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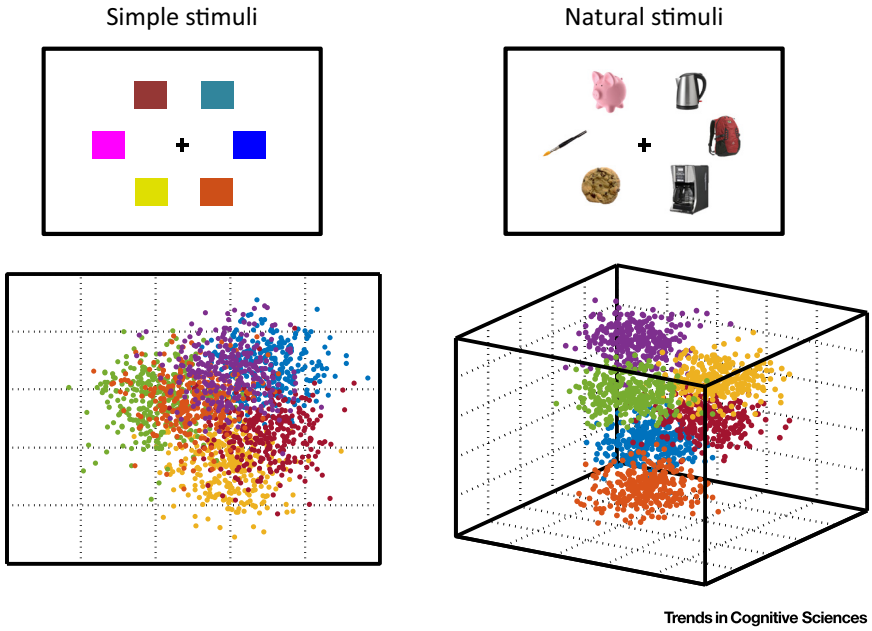

Figure 1. High-Dimensional Representations Allow Increased Capacity. One possible reason for the increased active memory capacity for natural objects is that those stimuli are represented with a higher dimensionality than simpler objects, which allows patterns of neural activity to be more distinct. In this illustration, each colored cluster corresponds to a hypothetical neural representation for one of six objects, with the assumption that information having conceptual meaning has access to a higher dimensional mental representation.

(Figure 1). This high-dimensional space would be based on a lifetime of visual experience, and would permit meaningful information to activate distinct representations that can be stored with less interference compared with relatively meaningless shapes. The key findings of Brady *et al.*, namely, that memory for multiple natural objects benefits from extra study time, that these differences exist only for large set sizes, and that this effect involves active storage, collectively provide valuable constraints on models of visual memory. Moreover, studying memory for natural stimuli has the potential to bridge the gap between theoretical models of memory storage in humans and the rapidly developing field of deep-learning networks for image comprehension. Such a bridge will be instrumental for the development of memory systems that will allow artificial intelligence to learn how to navigate and interact in the natural world. Such technology might even allow memory prostheses for individuals with brain damage or dementia.

[1]Department of Psychology, Penn State University, University Park, PA 16801, USA

*Correspondence: bwyble@gmail.com (B. Wyble).

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Forum

Using a Foreign Language Changes Our Choices

Sayuri Hayakawa,[1,*] Albert Costa,[2,3] Alice Foucart,[2] and Boaz Keysar[1]

A growing literature demonstrates that using a foreign language affects choice. This is surprising because if people understand their options, choice should be language independent. Here, we review the impact of using a foreign language on risk, inference, and morality, and discuss potential explanations, including reduced emotion, psychological distance, and increased deliberation.

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Imagine that you have an opportunity to save the lives of five people, but to do so you must kill one person. Would you kill the one person or would you do nothing and let the five people die? Whatever your choice is, it should not depend on whether you made it in your native tongue or in a foreign language: but it does.

