possible to simply apply neuroscientific findings[1] to our CCC-based practices. In order to see why translating scientific data to CCC-based practices is a serious problem, let us briefly rehearse the different steps from CCCs to brain data and their associated problems (for an extensive discussion, please refer to Francken & Slors, 2014; see also Poldrack et al., 2011). The main obstacle for a direct translation from neuroscientific findings to CCCs lies in the fact that there are (at least) three steps to get from CCCs to the brain, where each of these steps contains a many-to-many rather than a one-to-one mapping (Fig. 1).

2.1. Common-sense cognitive concepts (CCCs) and scientific cognitive concepts (SCCs)

The first step takes us from our folk-psychological, common-sense concepts to scientific cognitive concepts (SCCs) (Fig. 1: (a)). CCCs are usually too coarse-grained and unspecific to be objects of informative and well-controlled scientific research. Therefore, they are typically turned into more formal and fine-grained SCCs. Often, SCCs and CCCs have the same name (e.g. 'memory') but the SCCs usually differ from CCCs in being partitioned into sub-concepts (e.g., 'working memory', 'long-term memory'). Ideally, SCCs are formalized versions of CCCs with more precise definitions that are shared by the scientific community. However, this is often not the case. Many SCCs capture only

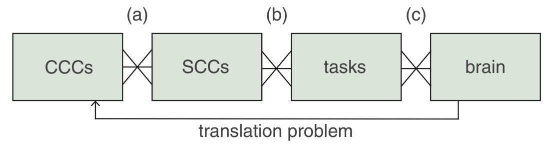

Fig. 1. The translation problem. Because of the many-to-many mapping between common-sense cognitive concepts (CCCs), scientific cognitive concepts (SCCs), operationalisations in experimental tasks and brain data, it is not possible to simply apply neuroscientific findings to our everyday practices.

part of the meaning of CCCs (Francken & Slors, 2014). Sometimes the meaning of SCCs and associated CCCs are even conflicting (Figdor, 2013). For instance, Figdor showed that a neural system initially associated with 'reward' defined in a behaviourist way, i.e., a stimulus associated with increased frequency of response, is later related to feelings of pleasure that are associated with the ordinary meaning of the term 'reward'.

Divergence does not only occur when we go from CCCs to SCCs, but also in the reverse direction. For example, the CCC 'consciousness' plays a role in everyday explanations of experiences and actions. But the concept is also important in legal practices (is the defendant responsible?), medical practices (is the patient conscious?), and psychiatric practices (are this patient's beliefs misinformed or is she delusional?). Definitions of the CCC can diverge depending on the everyday context, resulting in a many-to-many mapping between CCCs and SCCs and reduced applicability of scientific findings to our common-sense concepts (or ecological validity, see for a discussion e.g., Sullivan, 2009).

2.2. SCCs and task operationalisations

After the first step of converting a CCC to an SCC, a second step is required to be able to study the behavioural and neural mechanisms of an SCC (Fig. 1: (b)). In order to study SCCs in the brain, an experimental task has to be designed to activate the cognitive process associated with the SCC. For example, the Wisconsin card-sorting task is used to measure the underlying cognitive and neural mechanisms of 'task-switching'. In this task, subjects have to match a target card to one of four cards. Matching can be based on colour, shape or number of the items on the cards, and the correct matching rule has to be inferred by the subjects, based on feedback about whether their previous match was correct or incorrect. The matching rule changes every ten cards. Scoring well on the task requires the ability to adapt quickly to a new rule (Berg, 1948), i.e. the ability to switch tasks. However, some researchers use the same task to study the SCC 'working memory', since the participant has to remember which is the current matching rule (e.g., 'match on colour') (Keefe, 1995). This clearly complicates the interpretation of the scientific findings: how does the researcher know whether the measured brain activity correlates with task-switching or with working memory?

Two issues are important here. First, the example shows that there is no shared or systematic relationship between concepts and tasks. As a consequence, different tasks and versions of tasks are used in the scientific community to tap into a particular concept - and there is even more diversity when including different levels of investigation, i.e. animal studies, patient studies, etc. This situation impedes the generalizability (or external validity, see Sullivan, 2009) of research findings (Poldrack et al., 2011).

Second, the example demonstrates that SCCs are *interpretations* of certain behaviour elicited by specific tasks. Whether the Wisconsin card-sorting task measures working memory or task-switching is not something that can be determined by scientific experiments. SCCs are human constructs, derived from CCCs that preceded neuroscience by millennia (Danziger, 1997; Hacking, 1986). CCCs are designed to interpret, explain and predict behaviour in everyday life (Dennett, 1971,

[1] The translation problem as we will discuss it here pertains to the translation of neuroscientific results to domains outside of neuroscience. Similar problems exist with respect to the translatability of the results of cognitive psychology and artificial intelligence, since there the sub-steps that we will discuss in this section, from common-sense cognitive concepts (CCCs) to scientific cognitive concepts (SCCs) and from SCCs to tasks are necessary too. Yet, we think the problems for neuroscience are more visible and severe because, first, lay people take neuroscience more seriously than cognitive psychology findings, e.g. because neuroscience findings are accompanied by fancy brain images (see e.g., Roskies, 2008; Trout, 2008; Weisberg, Keil, Goodstein, Rawson, & Gray, 2009), increasing the impact. Second, in neuroscience experiments, the dependence on behaviour - that is equally big - is less clear. Usually operationalisations are not extensively discussed because the brain data are what makes the findings exciting. On the contrary, in cognitive psychology studies behavioural measures are the only outcome measures, requiring discussion of what was actually experimentally manipulated.