Cognition 210 (2021) 104609

Contents lists available at ScienceDirect

Cognition

journal homepage: www.elsevier.com/locate/cognit

Culture moderates the relationship between self-control ability and free will beliefs in childhood

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ARTICLE INFO

Keywords:
Cognitive development
Self-control
Free will
Theory of mind
Cultural differences
Agency
Inhibitory contro

ABSTRACT

We investigate individual, developmental, and cultural differences in self-control in relation to children's changing belief in "free will" – the possibility of acting against and inhibiting strong desires. In three studies, 4- to 8-year-olds in the U.S., China, Singapore, and Peru ($N = 441$) answered questions to gauge their belief in free will and completed a series of self-control and inhibitory control tasks. Children across all four cultures showed predictable age-related improvements in self-control, as well as changes in their free will beliefs. Cultural context played a role in the timing of these emerging free will beliefs: Singaporean and Peruvian children's beliefs changed at later ages than Chinese and U.S. children. Critically, culture moderated the link between self-control abilities and free will beliefs: Individual differences in self-control behaviors were linked to individual differences in free will beliefs in U.S. children, but not in children from China, Singapore or Peru. There was also evidence of a causal influence of self-control performance on free will beliefs in our U.S. sample. In Study 2, a randomly assigned group of U.S. 4- and 5-year-olds who failed at two self-control tasks showed reduced belief in free will, but a group of children who completed free will questions first did not show changes to self-control. Together these results suggest that culturally-acquired causal-explanatory frameworks for action, along with observations of one's own abilities, might influence children's emerging understanding of free will.

1. Introduction

The ability to control one's impulses and desires is critical to personal and social success. Young children with better self-control abilities tend to have higher math and literacy scores in kindergarten and elementary school (Blair & Razza, 2007; Bull & Scerif, 2001; McClelland, Morrison, & Holmes, 2000), have better social functioning and fewer problem behaviors in elementary middle school (Eisenberg et al., 2001; Eisenberg, Fabes, & Murphy, 1996), have higher educational achievement and better emotional coping skills in adolescence (Mischel, Shoda, & Rodriguez, 1989; Mischel, Shoda, & Peake, 1988; Shoda, Mischel, & Peake, 1990), better financial outcomes, less criminality and better health in adulthood (Moffitt et al., 2011; Ayduk et al., 2000). It is unsurprising, then, that so much psychological research is devoted to understanding how self-control works and how we can work to improve it.

Developmental research can shed light on these questions. Self-control abilities originate in childhood as stable and early-emerging individual differences (Kochanska & Knaack, 2003; Mischel, 2014; Mischel & Ebbesen, 1970; Rothbart, Sheese, & Posner, 2007) but also improve over time as part of developing executive functioning (e.g. Carlson & Moses, 2001; Diamond & Lee, 2011). These studies suggest developmental origins of stable individual differences in "trait" self-control (Ent, Baumeister, & Tice, 2015). But not all of the variability in self-control is accounted for by individual traits or age. In fact, beginning in childhood, our understanding of both our own minds and the external world plays an important role in facilitating self-control. For example, in laboratory studies, children can improve self-control by being taught various cognitive techniques such as distraction, reframing, pretending, psychological distancing, or changing their self-beliefs (Haimovitz, Dweck, & Walton, 2019; Lee & Atance, 2016; Mischel & Ebbesen, 1970; Mischel, 2014; White & Carlson, 2016; White et al.,

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https://doi.org/10.1016/j.cognition.2021.104609
Received 13 April 2020; Received in revised form 17 January 2021; Accepted 18 January 2021
Available online 31 January 2021

2017).

These cognitive influences on self-control raise questions about whether young children are already forming enduring beliefs they can draw on to manage difficult situations as they arise in daily life. Indeed, research has uncovered such enduring beliefs in adolescents and adults and shows that they do play a role in self-regulation. This includes belief in willpower, self-efficacy, agency, self-determination, "grit", and growth mindset, among others (Baumeister & Monroe, 2014; Duckworth, Peterson, Matthews, & Kelly, 2007; Dweck, 2000; Eccles & Wigfield, 2002; Iyengar & DeVoe, 2003; Job, Dweck, & Walton, 2010; Miller, Das, & Chakravarthy, 2011; Ryan & Deci, 2000; Vohs & Schooler, 2008). But to date little is known about the origins of these beliefs in early childhood, or the time course of their development before adolescence. This study aims to address that gap by exploring one relevant belief – the belief in free will – how it develops in early childhood, and how it relates to self-control.

