



Grounding the neuroscience of behavior change in the sociocultural context

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Recent work has identified ventral medial prefrontal cortex (vmPFC) as a key region predicting whether people will change their behavior in response to persuasive messages. Moreover, a parallel and complementary area of research has examined sociocultural factors that contribute to successful behavior change. In the current paper we aim to integrate these two distinct lines of research and discuss novel implications for the study of both behavior change and culture. We propose that personally and culturally tailored messages should lead to greater neural activation in vmPFC and this greater neural activation should lead to greater subsequent behavior change; we also consider broader neural systems that may integrate social norms and perspectives into judgments across culture.

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Introduction

What motivates people to change their behavior? Researchers have long been interested in understanding and predicting changes in behavior in diverse domains [1,2], including health, financial, consumer, and political behaviors. Much of this work focuses on how to develop messages that promote behavior change in a certain direction (e.g. engaging in a specific health behavior, buying a company's product, voting for a particular political candidate, etc.). Recent work in social and communication neuroscience has found that neural activation is a reliable predictor of behavior change, explaining variance

above and beyond a range of self-report measures. For health behaviors as diverse as sunscreen usage [3], smoking cessation [4*,5], and physical activity [6**], activation in the ventral medial prefrontal cortex (vmPFC) in response to health communications predicts whether individuals will subsequently engage in healthier behaviors (or reduce unhealthy behaviors). Additionally, activation in vmPFC has also been shown to predict financial and consumer decisions [7,8].

Why does vmPFC predict behavior change? vmPFC is one of the regions most commonly engaged in studies of self-related processing [9,10], as well as positive valuation [11], and current thinking suggests that these processes may play integral roles driving the effects of social influence on behavior change [12]. In addition, researchers have begun to tease apart the social factors and message characteristics that lead to increased vmPFC activation and subsequent behavior change. As described in more detail below, personal relevance of the message [13], behavior-relevant messages [14], and opportunities for self-affirmation [6**] have all been shown to lead to increased vmPFC activation, which in turn predicts behavior change. Moreover, localizer tasks used to identify a priori ROIs implicated in self-related processing suggest that thinking about the self while evaluating the message may play a key role underlying the link between vmPFC activation and behavior change [4*].

A parallel and complementary area of research in health psychology and health communications also suggests that personally relevant tailored messages are more effective at promoting healthy behaviors [15,16]. Similarly, the cultural match between the message content and personal values influences the effectiveness of health messages [17–19,20**]. Thus, integrating recent neuroimaging evidence regarding the role of vmPFC in promoting behavior change in response to health messages and recent work on personal and cultural message tailoring, we suggest novel implications of these previously distinct areas of research and argue for their combination.

Neuroscience of persuasion and behavior change

Personalized messages that are tailored to the individual are rated as more relevant to the self and congruent with important identities [13,16]. Importantly, more personalized messages also lead to greater goal-consistent behavior change [21*], and increased perceptions of the relevance of the message to the self have been shown

to mediate this effect [22]. For example, people who are trying to quit smoking and are given tailored messages are more likely to succeed in quitting than smokers given non-tailored messages [16] and tailored messages about breast cancer screening lead to greater subsequent intentions to get breast cancer screening [22]. Tailored health messages also activate vmPFC to a greater degree than non-tailored messages and activation in a more dorsal part of mPFC (dmPFC) in response to these health messages predicts subsequent behavior change [23**].

Recently, we used a self-localizer task to identify sub-regions of vmPFC that are recruited when smokers think about the self [4*]. Participants recruited vmPFC more when evaluating whether a trait word described themselves relative to a control judgment (i.e. whether a word was positive or negative). Activation in this same sub-region of vmPFC while our smokers viewed anti-smoking messages predicted changes in smoking behavior [4*].

Additional work has found that vmPFC activation in a small group of participants can also predict the population-level success of a set of health messages [14,24]. Importantly, the relevance of the message content to the behavior being promoted moderates the relationship between vmPFC activation and population-level responses to the health message. vmPFC activation predicted population level behavior (clicks on online anti-smoking ads) when the message content was smoking-relevant, whereas vmPFC activation does not predict click rate for ads containing compositionally similar but behavior-irrelevant images [14].

