Religion and cognitive control: An event-coding approach

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ABSTRACT

Religion is playing an important role in our lives, be it from a personal perspective as member of a particular congregation or as an agnostic living among believers. What impact has religion on our decision-making and action? Two kinds of impact have been considered: religious goals are likely to constrain and color our behavior, but religion may also strengthen cognitive control in a more generic sense. While evidence supports both considerations, it remains a mystery how that works, that is, which mechanisms underlie the impact of religion on our decisions and action control. Here I suggest a preliminary mechanistic model accounting for this impact. It is based on the Theory of Event Coding (TEC), a general theory of human perception, attention, and action control, and the assumptions that goals are represented in a distributed fashion (as selection criteria) and that their impact is moderated by metacontrol, the current control style that varies between persistence and flexibility. The model is parsimonious (i.e., not religion-specific) and mechanistically transparent, and thus provides a solid basis for more systematic experimentation and theorizing.

1. Introduction

Religion is playing a particularly important role in our lives, be it as member of a particular congregation or as an agnostic living among believers. About 85% of the world population reports belonging to a religious group and having religious convictions, and even atheists often share religiously motivated values with confessing individuals. Hence, religion is everywhere. One important psychological question is why that is, hence, which human needs might be met by being religious, by engaging in religious activities. The typical answer to this is meaning (cf., Hood, Hill, & Spilka, 2009; Inzlicht, Tullett, & Good, 2011): being religious provides individuals with an interpretational framework that helps them to make sense of the world, to identify rules the following of which is assumed to make the person better and presumably happier, and to find other, equally minded individuals that one understands, and among which one feels understood and accepted. Indeed, leading a religious life seems to be a rewarding, as shown in positive correlations between religiosity and well-being (e.g., Smith, McCullough, & Poll, 2003), longevity (e.g., McCullough, Hoyt, Larson, Koenig, & Thoresen, 2000), and healthy behavior (e.g., Yeager et al., 2006). Hence, religions may have aggregated rules and behavioral goals that are indeed promoting a happier life.

The question I would like to address in the following is how this works. More specifically, how does religion exert its impact on us in a mechanistic sense? Scientifically tackling this question is not easy, because engaging in religious activities is likely to create various kinds of placebo effects. Hence, people may be happier, more satisfied, and healthier simply because they believe that religion makes them happier, which in turn might promote their health, and so forth and so on. However, McCullough and Willoughby (2009) have raised a psychologically more interesting, and easier to test possibility: Religion may have a direct impact on people's cognitive-control abilities, and these abilities may be responsible for the positive outcomes. Religion might promote self-control by affecting the selection and organization of action goals, increasing self-monitoring, and improving self-regulation. Hence, it is possible that engaging in religion changes the way we perceive and act, and the way we control our perceptions and actions. Various authors have pursued this possibility and have claimed the existence of considerable empirical support for it. However, a critical examination of most of the available evidence suggests that it might be less diagnostic for the claim that religion promotes cognitive control than researchers commonly think.

Take, for instance, the review articles of McCullough and Willoughby (2009) and of McCullough and Carter (2013). The authors discuss empirical evidence that religious, as compared to non-religious, people are more likely to hold goals that are consistent with their religion, and that the degree to which they hold these goals correlates positively with their degree of religiosity; that they are more likely to show religion-consistent behavior when being reminded of religion-specific values; and that they in general tend to show behavior that is more consistent with their religious goals and values, and feel better if they do so. According to the authors, these observations provide an insight into

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the *how* of the connection between religiousness and cognitive control. But do they?

Let us briefly consider the possibility that the findings would have been different: religious people would not at all hold religion-related goals, they would not tend to show religion-consistent behavior, and they would be immune to being reminded of their religiosity. What would be our conclusion? I assume that no one would conclude from this that religion and control are unrelated. Rather, researchers would question whether the investigated participants were really religious. The reason is that the studied behaviors were not just related to religion, but they can actually be considered as constituting elements of being religious. Hence, what we mean by saying someone is religious necessarily entails the assumption that this person holds religion-specific values, behaves according to these values, and feels uncomfortable if not doing so. Accordingly, the empirical observations provide nothing but a manipulation check: they demonstrate that the investigated participants were indeed religious and thus showed behavior that is diagnostic for being so. If we assume that behavior is steered by goals, and monitored and evaluated according to its fit with these goals (Carver & Scheier, 1998), it is obvious that religious people have different goals and show different behavior than non-religious people. In other words, the assumption that being religious entails the holding of religious values and the showing of behavior consistent with the values has no empirical content but rather represents a logical necessity (Popper, 1959). The same arguably holds for empirical observations related to behavior that is directly dictated by, or at least strongly implied by the values defining people's religion, such as negative correlations between religiousness and delinquency (e.g., Baier & Wright, 2001) and positive correlations between religiousness and school performance (e.g., Jeynes, 2002): A person who steals from others and does not comply with advice from teachers is not a religious person that happens to violate the values and norms of her religion, but rather someone who demonstrably does not subscribe to these values and norms in the first place.

These considerations imply that the claim of a relationship between religion and control can only be filled with empirical content if religion can be assumed and be demonstrated to affect cognitive processes that are not constitutional for religiousness. In the following, I will argue that such a relationship between religion and non-religious thought and action is indeed possible and can indeed be empirically demonstrated. However, in order to understand why such effects should be possible at all requires a deeper insight into the mechanics of cognitive control and into how religious engagement and upbringing might affect these mechanics. Hypotheses regarding such mechanisms could then be experimentally tested outside of the religious context, which would help to circumvent ethical objections and allow researchers to overcome the limitations of correlational research. To pave the way for such an approach, I suggest a model of how (i.e., by virtue of which kind of mechanism) religion might affect cognitive control. The model is aimed to explain the impact of two factors: (1) how faith-specific (and other) goals constrain and steer behavior; and (2) how religion (as one of many cultural factors) can change and partly improve self-control in the sense of McCullough and Willoughby (2009). In developing this model, I will not assume that religion is the only way to affect cognitive control. As elaborated elsewhere (Hommel & Colzato, 2010), religious upbringing and training can be considered as one of many cultural training regimes that can impact the way we control our perception and action.