Our theory of mind, namely the understanding of beliefs, desires and other mental states as causes of action (Wellman, 1990), may give rise to our earliest beliefs relevant to the practice of self-control. Early in development, infants and toddlers understand that subjective desires cause actions, and thus that one can infer a person's desires from their actions, especially in situations where the person could have acted otherwise (Kushnir, Xu, & Wellman, 2010; Repacholi & Gopnik, 1997; Wellman & Woolley, 1990). A more complex understanding of the relation between desire and action comes later, as children begin to appreciate the many constraints on actions both internal and external. For one thing, by the preschool years, children across cultures understand that beliefs, in addition to desires, guide and constrain actions, and that people can hold false beliefs (see Wellman & Liu, 2004 for review).

By the preschool years, children's theory of mind includes understanding some of the possibilities and limitations of free will. In particular, they understand that agents are free to "choose to" do otherwise when there are no external constraints. For example, 4-year-old children in the US, Singapore, Nepal, and China say that if they want to, they can freely choose among possible alternative actions (other toys to play with, other foods to eat), but that no matter how much they want to, they cannot choose to violate physical laws (floating in the air, running faster than a train) (Chernyak, Kang, & Kushnir, 2019; Chernyak, Kushnir, Sullivan, & Wang, 2013; Kushnir, Gopnik, Chernyak, Seiver, & Wellman, 2015; Lane, Ronfard, Francioli, & Harris, 2016; Nichols, 2004; Shtulman & Carey, 2007; Wente et al., 2016). In addition, 4-year-olds across cultures say that they cannot choose to act against social and moral norms (i.e. cannot choose to harm others, act unfairly, or violate rules), even if they want to (Chernyak et al., 2013, 2019; Shtulman & Phillips, 2018).

What about the belief that we can, if we choose, inhibit actions – a belief that is most directly relevant to self-control? Four-year-old children in the U.S. generally say that if a person "really wants" to do something – play a fun game, for example – she *has* to do it (cannot choose *not* to do it). Similarly, 4-year-olds say if someone "really *doesn't* want" to do something – e.g. look in a scary closet – they cannot choose to do it. (Kushnir et al., 2015; Wente et al., 2016). Six-year-olds and older children in the U.S. are more optimistic about their own and others' ability to perform undesirable actions and to inhibit desirable ones – they have a conception more like the classic Western notion of absolute free will. The time course of these developments in free will beliefs may differ across cultures; Wente and colleagues found that a sample of children in China appear to develop free will beliefs later than a similar-age sample of children in the U.S. (Wente et al., 2016).

This change in children's beliefs about free will occurs roughly at the same time we see improvements in cognitive, emotional, and social self-regulation and executive functioning (Davidson, Amso, Anderson, & Diamond, 2006; Diamond & Taylor, 1996; Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996; Zelazo & Carlson, 2012). This supports the possibility that children's beliefs about free will are causally related to their first-person experience of practicing self-control. In one direction, successfully practicing self-control could cause children to believe that people (others, as well as themselves) can choose to act against and inhibit desires. In the other direction, believing that they can exercise free will may facilitate children's ability to practice self-control.

It may also be the case that changing belief in free will and developments in self-control do not directly influence each other but are instead effects of the same common cause. A large body of literature has documented that executive functioning – a range of component abilities including working memory, task switching, and, importantly for our purposes, response inhibition, an ability which requires self-control, – is positively correlated with developments in explicit causal knowledge about psychological states as indexed by performance on the Theory of mind scale (Wellman & Liu, 2004). This relationship is observed universally in children from both individualistic cultures (e.g. U.S.: Carlson & Moses, 2001; Flynn, O'Malley, & Wood, 2004; Perner, Lang, & Kloo, 2002; UK: Wang, Devine, Wong, & Hughes, 2016) and collectivistic cultures (mainland China: Sabbagh, Xu, Carlson, Moses, & Lee, 2006; Hong Kong: Wang et al., 2016). Inasmuch as free will beliefs emerge as part of a child's theory of mind, and track developments in theory of mind beyond age four, it stands to reason that self-control behaviors and free will beliefs may be positively correlated in childhood, regardless of cultural variation in each.