Another study manipulated activation within vmPFC using self-affirmation priming [6**]. In this study, sedentary individuals were given accelerometers to track their physical activity and then shown health messages promoting the benefits of increased physical activity. Some participants affirmed core values important to the self prior to viewing physical activity health messages, whereas control participants reflected on values rated as personally unimportant. The authors hypothesized that the affirmation manipulation should decrease perceived threat of the messages and increase the ability of participants to internalize the message [6**]. There are three noteworthy findings from this study. First, vmPFC activation was greater for people who had an opportunity to self-affirm prior to seeing the health messages. Second, people who saw the health messages coupled with self-affirmation showed greater improvements in physical activity than people who saw the control messages. Third, vmPFC activation in response to the health messages predicted subsequent changes in behavior, such that people who exhibited greater vmPFC activation while viewing the health messages showed steeper declines in sedentary behavior over the next 30 days.

Research on consumer decision-making provides additional evidence for the role of vmPFC in predicting subsequent behaviors. vmPFC activation predicts whether people will purchase a consumer product [7] as well as the endowment effect (increased valuation of items as a function of object ownership) [25–27], providing evidence that activation in vmPFC may be indexing self-relevance or value of the particular stimuli to the self. More broadly, converging evidence suggests that vmPFC is involved in integrating signals (including self-relevance and value) with both external and internal information to trigger a goal-motivated behavioral response [28–30]. In the context of health messages, vmPFC may therefore be involved in integrating signals about the personal value of a particular message and activating goals related to the health message.

Cultural influences on message effectiveness

There are many ways that culture could influence effectiveness of persuasive messages, but two primary routes include normative influence (changing behavior because of what other people think) and individual values and beliefs. A number of behavior change theories argue that both attitudes and subjective norms influence behavioral intentions [31,32], and culture constitutes a primary source of information about what is sanctioned, valued, and normative. Cultures may reinforce and promote different types of normative beliefs about how people should act and what they should care about; these cultural norms may in turn influence the types of goals, values, and beliefs that people hold [33*,34].

Individualistic cultural contexts are more likely to promote goals, beliefs, and values that emphasize one's individuality, personal achievement, and uniqueness [35–37]. People from individualistic cultures tend to view the self as distinct from others and defined by their personality and personal preferences [34] and as a result, tend to be motivated by the desire to be unique, be the best, and express one's important characteristics through behaviors and decisions [38,39]. In contrast, collectivistic cultures are more likely to promote goals, beliefs, and values that emphasize social harmony and the importance of the group [34–37]. People from collectivistic cultures tend to view the self as intertwined with others and defined by relational attributes and social roles, and as a result primary motivators of behavior include the desire to promote and maintain social harmony, and concern for close others [38,39].

For example, European American children are more motivated and work harder on tasks that are perceived to be freely chosen, whereas Asian and Asian American children are more motivated and work harder on tasks that are chosen for them by close others [38]. Similarly, personally tailored messages are less effective in non-Western cultural contexts [21*,40]. For people from non-Western cultures that are less likely to value individuality and uniqueness, it

may be important to tailor messages more broadly to important cultural identities, beliefs, and values [17].

Recently, social psychologists experimentally manipulated the content of health messages and found that individualistic messages were more effective for European Americans whereas Asians and Asian Americans were more persuaded by collectivistic health messages [20**]. In this research, European Americans, Asians, and Asian Americans read articles that either focused on the personal consequences of excessive caffeine consumption or the social/relational consequences of excessive caffeine consumption. In both cases the article talked about the link between caffeine consumption and fibrocystic disease, but in the self-focused article participants were informed about how the disease could impact them personally, whereas in the relational-focused article participants were informed about how the disease could impact their friends and family. European Americans were more persuaded by the self-focused article, as evidenced by increased endorsement of the message, increased perceived risk associated with excess caffeine consumption, and increased personal relevance of the message. Importantly, European Americans who received the self-focused article also engaged in healthier behaviors immediately following the experiment (i.e. were less likely to choose caffeinated food options). Asian and Asian American participants, on the other hand, believed it was more important to reduce their caffeine consumption, believed the message was more personally relevant, and were less likely to choose the caffeinated food options if they had read the relationship-focused article [20**].