Hommel (2020) has argued that efficient psychological theorizing should be parsimonious and conservative with regard to the invention of new phenomenon-specific concepts, systems, and processes, and rather seek to account for phenomena by reconstructing them by means of basic (i.e., phenomenon-nonspecific) mechanisms (Hommel & Colzato, 2015). These mechanisms, and the cognitive infrastructure they are assumed to operate on, I shall take from the Theory of Event Coding (TEC; Hommel, Müsseler, Aschersleben, & Prinz, 2001; Hommel, 2009), the currently most comprehensive model of human perception and action planning that has recently been extended for, and applied to the

embodiment of cognition (Hommel, 2016), the cognitive representation of self and other (Hommel, 2018), and the representation of goals, needs, and values (Hommel, 2022; Hommel & Wiers, 2017), among other things. TEC has received very considerable empirical support (e.g., Frings et al., 2020; Hommel et al., 2001; Hommel & Wiers, 2017; Janczyk et al., 2023 in press; Shin, Proctor, & Capaldi, 2010), so that I shall not provide a comprehensive review of the theory and its empirical justification, but rather focus on the possible application of the theory to religious cognition.

2. Religion and goals

Religions promote particular kinds of behavior, and it is indeed this behavior that for the outside observer best characterizes religions and religious believers. This will comprise of behavior that is promoted or implied by the values that people's religious denominations propagate, require, and suggest—such as behavior reflecting the 10 Commandments in Christians. But it may also comprise of religious rituals, like praying, dancing, or chanting, as well as behaviors that do not bear a necessarily obvious or specific relationship to religion, like fasting, being kind and patient, trusting, or not paying one's taxes. All this behavior is intentional and, thus, driven by particular goals. Some goals are shared by many religions, such as the goal not to steal from and not to kill others, to lead a monogamous life, or to be humble, while other goals are rather unique. Some goals are very general, like the commandment to honor one's parents, and some are rather specific, such as not eating particular food at particular times. Some are so specific that one may rather call them rules or regulations, but I will use a goal concept that is not sensitive to these semantic issues. Religious upbringing and training can be assumed to establish these goals to a stronger or weaker degree in the individual believer and, as I have explained above, it is unsurprising and not of theoretical relevance that members of a particular denomination tend to show behavior that is consistent with this denomination's values. What is more interesting, I suggest, is the question how, and under which circumstances the acquisition of these values actually steers behavior. Hence, how can values and the goals they imply mechanistically impact human behavior?

Given that religious goals are unlikely to differ in their operational characteristics from non-religious goals, let us first discuss how more mundane goals might be driving behavior. Fig. 1 sketches how TEC accounts for goal-based behavioral control. Perceptual events and action plans are assumed to be represented by means of *event files* (Hommel, 2004), which is captured by the three larger circles shown in the middle of panel A and B. Event files are integrated networks of codes representing the perceived features of the respective event, be it an external event that a person has perceived or an action that the person has carried out. This assumption is based on ideomotor theory (Shin et al., 2010), which states that people represent actions (and other events) by sensory codes of their generated outcomes. Accordingly, the event of grasping an object, say, would be represented by the sensory feedback that the movement towards the object and the eventual contact with the object generate in the agent. Evidence in support of this assumption is available from adults, children, and even infants of about one year of age (e.g., Verschoor, Weidema, Biro, & Hommel, 2010), who all were shown to spontaneously acquire the sensory (i.e., perceivable) consequences of their movements, to associate these consequences with the movements that generated them, and to reactivate the movements when encountering the sensory consequences again on another occasion. TEC does not only provide assumptions regarding the representations of perceived and produced events, but also a principled, evidence-based account of how the hypothesized representations are acquired. Computational models have shown that the simulation of the representation-acquisition process generates a transparent cognitive infrastructure that accounts for performance in basic psychological tasks, like the Stroop task (e.g., Haazebroek, Raffone, & Hommel, 2017).

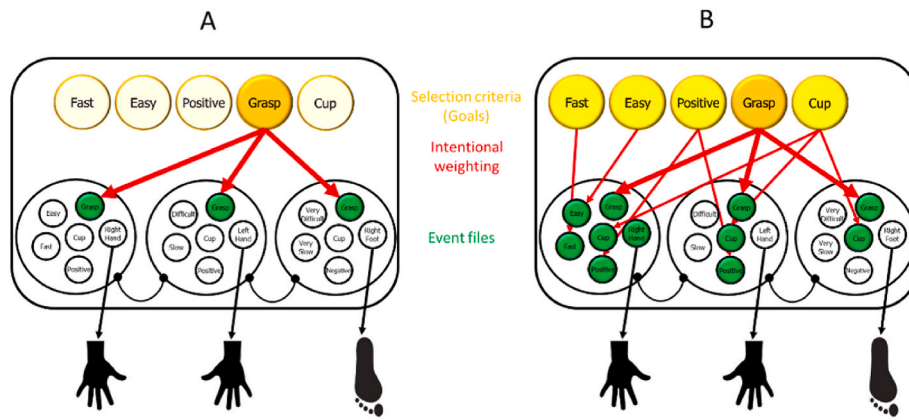In the example captured in Fig. 1 (see Hommel & Wiers, 2017), the

Fig. 1. How goals impact behavior.

person's goal is to drink a coffee by grasping a cup in front of her. The task context primes actions that on previous occasions have been carried out to grasp a cup: one grasp with the person's dominant right hand, one with her non-dominant left hand, and one with the right foot. Technically speaking, all three shown actions are suitable, so that all three event files are active and competing with each other, which is indicated by the inhibitory links between them. They have been filtered by the context (so that for instance even more artistic action possibilities are not sufficiently activated to contribute) and primed by the activated key criteria, namely, the intention to grasp (represented by the highly activated feature code Grasp, which activates all event files containing the same code). The competition shown in Panel A is unlikely to lead to any outcome, which brings additional criteria into play (Panel B)—which all may be activated by internal causes ("needs", "habits") or external stimuli (contextual cues) or both. In this example, the other criteria are that it should be a cup that is being grasped (Cup), and that actions would be preferred if they are easy to carry out (Easy), fast (Fast), and if producing that action has been led to positive outcomes (reward) in the past (Positive). While each of these criteria (if sufficiently activated) provides additional support for at least one of the competing event files, the most common solution receives the most support: the use of the dominant right hand. Accordingly, the leftmost event file is most likely to outcompete all other competitors (the winner-takes-all principle),

with the result that this event file will be controlling the behavior: the person would grasp the cup with her right hand.

Note that goals are intentionally not well defined in the TEC account. One may thus rightly argue that the criteria that are actively involved in action selection in panel B do not form one coherent goal. For instance, whether the action is fast and easy is not a necessary implication of the goal to drink coffee and grasp the cup in front of oneself. Instead, one may consider them part of another goal, such as the need to save energy, as implied by resource models (Baumeister, Bratslavsky, Muraven, & Tice, 1998), or of a chronic goal (doing things quick). Elsewhere I have argued that this approach is more realistic than the common idea that people follow only one goal at one time. Indeed, it has been argued (Atkinson & Birch, 1970) and empirically shown (e.g., Hommel, Lippelt, Gurbuz, & Pfister, 2017) that people maintain various goals concurrently, so that effective behavioral control is indeed likely to be driven by a blend of various criteria derived from various goals (Hommel, 2022; Hommel & Wiers, 2017).