However, a look at the developmental timetables of self-control abilities and free will beliefs across cultures suggests a third alternative hypothesis. School-age children from Asian cultures (e.g. China, Nepal and Singapore) consistently attribute less free will than U.S. children of the same age (Chernyak et al., 2013; Chernyak et al., 2019; Wente et al., 2016). At the same time, Asian children (e.g., South Korea, China) score higher in executive functioning measures compared to their Western counterparts (Oh & Lewis, 2008; Sabbagh et al., 2006). Thus, the relationship between self-control behaviors and beliefs about free will may be more nuanced, and more culturally dependent, than the general link between theory of mind and executive functioning.

We suggest a way to characterize the relationship between beliefs and behaviors that takes into account the role that culture may play. It begins with the idea that culture shapes our interpretation of experience; in this case, experiences of intentional agency, and of how our struggles with – and failure and success in – self-control are interpreted and explained. For young children, struggles of self-control are common. If such experiences are interpreted as an individual internal conflict between desire and inhibition, they could serve as evidence for beliefs about free will. Put another way, success or failure at achieving self-control could change a child's mind about what is possible and impossible. But this may depend on how that behavior is framed and explained. In particular, if children instead interpret failures of self-control as a conflict between internal individual desires and external social norms, they may be less likely to infer a general notion of free will.

Decades of research in cultural psychology show that adults in different cultures have different views of agency, different conceptions of the self, and different views on the centrality of mental states in causal explanations for action. In particular, research has documented differences between individualistic European and American cultures and collectivistic East and South Asian cultures – (Kitayama & Uchida, 2005; Markus & Kitayama, 2003; Miller et al., 2011; Morris, Menon, & Ames, 2001; Morris & Peng, 1994; Savani, Markus, Naidu, Kumar, & Berlia, 2010). Children in different cultures grow up surrounded by these different folk-psychological theories of mind and self. For example, children growing up in middle-class North American cultures are raised by adults who often view intentional actions as stemming from individual desires, preferences, and subjective mental states. Children growing up in Asian cultures are raised by adults who more frequently view agents as responding to situations, social roles, and the expectations of other individuals. Of course, all children across these cultural contexts develop understandings of individual minds and mental states *and* learn the importance of social roles and expectations. However, culture plays a role in how we emphasize and weigh these different

factors in ordinary causal-explanatory reasoning about actions (Morris & Peng, 1994). Culture also plays a role in how we talk to children about actions: a large body of work shows that, in conversations with children about events and experiences, parents in individualistic versus collectivistic cultural contexts consistently emphasize individual mental states versus relational roles and social expectations respectively, and through these conversations transmit different cultural views on agency and self to their children (Wang, 2006; Wang & Leichtman, 2000). It is therefore conceivable that, even for children as young as four, self-control experience could be interpreted through a cultural lens.

We investigated these possibilities about how culture shapes the relationship between belief in free will and self-control behaviors by sampling from four cultures: U.S., China, Singapore and Peru. In study 1, we sampled from two East Asian cultures (China and Singapore) as these samples mirror well-studied cultural comparisons between Eastern and Western views of mind and self, including belief in free will, in children and adults (Chernyak et al., 2019; Morris & Peng, 1994; Wente et al., 2016). This also allows us to directly compare our results to prior work (Sabbagh et al., 2006) showing links between and executive functioning in U.S. and Chinese children. In study 3 we extend beyond the traditional East versus West cultural comparison, and sample children from a culture that is less studied – Peru. Below we introduce the background of each culture in more detail and motivate our hypotheses.

Historically, mainland China has been considered a collectivistic society where group harmony and social bonds are emphasized. However, with the rapid socioeconomic changes after the economic reform in the 1970s, there has been a salient rise of individualism-related values (e.g., autonomy and freedom) (Cai, Zou, Feng, Liu, & Jing, 2018; Xu & Hamamura, 2014; Zeng & Greenfield, 2015). Nevertheless, some traditional collectivistic values such as family love, friendship, and social obligations have continued or become even more prioritized in Chinese culture (Zeng & Greenfield, 2015). On the other hand, Singapore is characterized by its shared core Asian values among its ethnic communities (Quah, 1990) and its Western influences given its colonial history and English-mediated education. Similar to Chinese culture, "collectivist" values of family ties are fundamental, and the group — rather than the individual — is prioritized in Singapore (Kau & Yang, 1991). However, compared with Chinese society, Singaporean society places a stronger emphasis on authoritarian values, which leads to emphasis on authority, hierarchy, and punishment for rule violations. Singapore has a reputation for being tough on crime (Shanmugam, 2012), and consequences for various transgressions are, by U.S. standards, severe (Bahrampour, 1995).