Decision research often addresses how choices are affected by the way in which situations are framed or described, as in highlighting gains versus losses. In these cases, language is treated as a conduit to deliver information or a tool to draw attention to specific features of a decision. Only recently have psychologists begun to explore how the nativeness of a language, rather than its content, affects choice. A rapidly growing body of research suggests that, even when the content of a message is exactly the same, decisions depend on whether the information is delivered in a

native or foreign tongue. This is theoretically relevant to the relation between language and thought, and to the lives of millions of individuals who use a foreign language and might be unaware that their decisions are affected by it. Here, we review some of this research and discuss potential explanations for this foreign language effect.

Dealing with Risk

Using a foreign language affects how people perceive and act in risky situations [1,2]. Findings suggest that risks appear smaller in a foreign language. For example, when people consider potential hazards and activities, such as 'traveling by airplane' and 'biotechnology', they perceive the risks associated with them as lower and the benefits as larger, when using a foreign language [3]. This reduction in risk perception may in part explain why those using a foreign language are more willing to take on risky ventures when presented with monetary gambles [1,2]. People using a foreign language also show more consistent risk preferences, which is reflected in both the Asian Disease paradigm [1,2] and the Holt–Laury test [2]. The Asian Disease paradigm illustrates the robust finding that people tend to be risk seeking when a situation is framed in terms of losses (e.g., 400 out of 600 people will die), but risk averse when it is framed as gains (e.g., 200 out of 600 people will be saved). This asymmetry is reduced when using a foreign language [1,2]. The Holt–Laury test involves progressively choosing among pairs of gambles from one column or another. At the one extreme, choosing from a certain column suggests extreme risk seeking, whereas at the other extreme it reveals extreme risk aversion. The point at which an individual switches between the two is an indication of risk preferences. When people perform this task using a foreign language, they express higher risk-seeking tendencies and are more consistent in their choices [2]. Taken together, this suggests that risks are evaluated differently and more consistently when processed in a foreign language.

Box 1. Does Using a Foreign Language Lead to Better Choices?

In some contexts, using a foreign language appears to improve decision-making, since it reduces various decision biases [1,2,4], such as loss aversion. This is consistent with the idea that reasoning in a foreign language is less affected by emotional concerns [6–10]. It is intuitive that optimal choices are those that are made with a cooler mindset and, to the extent that using a foreign language reduces emotional reactivity, it might lead to better choices. However, we propose that whether using a foreign language leads to better or worse decisions entirely depends on the type of problem that the user is trying to solve. In many cases, emotions can be helpful, such as by providing a quick evaluation of complex information and helping us learn from past mistakes. Therefore, when emotional reactions serve a beneficial function, such as when there is little time or few resources available to engage in careful deliberation, using a foreign language should lead to less optimal decisions. Future research could explore the factors that determine when using a foreign language leads to better decisions and when it makes them worse.

Box 1 provides further discussion of whether a foreign language increases normative choice in general.

Making Inferences and the Role of Agency

How individuals infer causal relations varies depending on the language being used. For example, using a foreign language has been shown to abolish the 'hot hand' fallacy [4]. When participants were presented with a series of independent gambles, people using a native language overestimated the likelihood of a positive outcome after a series of prior successes, an effect that was reduced when using a foreign language. It should be noted that this 'hot hand' fallacy is generally only present when individuals perceive that the outcomes are generated not by chance, but by an intentional agent who may continue 'streaking' [5]. This brings us to yet another effect of language: people are less sensitive to intention and more sensitive to outcomes when using a foreign tongue [6]. This could explain why using a foreign language eliminates the 'hot hand' fallacy and could even affect judgments in the moral domain.

Making Moral Judgment

Perhaps the most striking effects of language have been found in the moral domain. There is robust evidence demonstrating that individuals are more likely to endorse utilitarian behaviors when using a foreign language. In one study, people using a foreign language were more than twice as willing to sacrifice one life to save five, compared with those using their native tongue [7]. This effect was independently replicated with several languages, such as English, Spanish, German, and Italian [8,9]. This suggests that, when deontological prohibitions, such as 'cause no harm', conflict with the utilitarian value of promoting the greater good, using a foreign language increases the weight of the greater good compared with moral rules. This is consistent with findings that people using a foreign language are less condemning of moral or social taboo violations [10].