Let us now turn to religious goals, which are particularly likely to coexist with many other, often more specific non-religious goals. Accordingly, religious goals are likely to shape the way believers approach and achieve other goals as well. Fig. 2A sketches a hypothetical situation in which a non-religious person wants to meet friends at the cinema, which takes a 30-min walk to get there. The person is late,
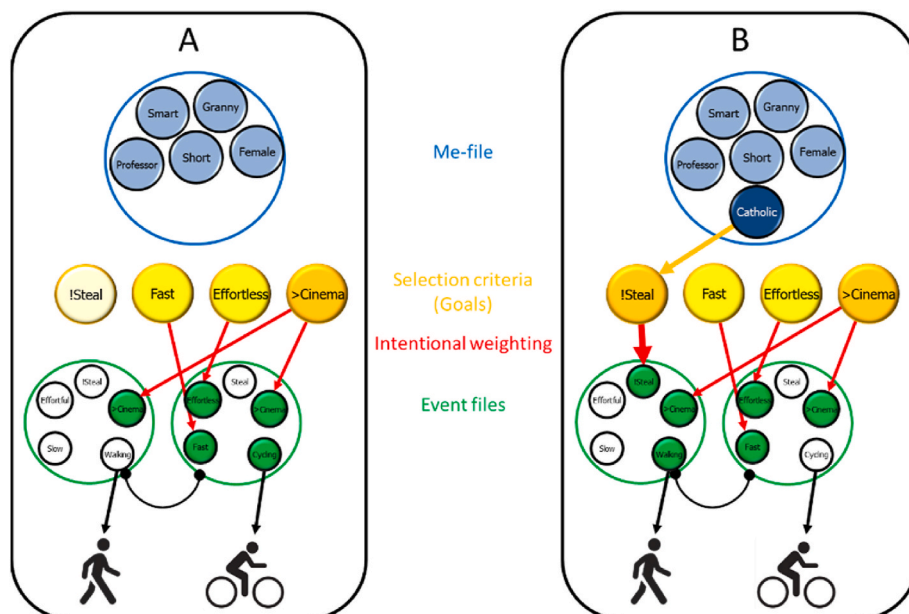

Fig. 2. How religious goals impact behavior.

and the walk is rather long, so it might be tempting to "borrow" the unlocked bike that the person finds in her street. The bike looks old and was apparently not used for some time, so chances are that no harm would be done by taking it. Using the bike would make it much more comfortable to get to the cinema, and the person would meet her friends right on time. Would she take it? The example depicts the decision-making process that in the example is controlled by three activated criteria: the intention to go to the cinema, the somewhat less relevant, perhaps chronic need to do that rather effortless, and the situational wish to do that fast. The decision is to make between two event files that would guide further action (picked from many more event files that people are likely to possess). The need to get to the cinema supports both action alternatives, in the sense that the three active criteria activate matching feature codes in both event files, which leads to some degree of activation of both files, which in turn increases the likelihood that one of them will eventually be selected overt action. However, the relative activation of the criteria is likely to change over time, which may favor one of the event files more than others. For instance, the more the criteria of getting to the cinema quick and effortless are activated (e.g., as the available time shrinks), the more the person would opt for taking the bike, even if that could be considered stealing (which, in this example, is not a relevant criterion for this person).

A new element in the figure is the *Me-file* (Hommel, 2021), shown in blue. This is shorthand for all the feature codes that the person has associated with herself, which in our case is an elderly, rather short professor with grandchildren—as indicated by the respective feature codes belonging to the Me-file (in addition to many others that are not shown here). The Me-file represents the idea of a *bundle-self*, as propagated by the British empiricist David Hume (1739), according to which a self consists of all the perceptual impressions related to oneself. Greenwald et al. (2002) have suggested that self-representation may consist of representations of one's own characteristics, irrespective of whether they can currently be perceived (which is the set of features that Hume had in mind) or whether they have been perceived often enough in the past to become integrated into the self-representation. Recently, I suggested to consider these self-representations event files that are richer and better interconnected than most other event files but that nevertheless have the same infrastructure and are acquired the same way as other event files (Hommel, 2021). Given that ingredients of Me-files are more strongly interconnected, especially to the (Humean) features representing a person here and now (such as ongoing feedback about one's body, about the impact of one's ongoing actions on the environment, etc.), the Me-file is likely to be activated to some degree almost always in an awake person. This provides ingredients of the Me-file with a particularly strong impact on behavioral choices, especially if the ingredient is also primed by other cues, such as the current situation and behavioral context.

If the person in question is agnostic, as assumed in Panel 2A, the ingredients of the Me-file have no particular bearing for the decision-making process, except perhaps that being an elderly person makes saving energy particularly salient. This is different if the person would be religious, catholic in the example described in 2B. One of the 10 Commandments that for a Catholic are essential, similarly to many other religions, is that one should not steal. The criterion not to steal is represented here as *!Steal* (meaning NOT-STEAL in programming language C notation). The real functional representation is likely to be more complex, presumably consisting of a representation of stealing, which in turn might consist of representations of the operationalization of the stealing act, associated with codes representing social disapproval and negative feelings. Identifying the internal structure of such representations is certainly interesting and important, but the condensed format will do for present purposes. Given that taking a bike one does not own must be considered at least a mild form of stealing (depending on whether the intention is to give it back later), the Catholic receives some support for taking a walk from her Me-file: the relative activations of the four activated criteria favor the walking option over the bike-taking option. Hence, given that ingredients of the Me-file are assumed to be particularly active, this support for walking would be sufficiently strong to override the also available support for taking the bike. Thus, in the end, the Catholic is more likely than the agnostic to take the walk. The scenario suggests that religious individuals are more likely to obey the law than non-religious individuals, which is indeed what the available evidence suggests (e.g., Adamczyk, Freilich, & Kim, 2017).