By sampling from these two Asian cultures, and comparing to children in the U.S., we are able to examine our hypotheses on how our culturally-acquired social-cognitive frameworks may moderate the relationship between free will beliefs and self-control. Moreover, the comparison between Singaporean and Chinese children also provides an opportunity to investigate potential cultural variation between two Asian cultures. Though sharing traditional collectivist values, Singaporean culture is considered more authoritarian than Chinese culture. An emphasis on authority, hierarchy and punishment may lead children to reduced belief in free will. Indeed, previous studies have shown that Singaporean children feel more constrained by the social world – less free to act against moral and conventional norms – than U.S. children (Chernyak et al., 2019). In addition, including Singaporean children and comparing to U.S. children also allows us to control the interview language, as the first language for children in both cultures is English (Chernyak et al., 2019).

We sample children in Peru to extend our work beyond the well-studied "East vs West" dichotomy. Latin American cultures are sometimes also considered "collectivist" in prior social-psychological work, though there has been influence of individualism due to industrialization and modernization (Minkov et al., 2017; Oyserman, Coon, & Kemmelmeier, 2002; Vignoles et al., 2016). Thus, they may provide a relevant comparison to East Asian cultures. Moreover, the sample we tested included many first- or second-generation internal immigrants from rural areas that were heavily influenced by indigenous cultures. Including Peruvian children is also part of a broader effort to extend developmental research to less-studied populations, and address the lack of sampling diversity in the social sciences (Henrich, Heine, & Norenzayan, 2010; Nielsen, Haun, Kärtner, & Legare, 2017). Almost no developmental psychology research has been done in Peru and we are unaware of any related developmental research published so far sampling urban Peruvian children. Thus, the present study with Peruvian children was necessarily exploratory.

Across three studies, we ask whether and how individual differences in self-control are linked to individual differences in beliefs about free will in childhood. We also explore whether links are culturally universal or culturally moderated – suggesting an interpretation of self-control experience through a culture-specific framework of mind, self, and agency. Finally, we investigate potential causal influences of beliefs on behaviors, and vice versa, in a laboratory study.

In Study 1 we interviewed 4- to 8-year-old children in the U.S., mainland China, and Singapore. We measured free will beliefs using a task developed by Kushnir et al. (2015, Exp. 4) that asks children to reflect on a story character's ability to "choose to" act against and inhibit strong desires. We measured self-control with a battery of tasks from prior work that require different forms of non-reward response inhibition, roughly corresponding to the "conflict" and "delay" categories proposed by Carlson & Moses, 2001 (also see Oh & Lewis, 2008). All of the tasks involve inhibition in some form: Hearts & Flowers and Day-Night Stroop ("conflict" tasks) require response inhibition to achieve a correct answer, and Toy Sort and Gift Wrap ("delay" tasks) require response inhibition to comply with adult instructions. To ensure that we could reliably capture within-individual consistency with this battery, we checked for reliability across tasks and combined them into a single self-control score. We looked for age-related changes in free will beliefs and self-control abilities, cultural differences in each and, finally, individual-level correlations between free will and self-control controlling for age within each culture. The inclusion of a wide age range allowed us to examine the relation between free will beliefs and self-control abilities beyond general age-related improvements in executive functioning.

Studies 2 and 3 are conceptual replications and extensions of Study 1 with some critical modifications. First, we attempted to replicate our correlational findings with a task (Kushnir et al., 2015, Exp. 5) that asks children to reflect on their own free will. In prior work, this task yielded similar age-related changes, but also more individual variability and fewer endorsements of free will overall. Second, we explored the causal direction of the belief-behavior link: we randomly assigned children to be given self-control experience in the lab prior to being asked about their own free will, or vice versa. Study 2 focuses on younger (4- and 5-year old) U.S. children, and, included a cognitive task (conservation) as a further control for cognitive development beyond just age. Study 3 replicated the procedure of Study 2 with a sample from of 4- to 7- year-olds from another, less well-studied culture – Peru. All study materials and data have been made publicly available via the Open Science Framework and can be accessed at https://osf.io/4kj75/?view_only=5616b47d99f641da9d6cadf74b19da82.