The above research suggests two potential routes whereby persuasive messages can be tailored to the individual. Personalized tailoring leverages important aspects of an individual's identity, matching the message to relevant beliefs, behaviors, and goals. Cultural tailoring enhances the fit between the message and salient cultural identities as well as values and beliefs considered important by that cultural group. To the extent that the individual has internalized the values and beliefs considered important by their cultural group, cultural tailoring and personalized tailoring may appear similar. But, in addition to emphasizing that the behavior change is consistent with the individual's beliefs and values (employing a similar route as personalized tailoring), cultural tailoring also emphasizes normative information that other in-group members care about the behavior being promoted and compare their current self to normative goals and idealized self [41]. In fact, research has found that, for individuals with a strong cultural identity, cultural tailoring can actually be more effective than personalized tailoring [19].

Toward a contextual understanding of persuasion and behavior change

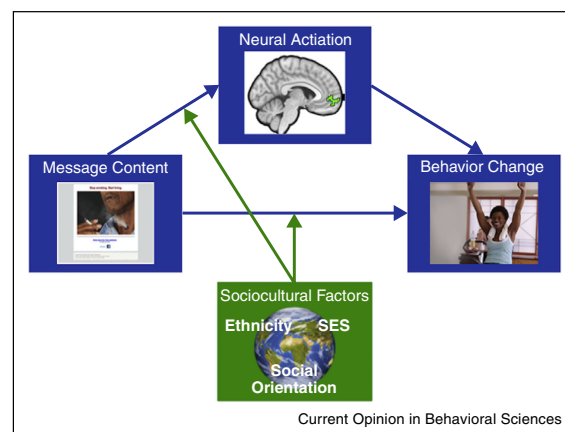
Growing evidence suggests that vmPFC plays a crucial role in promoting behavior change (especially in response

to persuasive messages), but the way in which people respond to different types of health messages might vary across cultures [20**,40], and the types of messages, goals, and reasons that recruit vmPFC and promote behavior change may be fundamentally different across cultures. Moreover, messages that are tailored to the individual's important characteristics lead to greater vmPFC activation and subsequent behavior change [13,23**]. But, the type of characteristics and judgments that activate vmPFC should be influenced by one's chronic cultural frame and other sociocultural factors [42,43**,44,45].

These predictions are reinforced by cultural neuroscience research, which has identified vmPFC as a key region in mediating cultural differences in various types of social judgments (including evaluating the self — [46,47,48*,49]; and empathizing with others — [50]). Moreover, the neural mechanisms that support persuasion seem to be consistent across cultures [51]. Because cultural context is known to influence both what types of persuasive messages lead to behavior change [20**], as well as what types of stimuli activate vmPFC [48*,49] we suggest that combining these insights to explore culturally moderated vmPFC activation in response to persuasive messaging will lend new insight into culturally relevant, persuasion-induced, behavior change (see Figure 1).

This model leads to a number of testable predictions. First, activation in vmPFC should mediate the relationship between message content and behavior change; messages that are perceived as more important to the self and fit with important and salient identities should lead to increased vmPFC activation and subsequent behavior change. Second, sociocultural factors including ethnicity, socioeconomic status, and chronic cultural frame (e.g. individualistic versus collectivistic) should

Figure 1



The effect of message content on behavior change should be mediated by neural activation and moderated by sociocultural factors.

moderate the links between message content, vmPFC activation, and behavior change. Messages that fit with values and beliefs that the individual considers important or that the individual perceives as being important to their cultural group should lead to greater vmPFC activation and subsequent behavior change. For example, personal messages should lead to greater vmPFC activation and subsequent behavior change for people with individualistic cultural frame (versus collectivistic cultural frame) and social messages should lead to greater vmPFC activation and subsequent behavior change for people with collectivistic cultural frame (versus individualistic cultural frame).