And yet, there is also evidence that religious people might behave more morally than others, at least if and to the degree that this behavior is consistent with their religious values and goals, on average but not necessarily under all circumstances (e.g., Galen, 2012). In other words, religious goals and values do not necessarily generalize from religious situations (such as services or other in-group gatherings) to other situations. How would TEC-based theorizing account for such observations? Situation-specific impact of representations is not restricted to religion and religion-related behavior. For instance, people have been demonstrated to be highly sensitive to the spatial location of stimuli even in tasks, where this location is rendered entirely non-informative (e.g., Simon & Rudell, 1967). However, it has also been shown that this sensitivity is bound to the (explicit or implicit) task-relevance of location for the current task, such as if the task requires a distinction between left and right keep pressing actions (e.g., Valle-Inclán & Redondo, 1998). To account for observations of this sort, TEC contains a so-called *intentional weighting* process (Memelink & Hommel, 2013) that is assumed to increase the activation of all those feature dimensions that are relevant for the present action goal. Hence, if I intend to make decisions between left and right keypressing actions, I activate the dimension of horizontal location. This will help me to distinguish between left and right keypresses, but will also make me distinguish between other events on the same dimension.

The same logic can be applied to the impact of religious goals and values on behavior. According to TEC, any goal or value affects behavior by activating particular selection criteria that, in concert with others, will promote actions that fit these criteria (by generating action outcomes satisfying them). The degree to which selection criteria are activated determines the relevance of this criterion in the selection process. Accordingly, activating the criterion of left and right renders the horizontal location of actions (and other events) more relevant, which increases the impact of the horizontal dimension on action selection. Likewise, any increase of the !Steal criterion will increase the morality of the chosen action. Religious and other values are one source of such activation, and they are particularly strong to the degree that they are ingredients of the Me-file. And yet, not all values and not all components of the Me-file are always activated to the same degree. Some are likely to be associated with particular contexts or circumstances; e.g., believers might change their behavior considerably when entering a religious place like a church or a temple, or when meeting fellow believers. Entering a church, say, is likely to activate a particular behavioral repertoire that under other circumstances will be much less dominant, such as praying, singing, and kneeling. From a TEC point of view, this would suggest that particular selection criteria have become conditioned to particular context cues that, if present, increase the impact of these criteria on behavioral selection. Accordingly, the degree to which religious people show behavior that is consistent with their religious values and goals will depend on both situational and dispositional variables, as has been reported by Darley and Batson (1973) in their classical good Samaritan study. In theory, the dynamic changes of the impact of religious values and goals will depend on the relative activation of criteria with religious content, where some criteria might be consistently activated to a certain degree (e.g., because they are an integral part of the chronically active Me-file), while the activation of other criteria might vary with the context to which they have become conditioned.

3. Religion and cognitive control

The previous section dealt with the question how particular religion-specific goals affect human decision-making and action control. True, the empirical demonstration that people who learn that they should not steal are stealing less is neither surprising nor overly informative regarding the cognitive consequences of religious upbringing and training. However, the claim of McCullough and Willoughby (2009) about the relationship between religiousness and cognitive control went beyond specific goals. In addition to such direct impact of specific goals, McCullough and Willoughby consider that religious individuals might exert cognitive control in different ways than non-religious individuals do. More concretely, believers might possess a stronger self-control and more active or more efficient self-monitoring processes subserving this self-control. The evidence discussed by McCullough and Willoughby is not very strong and rather inconsistent, as the authors admit in various places. For instance, the predicted relationship between religiousness and private self-consciousness was found in only one out of four samples, and the evidence supporting the proposed ways to build self-regulatory strength is considered to be "currently quite thin" (McCullough & Willoughby, p. 82). While this might be a reason to be skeptical about the claim that religiousness and cognitive control are related, there are both theoretical and empirical reasons to suggest that McCullough and Willoughby's assessment of the available evidence might be too pessimistic.

The theoretical reasons are twofold. First, McCullough and Willoughby seem to assume that self-control and self-monitoring rely on conscious processes or, more precisely, on a critical role of consciousness in regulatory processes. This is obvious from their assumption that cognitive control should relate to self-consciousness, that is, to conscious representations of one's actions and their consequences, and of the relationship between these consequences and one's goals and values. However, there is no reason why consciousness should play any role in control and monitoring. For one, there is no unequivocal empirical evidence that consciousness plays any crucial role in action planning and cognitive control (Hommel, 2007, 2013). For another, there is strong evidence that control processes and especially action-control operations take place within a few hundred milliseconds (e.g., Botvinick, Braver, Barch, Carter, & Cohen, 2001), whereas conscious representations are known to take 500 ms or longer to emerge (e.g., Dehaene, Changeux, Naccache, Sackur, & Sergent, 2006; Libet, 2004). This suggests that conscious representations would commonly be too slow to actually influence action control in many everyday actions. This does not necessarily preclude the possibility that the *outcomes* of control processes are often consciously represented. For instance, Wegner (2003) has suggested that unconscious action decisions do not only drive the motor system but also keep consciousness informed about what is going to happen, which creates the personal illusion that it is the conscious representation that was actually driving the action. According to this view, conscious representations of one's action and possible interindividual differences therein may well reflect interindividual differences in cognitive control and monitoring, but the lack of such differences regarding the conscious representations do not necessarily provide evidence for a lack of differences in the underlying unconscious processes.

A second theoretical reason to consider McCullough and Willoughby's assessment of the evidence of a relationship between religiousness and cognitive control as too negative relates to their conception of cognitive control. It is customary to view cognitive control as willpower, that is, as the degree to which a person can stick to one goal, overcome obstacles, and eventually realize the intended action—not unlike the characteristics of videogame hero Super Mario. However, there is increasing evidence that this is a rather biased interpretation of cognitive control that considers only one half of the theoretical coin (Hommel & Wiers, 2017). Truly adaptive action control does require willpower, sticking to one's goal, keeping tight focus, and avoiding distraction under some circumstances, but it also demands giving up, considering alternatives, and switching to other options under other circumstances. Adaptive action control therefore calls for finding the right balance between *persistence* and goal stability on the one hand and *flexibility* on the other (Cools, 2008; Durstewitz & Seamans, 2008; Goschke, 2003), an ability that I have called metacontrol (Hommel, 2015; Hommel & Colzato, 2017a). If so, considering only the impact of religion on persistence, as in McCullough and Willoughby's (2009) article, neglects the possible impact of religion on flexibility, which is the other side of the theoretical coin. Such an impact is particularly plausible in the case of Buddhism, the ultimate aim of which is letting go of desires and attachments. An important means to achieve this is the elimination of selectivity in attention and consciousness, so that the individual can reach a more integrated view and understanding of the world (e.g., Santucci, 1979). Given that the mechanistic cause and driving force of selective processing is goals, which tailor the information uptake according to their informational needs (Hommel, 2022), the letting go of desires and attachments can be assumed to require the letting go of persistence on current goals. Indeed, Buddhist meditation aims at becoming open to anything that pops up in one's mind—universal flexibility that is.