Why Does a Foreign Language Change Our Choices?

Although there is converging evidence that using a foreign language affects our decisions, the precise reasons for this are still unknown. The leading account is that a foreign language engages emotions less than does a native tongue [11,12]. Whereas a native tongue is acquired through affect-rich experiences, foreign languages are often acquired in less emotional classroom contexts. Therefore, decisions in a foreign language might not engage the emotional system as readily as decisions made in a native tongue. Such a reduction in emotional processing could explain effects such as increased risk taking, greater utilitarianism, and so on. Box 2 provides a more detailed evaluation of the evidence for and against this explanation.

Another possibility is that using a foreign language increases psychological distance, leading to a more abstract level of construal. Having such a 'bird's eye

Box 2. Evaluating the 'Reduced Emotion' Explanation

The processes driving the foreign language effects are not yet well understood, but a leading candidate is that the effects on decision-making result from a reduction or a change in emotional processing. One study found that using a foreign language increased perceived benefit and reduced perceived risk, and that this effect was mediated by an increase in positive affect and a decrease in negative affect when using a foreign language [3]. This finding is consistent with the notion that the effect of the foreign language may be due to changes in emotional processing. It has also been found that using a foreign language leads to more lenient judgments of taboo violations, such as consensual incest, but only in cases where the scenario is rated as significantly less emotional in the foreign language [10]. Similarly, using a foreign language increases utilitarian behavior specifically for highly emotional moral dilemmas, whereas the effect of language is negligible for less emotional ones [7]. However, inconsistent with this explanation is the finding that both more and less emotional types of dilemma were rated as less emotional in a foreign language, and that these ratings did not mediate the effect of language on choice [8]. Thus, the authors suggest that the change in choice may be driven by a reduced salience of social norms when using a foreign language rather than being a direct result of reduced emotion. Future research may attempt to utilize different methodologies, such as fMRI and skin conductance, to examine the role of emotion, as well as systematically examine the population-level differences that may contribute to the effect, such as proficiency and method of acquisition.

view' has been shown to increase focus on ends over means [13]. This could give more weight to benefits than to costs, and thereby increase utilitarianism. It could also explain why a foreign language reduces framing effects, because superficial differences in wording are less likely to be salient at a more abstract level. The disfluency of using a foreign language could also contribute to the effects, because processing disfluency in general could lead to a more deliberative mode of thinking, given that increased difficulty may signal a need for more careful consideration.

Concluding Remarks

As evidence of the foreign language effect on decision-making accumulates, it becomes important to better understand its origin. Depending on which processes are responsible for the effect, one could make specific predictions regarding when and how using a foreign language is likely to affect decision-making. For instance, if the effect is due to a reduction in emotion, this predicts an effect for biases that are likely to be the result of emotional, automatic processing, such as a difficulty ignoring sunk costs. It would also predict that biases that are likely the result of deliberative processing, such as biases in syllogistic reasoning, would not be affected by a foreign language. By contrast, if the effect is due to an increase in deliberation, this predicts an effect for both types of bias. It is possible that the effect of using a foreign language is multiply determined, and that the different processes also interact with one another. To better understand the effect, it will be important to systematically examine the effects of having various language backgrounds and competencies, such as the role of proficiency, method and age of acquisition, and cultural associations. Such factors may mediate or moderate the effect of foreign language on decision-making. This provides an exciting opportunity for future research to investigate the relative contributions of these various mechanisms to more fully understand both how people behave when using a foreign language and, more generally, how the languages we use affect the choices that we make.

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[1]Department of Psychology, University of Chicago, 5848 South University Avenue, Chicago, IL 60637, USA
[2]Center of Brain and Cognition, CBC, Universitat Pompeu Fabra, Barcelona, Spain, Roc Boronat, 138, 08018, Barcelona, Spain
[3]Institució Catalana de Recerca i Estudis Avançats (ICREA), 08010, Barcelona, Spain

*Correspondence: sayuri@uchicago.edu (S. Hayakawa).

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