Implications for future research

This framework has novel implications for future research directions. For example, our argument focuses on studies of vmPFC and the value that individuals from different backgrounds find in messages; however, additional studies have found that dmPFC is also predictive of behavior change under some circumstances [23^{**},52]. Recent meta-analyses suggest a distinction between the roles of vmPFC and dmPFC in social judgments, such that vmPFC is thought to compute the degree to which an object is relevant, valued, or important to the self, whereas dmPFC is involved in evaluating social information about relevant goals, social norms, and contextual factors in order to make a judgment or decision [9,28] and is recruited by both Americans and Koreans when evaluating persuasive messages [51]. People from collectivist cultures, however, also recruit dmPFC and TPJ when making judgments about the self [43^{**},48^{*}].

One tentative interpretation of this body of work is that vmPFC may index whether the message being presented is relevant and important to the self, which includes cultural cues (e.g. about the individual in Western cultures; about the collective in East Asian cultures). To the extent that social norms and societal expectations are internalized and valued more by people in collectivistic cultures, vmPFC should be more active for people from individualistic cultures presented with personal messages and more active for people from collectivistic cultures presented with social messages. dmPFC may instead evaluate whether the persuasive message fits with relevant social norms, expectations, and information about others' thoughts and opinions and may be recruited whenever people from any culture think about social norms and societal expectations; however, activation in this region may more strongly influence behavior change for people from collectivistic or tight cultures where norms and expectations are paramount. Thus, different types of messages may recruit vmPFC to differing degrees across culture, whereas the importance of dmPFC for evaluating social information and promoting behavior change might be stronger in East Asian cultures than Western cultures.

The extent to which this argument is supported empirically can also help to address a prominent open question in the study of the neuroscience of behavior change; namely, what cognitive processing roles are regions of mPFC playing when people are exposed to persuasive messages that ultimately leads to greater subsequent behavior change? To the extent that vmPFC increases in response to culturally congruent messages (e.g. personal messages in Western, and social messages in East Asian cultures), it would highlight a role for vmPFC as assessing broad fit between personally motivating factors and behavioral outcomes. By contrast, if vmPFC only increased to personal messages across cultures, it would suggest a focus on a more narrow definition of 'self' within vmPFC.

Second, this framework can extend recent work in cultural neuroscience to health behaviors and health decisions, addressing the types of stimuli and contexts that are likely to activate vmPFC and lead to subsequent behavior change across individuals from diverse cultural backgrounds. In the current paper we focused on individualism and collectivism as promising dimensions by which cultural differences in responses to persuasive messages might emerge, although other dimensions may also be involved. Tightness of social rules and norms [53], motivation to avoid uncertain outcomes [54,55], and orientation toward long term versus short term goals [55] have been shown to vary across cultures and may also influence how people respond to health messages (and the degree to which their vmPFC activates in response to these messages).

Conclusions

Combining research on personally and culturally tailored messages with neuroscience research on behavior change suggests fruitful levers through which health advocates and others interested in changing behavior can build interventions. Integrating multiple methods and linking neuroscience with health communications and other data on sociocultural context promises to improve our understanding of what makes some persuasive messages more effective than others [2,56,57] and will enable health advocates to optimize the personal and cultural fit of persuasive messages. Using brain data will increase understanding of not only which messages work better, but why they work better, whether it is through influence of cultural norms and beliefs, group pressure, or match with internalized values, beliefs, and goals. This has the potential to improve health outcomes for individuals from disadvantaged groups currently encountering stark health disparities. Finally, to the extent that sociocultural factors influence the types of persuasive messages that activate dorsal versus ventral mPFC, this could inform our understanding about how the brain works and how cortical structures integrate both internal and external information.

Conflict of interest

Nothing declared.

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