Considering that some religions might foster persistence while others might promote flexibility leads to a different view on the relationship between religiousness and cognitive control, and in particular to a differential view that takes the specific denomination into account. Max Weber (1958/2003) was probably the first to emphasize the strong individualistic nature of Protestantism as compared to the collectivist ambitions of Catholicism, and the possible impact of these denominations on the individual lifestyle and motivational structure. To assess the psychological validity and the possible implications of this approach, colleagues and I began to systematically compare various kinds of practicing Protestants (mostly neo-Calvinists), practicing believers of more collectivistic denominations, such as Catholics, Orthodox Jews, and Buddhists, and atheists matched for nationality and various other socioeconomic variables (for a summary, see Hommel & Colzato, 2017a). The outcomes were very systematic: As compared to matched atheists, Protestants excelled in processing the details of complex visual stimuli (Colzato, van den Wildenberg, & Hommel, 2008; Colzato, van Beest, et al., 2010), while Catholics (Colzato, van Beest, et al., 2010), Orthodox Jews (Colzato, van Beest, et al., 2010), and Buddhists (Colzato, Hommel, van den Wildenberg, & Hsieh, 2010) showed better performance in processing the global features. For instance, while most people can respond faster and more accurately to global stimuli (e.g., the global shape of a symbol that is made of smaller symbols) than to local stimuli (the smaller symbols making up the global one; Navon, 1977), this difference in performance is less pronounced in Protestants than it is in Catholics (Colzato, van Beest, et al., 2010).

Along the same lines, Protestants were better, and Catholics worse than atheists in ignoring task-irrelevant information (Hommel, Colzato, Scorolli, Borghi, & van den Wildenberg, 2011), while Protestants were worse than atheists in integrating sequentially presented stimuli (Colzato, Hommel & Shapiro, 2010b). More specifically, Protestants are less distracted than Catholics by task-irrelevant spatial information in a Simon task (Hommel et al., 2011), but more likely than Catholics to overlook the second of two targets that appear in brief succession (Colzato, Hommel, & Shapiro, 2010). Most directly related to Weber's (1958/2003) claim of a strong connection between the capitalist spirit and Protestantism, Protestants were more willing, and Catholics were less willing to wait for a larger reward than atheists in a temporal discounting task (Paglieri, Borghi, Colzato, Hommel, & Scorolli, 2013). Most directly related to the individualistic versus collectivist nature of religions, Buddhists showed a stronger tendency to include other individuals into their self-representation in a joint-Simon task (Colzato et al., 2012). Related to these findings, meditation techniques representing the core of Buddhist training have shown to affect similar cognitive tasks. More specifically, so-called focused attention meditation techniques were found to promote concentration and focusing on

task details, presumably by increasing the functional connectivity between attention-related neural networks, conflict detection and resolution, presumably by enhancing the functioning of the anterior cingulate cortex, while so-called open monitoring meditation was found to improve divergent, but not convergent thinking (for a review, see Lippelt, Hommel, & Colzato, 2014).

Taken altogether, these observations suggest that individualistic religions are associated with particularly good performance in tasks that require focusing, concentration, detail, and overcoming distractions and internal conflict, similarly to meditation techniques that emphasize the focusing of attention, whereas collectivistic religions are associated with excellent performance in tasks that require integration, consideration of context, and mental flexibility, similarly to meditation techniques that emphasize openness (Hommel & Colzato, 2017b). These findings are consistent with McCullough and Willoughby's (2009) claim of a strong connection between religion and cognitive control but provide much more diagnostic evidence than the findings that these authors have considered: As the stimuli and tasks being investigated were entirely unrelated to religion, the obtained findings are the first to demonstrate a transfer from religiousness to non-religious information processing. Moreover, the findings on Protestants, Catholics, Jews, and Buddhists demonstrate that different denominations can affect cognitive control in opposite ways, suggesting that it is not religiousness per se that affects control. Rather, different denominations are associated with different control styles (that seem to differ on a dimension ranging from extreme persistence to extreme flexibility), and there are reasons to assume that the degree of individualism and collectivism associated with the particular denomination is the critical factor. How might that work? How would denomination-specific metacontrol modes fit with the mechanistic model developed above?

Colleagues and I (Hommel, 2015; Hommel & Colzato, 2017a; Hommel & Wiers, 2017) have argued that metacontrol modes express themselves by modifying cognitive information processing in three ways. First, while goal-directed action always requires some degree of top-down impact of selection criteria on event-file selection, variability ranging from persistence to flexibility presupposes that the strength of this control can vary. More specifically, strong persistence should be associated with a strong impact of selection criteria on the selection process, as indicated by the thick red downward arrows in Fig. 3A, while strong flexibility should be associated with a weaker impact, as indicated by the thin red arrows in Fig. 3B. Second, while the competitive

nature of selection can be considered a guiding principle of neural communication and decision-making (Bogacz, 2007), the degree of competitiveness between alternative representations might vary. Hence, persistence might be associated with strong competition between event files (Fig. 3A) and flexibility with weak competition (Fig. 3B). Third, preparing for a task induces intentional weighting (Memelink & Hommel, 2013) that increases the activation of task-relevant selection criteria, which in turn increases their weight in the selection process. Given the stronger focus and greater selectivity associated with persistence, the difference between the activation of task-relevant and task-irrelevant selection criteria can be assumed to be more pronounced in the persistence mode (3A) than in the flexibility mode (3B). Given that performance in Protestants shows clear signs of stronger persistence (greater selectivity, stronger focus on task, less distraction), it makes sense to assume that (all other things equal) information processing in Protestants is more strongly guided by the task-specific selection criteria and more competitive, leading to a highly selective, exclusive processing style of persistence (3A). Performance in Catholics, Orthodox Jews, and Buddhists shows more indication of flexibility (lesser selectivity, more openness to task-irrelevant stimuli), at least as compared to Protestants and atheists, suggesting that information processing in members of these groups is less strongly guided by the task-specific selection criteria and less competitive, thus giving higher chances to alternative options to take over action control (3B).