1.1. Study 1

Study 1 included children in the U.S. and two Asian cultures: mainland China, and Singapore. We investigate developmental changes in free will beliefs and in self-control abilities in all three cultures and explore whether there are any significant effects of culture on each. We then investigate whether there is a relationship between individual differences in free will beliefs and self-control controlling for age, and whether this relationship is culturally dependent. A positive correlation in all three cultures would suggest that developmental changes reflect a link between improvements in self-control and conceptual

developments in children's theory of mind. This might reflect specific links between free-will beliefs and self-control or reflect a more general relationship between executive function and theory of mind (as in Sabbagh et al., 2006).

A culturally moderated correlation would paint a different picture. One hypothesis is that cultural worldviews provide the explanatory frame for interpreting self-control experience. This hypothesis would have the strongest support if, across cultures, the relationship between self-control and free will beliefs is strongest in cultures where individual mental states such as desires are emphasized in causal explanations for action.

2. Methods

2.1. Participants

Children were recruited from the U.S. ($N = 54$, 3.97–8.90 years old, $M = 6.21$, $SD = 1.36$, 32 girls), China ($N = 72$, 4.39–8.80 years old, $M = 6.39$, $SD = 1.33$, 41 girls) and Singapore ($N = 50$, 4.00–8.58 years old, $M = 6.01$, $SD = 1.29$, 28 girls). Six more children were tested but excluded from the analysis due to missing video files ($N = 4$), or experimenter error ($N = 2$). U.S. participants were recruited from preschools, after school programs, and science museums in a small university town. The racial makeup of the school district was 64.76% White, 17.09% Asian, 6.15% Black or African American, 0.19% Native American, 0.67% from other races, and 4.36% from two or more races. Hispanic or Latino of any race were 6.8% of the population. The median income for a household was $32,712, and the median income for a family was $83,229. Most parents (63.67%) hold a bachelor's degree or above. Singaporean participants were recruited from local preschools and elementary schools. They were all middle to upper-middle class English-Chinese bilinguals. Chinese participants were recruited from preschools and elementary schools in Beijing. According to another unpublished study recruiting Chinese participants from the same schools, most of the parents (96%) of children in these schools hold a bachelor's degree or a higher degree, and most children (98%) were of the Han ethnicity. Chinese participants all spoke Mandarin as their native language and started learning English from preschool. We estimated our sample size in each culture based on effect sizes from previous work (Kushnir et al., 2015; Wente et al., 2016).

2.2. Procedure and measures

All children were tested individually in a quiet room in homes, local museums, cafes, preschools or elementary schools. A native Chinese and a native Singaporean experimenter collected data in each East Asian culture, and each collected 50% of the U.S. data (randomly assigned). Each session lasted approximately 20 min and all sessions were videotaped. Children in the U.S. and Singapore were interviewed in English while children in China were interviewed in Mandarin. The English protocol was first translated into Mandarin Chinese by the first author, a native Mandarin speaker, and back-translated into English by another Mandarin-English bilingual research assistant. Another research assistant unfamiliar with Mandarin then compared the back-translation with the original English protocol, to check for accuracy. Differences were revised through discussion.

2.2.1. Warm-up phase

Prior to the start of the experiment, each child first completed a warm-up phase. The experimenter asked 4 questions about whether a character can choose to perform possible actions (e.g. smiling if she really wanted to) and impossible actions (e.g. running faster than a train if she really wanted to). This was to ensure that children understood the questions and were not simply always answering "yes" or "no". If children answered incorrectly, prompts were given until they responded correctly.

2.2.2. Self-control tasks

Four measures were administered: the Day/Night Stroop task, Hearts and Flowers task, Toy Sort task, and Gift Wrap task. Task order was latin-square counterbalanced across participants.