Applied to the walking versus bike-taking example, this difference could be sketched as shown in Fig. 3, which aims at characterizing the hypothetical cognitive processing in a Protestant (3A) and a Catholic (3B). The assumption is that both consider stealing as bad and both would really like to go to the cinema. For these religious individuals, *! Steal* and *>Cinema* represent the task (obviously neglecting many other features that are likely to be involved), so that the corresponding selection criteria are highly, and equally highly activated. Both individuals are assumed to have other goals and needs, like the intention to act socially (represented by the Me-file ingredient *Social*). In the example, the individual would be late and likely to be missing her friends if walking, so that the Social code would support all event files affording *Fast* actions. While that would be true for both individuals, the stronger, exclusive focus on the task-relevant selection criteria, to which the speed of the action does not strictly belong, would lead to a lesser activation of the *Fast* criterion in the Protestant, while this criterion might be more strongly activated in the Catholic. If so, given the stronger exclusivity of
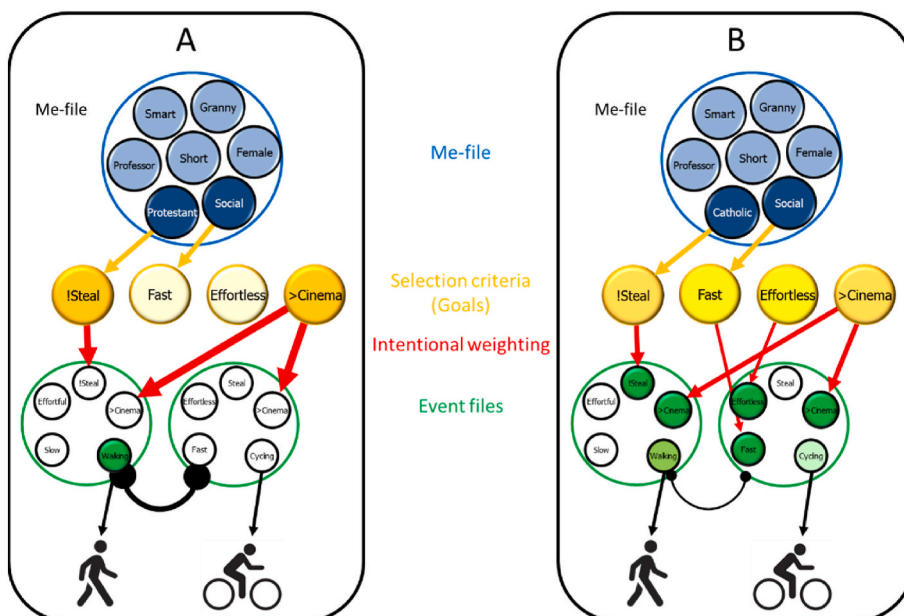

Fig. 3. How metacontrol moderates cognitive control. Panel A shows the impact of a strong bias towards metacontrol persistence, which leads to a stronger impact of criteria on selection (see red arrows) and stronger competition between event files (see black inhibitory link). Panel B shows the impact of a strong bias towards metacontrol flexibility, which leads to a weaker impact of criteria on selection and weaker competition between event files. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

the persistence mode in the Protestant, the Protestant would be faster and more likely to choose walking. The Catholic might have a harder time deciding and may still face some temptation to take the bike, but not because of a lesser impact of religious values but rather due to a comparatively stronger consideration of other values.

The same theoretical logic can be applied to the other available findings: stronger focus on task-relevant information and stronger ignorance of task-irrelevant information would make the Protestant, and more generally speaking everyone sharing the same persistence-biased metacontrol mode, an excellent performer in tasks that benefit from this strong exclusive focus, like conflict tasks (e.g., the Stroop task) and in tasks that require the discounting of task-irrelevant information in decision-making (like the delay-discounting task), but a bad performer in tasks requiring information integration over time or tasks that benefit from the processing of task-irrelevant context. The more collectivistically oriented believer, be it a Catholic, Orthodox Jew, or Buddhist, would rather be expected to excel in task requiring information integration and the consideration of context, but perform more poorly in tasks that benefit from ignoring nominally irrelevant information.

Note that this model is not only the first mechanistic model of the connection between religiousness and cognitive control, but it also has four key advantages. First, it is very parsimonious in taking all ingredients from TEC, a generic model of human perception and action, which keeps the theoretical overhead minimal. No new concepts or processes were invented, the model was only applied to religion-specific issues and problems. Second, the model is agnostic with respect to the direction of causality. On the one hand, it is possible that religious upbringing and training establishes particular control styles, which would render culture a causal factor. On the other hand, however, it could also be that individuals who are equipped with a particular control style are attracted by some religions more than by others, which would point to genetic predisposition and/or early environmental impact as the causal agent. Indeed, Hommel and Colzato (2017a) did not only identify cultural practices that are associated with particular control styles but also particular genetic predispositions, especially with regard to genes that affect dopaminergic neuromodulation. The model proposed here does not distinguish between nature and nurture. Hence, it could be that the metacontrol biases towards persistence or flexibility are due to particular genetic polymorphisms or combinations thereof, but it may also be that growing up in a particular culture or subculture provide selective reward for behavior that calls for a more persistent or a more flexible metacontrol style. Both effects would be fully accounted for by the model. Third, the model does not only allow for a mechanistic understanding of group differences, but it also allows to capture interindividual variability within groups (e.g., Protestants) and intraindividual variability. For instance, given that the model allows for contextual priming of selection criteria, it can easily account for the observation that reminding individuals of religious values biases action control towards the selection of behavior compatible with these values (e.g., Laurin, Kay, & Fitzsimons, 2012). Fourth, the model explains why religion affects behavioral choices not all the time and not always in the same way. Situational context interacts with individual goals and values to determine the current activation of selection criteria, which in turn affects the degree to which religious goals and values are coloring ongoing selection processes.

4. Outlook

The psychology of religion is relatively rich in findings but lacking mechanistic theorizing, so that our knowledge about what religion does is not in balance with our insight into how it does it. My present contribution aims to provide a point of departure for more mechanistic theorizing, which in turn can be taken to generate less descriptive, more experimental, analytical research into religion and its connection to, and possible impact on human decision-making and behavior. The proposed model is absolutely non-specific with respect to religion, which may be disappointing to many readers. However, I consider this feature a strength, because I see no reason why religion should operate on the human mind in fundamentally different ways than other cultural factors. Nevertheless, many gaps remain.

For instance, it is essential to generate a more principled approach to the question which religion promotes or reflects what kind of metacontrol style, and which characteristics of the religious training are essential for the linkage between religion and metacontrol. It is also an open question whether there are systematic genetic predispositions that make particular religions more attractive to some individuals, and whether these predispositions are associated with metacontrol processes. For instance, McNamara (2009) has considered that a strong degree of religiousness often comes with a certain lack of agency: God or other spiritual powers are held responsible for quite a bit of what less religious individuals would rather attribute to themselves. Accordingly, McNamara speculates that this lack of agency might be associated with a less efficient functioning of brain structures that underlie the experience of agency, such as the frontal lobe, and of neurotransmitters fueling these structures, like prefrontal dopamine. If so, individuals with genetic predispositions responsible for this lesser efficiency might be more likely to engage in religious or otherwise spiritual activities that attribute agency to higher powers. Given that genetic predispositions towards lower versus higher functioning of prefrontal and striatal dopaminergic pathways are also suspected to induce biases towards metacontrol persistence or flexibility (for an overview, see Hommel & Colzato, 2010), it is possible that genetic predispositions towards stronger or weaker experiences of personal agency are associated with respective biases towards metacontrol persistence or flexibility. Moreover, given that denominations differ with respect to the degree to which they attribute agency to higher powers (e.g., Catholicism versus Protestantism; Weber, 1958/2003), genetic predispositions with respect to dopaminergic functioning might play a role in the preference of particular denominations.

Another interesting open question is whether particular characteristics of religious training are sufficient to induce particular metacontrol styles, irrespective of any predisposition or personality factor. It would also be important to extend studies to other religions, Islam and Hinduism in particular. Finally, various aspects of TEC have been linked to particular neural mechanisms, which opens the door for a systematic, mechanistically informed neuroscience of religion—a fascinating prospective that relates to McNamara's (2009) interest in the neural underpinnings of religious experience. In any case, my hope is that more mechanistic theorizing translates into more systematic and more inventive experimentation, which in turn should increase our insight into how religion works.

Data availability

No data was used for the research described in the article.

References

Adamczyk, A., Freilich, J. D., & Kim, C. (2017). Religion and crime: A systematic review and assessment of next steps. *Sociology of Religion, 78*, 192–232.

Atkinson, J. W., & Birch, D. (1970). *The dynamics of action*. New York: John Wiley.

Baier, C., & Wright, B. R. E. (2001). If you love me, keep my commandments: A meta-analysis of the effect of religion on crime. *Journal of Research in Crime and Delinquency, 38*, 3–21.

Baumeister, R. F., Bratslavsky, E., Muraven, M., & Tice, D. M. (1998). Ego depletion: Is the active self a limited resource? *Journal of Personality and Social Psychology, 74*, 1252–1265.

Bogacz, R. (2007). Optimal decision-making theories: Linking neurobiology with behavior. *Trends in Cognitive Sciences, 11*, 118–125.

Botvinick, M. M., Braver, T. S., Barch, D. M., Carter, C. S., & Cohen, J. D. (2001). Conflict monitoring and cognitive control. *Psychological Review, 108*, 624–652.

Colzato, L. S., Hommel, B., & Shapiro, K. (2010). Religion and the Attentional Blink: Depth of faith predicts depth of the blink. *Frontiers in Psychology, 1*, 147.

Colzato, L. S., Hommel, B., van den Wildenberg, W., & Hsieh, S. (2010). Buddha as an eye opener: A link between prosocial attitude and attentional control. *Frontiers in Psychology, 1*, 156.

Colzato, L. S., van Beest, I., van den Wildenberg, W. P. M., Scorolli, C., Dorchin, S., Meiran, N., et al. (2010). God: Do I have your attention? *Cognition, 117*, 87–94.

Colzato, L. S., van den Wildenberg, W. P. M., & Hommel, B. (2008). Losing the big picture: How religion may control visual attention. *PLoS One.* http://dx.plos.org/10.1371/journal.pone.0003679.

Colzato, L. S., Zech, H., Hommel, B., Verdonschot, R., van den Wildenberg, W., & Hsieh, S. (2012). Loving-kindness brings loving-kindness: The impact of Buddhism on cognitive self-other integration. *Psychonomic Bulletin & Review, 19*, 541–545.

Cools, R. (2008). Role of dopamine in the motivational and cognitive control of behaviour. *The Neuroscientist, 14*, 381–395.

Darley, J. M., & Batson, C. D. (1973). From Jerusalem to Jericho": A study of situational and dispositional variables in helping behavior. *Journal of Personality and Social Psychology, 27*, 100–108.

Dehaene, S., Changeux, J.-P., Naccache, L., Sackur, J., & Sergent, C. (2006). Conscious, preconscious, and subliminal processing: A testable taxonomy. *Trends in Cognitive Sciences, 10*, 204–211.

Durstewitz, D., & Seamans, J. K. (2008). The dual-state theory of prefrontal cortex dopamine function with relevance to catechol-o-methyltransferase genotypes and schizophrenia. *Biological Psychiatry, 64*, 739–749.

Frings, C., Hommel, B., Koch, I., Rothermund, K., Dignath, D., Giesen, C., et al. (2020). Binding and retrieval in action control (BRAC). *Trends in Cognitive Sciences, 24*, 375–387.

Galen, L. W. (2012). Does religious belief promote prosociality? A critical examination. *Psychological Bulletin, 138*, 876–906.

Goschke, T. (2003). Voluntary action and cognitive control from a cognitive neuroscience perspective. In S. Maasen, W. Prinz, G. Roth, & Hrsg (Eds.), *Voluntary action: Brains, minds, and sociality* (pp. 49–85). Oxford: Oxford University Press.

Greenwald, A. G., Banaji, M. R., Rudman, L. A., Farnham, S. D., Nosek, B. A., & Mellott, D. S. (2002). A unified theory of implicit attitudes, stereotypes, self-esteem, and self-concept. *Psychological Review, 109*, 3–25.

Haazebroek, P., Raffone, A., & Hommel, B. (2017). HiTEC: A connectionist model of the interaction between perception and action planning. *Psychological Research, 81*, 1085–1109.

Hommel, B. (2004). Event files: Feature binding in and across perception and action. *Trends in Cognitive Sciences, 8*, 494–500.

Hommel, B. (2007). Consciousness and control: Not identical twins. *Journal of Consciousness Studies, 14*, 155–176.

Hommel, B. (2009). Action control according to TEC (theory of event coding). *Psychological Research, 73*, 512–526.

Hommel, B. (2013). Dancing in the dark: No role for consciousness in action control. *Frontiers in Psychology, 4*, 380.

Hommel, B. (2015). Between persistence and flexibility: The Yin and Yang of action control. In A. J. Elliot (Ed.), *Advances in motivation science* (Vol. 2, pp. 33–67). New York: Elsevier.

Hommel, B. (2016). Embodied cognition according to TEC. In Y. Coello, & M. Fischer (Eds.), *Foundations of embodied cognition, Volume 1: Perceptual and emotional embodiment* (pp. 75–92). New York: Psychology Press.

Hommel, B. (2018). Representing oneself and others: An event-coding approach. *Experimental Psychology, 65*, 323–331.

Hommel, B. (2020). Pseudo-mechanistic explanations in psychology and cognitive neuroscience. *Topics in Cognitive Science, 12*, 1294–1305.

Hommel, B. (2021). The Me-file: An event-coding approach to self-representation. *Frontiers in Psychology, 10*, 3389.

Hommel, B. (2022). Goaliath: A theory of goal-directed action. *Psychological Research, 86*, 1054–1077.

Hommel, B., & Colzato, L. S. (2010). Religion as a control guide: On the impact of religion on cognition. *Zygon: Journal of Religion & Science, 45*, 596–604.

Hommel, B., & Colzato, L. S. (2015). Learning from history: The need for a synthetic approach to human cognition. *Frontiers in Psychology, 6*, 1435.

Hommel, B., & Colzato, L. S. (2017a). The social transmission of metacontrol policies: Mechanisms underlying the interpersonal transfer of persistence and flexibility. *Neuroscience & Biobehavioral Reviews, 81*, 43–58.

Hommel, B., & Colzato, L. S. (2017b). Meditation and metacontrol. *Journal of Cognitive Enhancement, 1*, 115–121.

Hommel, B., Colzato, L. S., Scorolli, C., Borghi, A. M., & van den Wildenberg, W. P. M. (2011). Religion and action control: Faith-specific modulation of the Simon effect but not stop-signal performance. *Cognition, 120*, 177–185.

Hommel, B., Lippelt, D. P., Gurbuz, E., & Pfister, R. (2017). Contributions of expected sensory and affective action effects to action selection and performance: Evidence from forced- and free-choice tasks. *Psychonomic Bulletin & Review, 24*, 821–827.

Hommel, B., Müsseler, J., Aschersleben, G., & Prinz, W. (2001). The theory of event coding (TEC): A framework for perception and action planning. *Behavioral and Brain Sciences, 24*, 849–878.

Hommel, B., & Wiers, R. W. (2017). Towards a unitary approach to human action control. *Trends in Cognitive Sciences, 21*, 940–949.

Hood, R. W., Hill, P. C., & Spilka, B. (2009). *The psychology of religion*. New York: Guilford Press.

Hume, D. (1739). A treatise of human nature. Retrieved from https://librivox.org/treatise-of-human-nature-vol-1-by-david-hume.

Inzlicht, M., Tullett, A. M., & Good, M. (2011). The need to believe: A neuroscience account of religion as a motivated process. *Religion, Brain & Behavior, 1*, 192–212.

Janczyk, M., Giesen, C. G., Moeller, B., Dignath, D., & Pfister, R. (2023). Perception and action as viewed from the theory of event coding: A multi-lab replication and effect size estimation of common experimental designs (in press) *Psychological Research*.

Jeynes, W. H. (2002). A meta-analysis of the effects of attending religious schools and religiosity on Black and Hispanic academic achievement. *Education and Urban Society, 35*, 27–49.

Laurin, K., Kay, A. C., & Fitzsimons, G. M. (2012). Divergent effects of activating thoughts of God on self-regulation. *Journal of Personality and Social Psychology, 102*, 4–21.

Libet, B. (2004). *Mind time: The temporal Factor in consciousness*. Cambridge, MA: Harvard University Press.

Lippelt, D. P., Hommel, B., & Colzato, L. S. (2014). Focused attention, open monitoring and loving kindness meditation: Effects on attention, conflict monitoring and creativity. *Frontiers in Psychology, 5*, 1083.

McCullough, M. E., & Carter, E. C. (2013). Religion, self-control, and self-regulation: How and why are they related? In K. I. Pargament, J. J. Exline, & J. W. Jones (Eds.), *Context, theory, and research: (Vol. 1):. APA handbook of psychology, religion, and spirituality* (pp. 123–138). American Psychological Association.

McCullough, M. E., Hoyt, W. T., Larson, D. B., Koenig, H. G., & Thoresen, C. E. (2000). Religious involvement and mortality: A meta-analytic review. *Health Psychology, 19*, 211–222.

McCullough, M. E., & Willoughby, B. L. B. (2009). Religion, self-control, and self-regulation: Associations, explanations, and implications. *Psychological Bulletin, 135*, 69–93.

McNamara, R. (2009). *The Neuroscience of Religious Experience*. New York: Cambridge University Press.

Memelink, J., & Hommel, B. (2013). Intentional weighting: A basic principle in cognitive control. *Psychological Research, 77*, 249–259.

Navon, D. (1977). Forest before trees: The precedence of global features in visual perception. *Cognitive Psychology, 9*, 353–383.

Paglieri, F., Borghi, A. M., Colzato, L. S., Hommel, B., & Scorolli, C. (2013). Heaven can wait: How religion modulates temporal discounting. *Psychological Research, 77*, 738–747.

Popper, K. (1959). *The logic of scientific discovery*. London: Routledge.

Santucci, J. A. (1979). Transpersonal psychological observations on Theravada Buddhist meditative practices. *Journal of the International Association of Buddhist Studies, 2/2*, 66–78.

Shin, Y. K., Proctor, R. W., & Capaldi, E. J. (2010). A review of contemporary ideomotor theory. *Psychological Bulletin, 136*, 943–974.

Simon, J. R., & Rudell, A. P. (1967). Auditory S-R compatibility: The effect of an irrelevant cue on information processing. *Journal of Applied Psychology, 51*, 300–304.

Smith, T. B., McCullough, M. E., & Poll, J. (2003). Religiousness and depression: Evidence for a main effect and the moderating influence of stressful life events. *Psychological Bulletin, 129*, 614–636.

Valle-Inclán, F., & Redondo, M. (1998). On the automaticity of ipsilateral response activation in the Simon effect. *Psychophysiology, 35*, 366–371.

Verschoor, S. A., Weidema, M., Biro, S., & Hommel, B. (2010). Where do action goals come from? Evidence for spontaneous action-effect binding in infants. *Frontiers in Psychology, 1*, 201.

Weber, M. (1958/2003). *The Protestant ethic and the spirit of capitalism*. Mineola, NY: Dover Publications.

Wegner, D. M. (2003). The mind's best trick: How we experience conscious will. *Trends in Cognitive Sciences, 7*, 65–69.

Yeager, D. M., Glei, D. A., Au, M., Lin, H., Sloan, R. P., & Weinstein, M. (2006). Religious involvement and health outcomes among older persons in Taiwan. *Social Science & Medicine, 63*, 2228–2241.