2.2.3. Day/night stroop task

Children were instructed to say "day" when they saw a card with the moon, and "night" when they saw a card with the sun (Gerstadt, Hong, & Diamond, 1994). Children first completed a training phase where they were given feedback for 6 trials. The test phase comprised 16 cards (i.e. 8 "day" and 8 "night" in the same order across participants). We recorded the percentage of correct trials. The first author and a research assistant (both English-Chinese bilinguals) independently coded from video recordings, and the reliability between coders was 99%.

2.2.4. Hearts and flowers task

This task was adapted from Davidson et al. (2006). Children completed the Hearts and Flowers task on a laptop. The task includes three conditions – two congruent blocks (all Hearts, all Flowers) and one mixed block (both Hearts and Flowers). The Hearts condition (12 trials) is a pure-congruent block where participants were asked to press the response button on the same side as the stimulus. The Flowers condition (12 trials) is a pure-incongruent block where participants were asked to press the response button on the opposite side of the stimulus. The Hearts and Flowers condition (33 trials) is a mixed block condition where both the hearts and flowers stimuli appear together in the same block, and participants have to switch flexibly between same-side and opposite-side rules. We recorded 1) the accuracy of the Flowers block (i.e. incongruent trials) and 2) the accuracy of the Hearts and Flowers condition (i.e. mixed trials). These two variables were converted to z-scores and averaged to create a Hearts and Flowers score for each participant.

2.2.5. Toy sort task

This task was adapted from Denham, Warren-Khot, Bassett, Wyatt, and Perna (2012). The experimenter introduced children to 21 enticing toys and three buckets. Children were asked to sort the toys into three buckets according to the color of the stickers pasted on each toy. They were reminded not to play with any of the toys. We recorded 1) time taken to complete sorting the toys and 2) the number of toys each child played with. Performance was coded from video by the first author and a research assistant, and the reliability between coders was 98%. These two variables were converted to z-scores and averaged to create a Toy Sort score for each participant.

2.2.6. Gift wrap task

This task was adapted from Kochanska et al. (1996). In this task, children were told they would be receiving a gift but that the experimenter had to wrap it first. Children were instructed to turn 90 degrees from the experimenter and not to peek while the experimenter wrapped a gift. The experimenter then wrapped up the gift noisily for 60 s. We coded the time elapsed until children first peeked (i.e. either moving their eyes to sneak a peek or turning their head to peek) during the gift-wrapping phase. Again, two bilingual coders independently coded the videos, and the reliability between coders was 88%.

2.2.7. Free will questions

In addition to the Free Will questions about the possibility of choosing to act against or inhibit strong desires, we included two types of control questions in which story characters want to do something that is possible, impossible, or impermissible. Table 1 shows an example of each. Possible and impossible questions have a similar format to the Free Will Action and Inhibition items, and therefore serve as a confirmation that children as young as 4 can follow the linguistic structure of the task and respond accordingly.

As mentioned above, prior work has found both age and cultural

Table 1
Examples of Free Will Action and Inhibition questions, and possible, impossible, and impermissible controls.

Free Will Action (food item)	Let's imagine that there is a cracker/biscuit on the table in front of us. Rosie sees the cracker/biscuit and she doesn't like it. Rosie thinks the cracker/biscuit tastes yucky. Even though she does not like it, can Rosie **just choose to** eat the cracker/biscuit, or does she **have to not** eat the cracker/biscuit?
Free Will Inhibition (food item)	Let's imagine that there is a piece of cereal/cornflake on the table. Sophie sees the cereal and she likes it. Sophie thinks the cereal/cornflake tastes good. Even though she likes it, can Rosie **just choose to not** eat the cereal, or does she **have to** eat the cereal?
Possible action	Peter draws a picture every day. He always uses a color pencil to draw his picture. But today, he wants to do something different. Peter **wants** to draw his picture with a crayon. Even though he usually uses a color pencil, can Peter **just choose to** draw his picture with a crayon anyway?
Impossible action	Bobby walks to the store every day. He always walks around the big brick wall. But today, he wants to do something different. Bobby **wants** to walk right through the big brick wall. Even though the wall is made of bricks, can Bobby **just choose to** walk right through the wall anyway?
Impermissible action (harm item)	Johnny sees his friends every day. He always plays with his friends nicely. But today, Johnny wants to do something different. Johnny **wants** to hit his friends. Is it ok for Johnny to hit his friends? [response] Even though it is not ok, can Johnny **just choose to** hit his friends today anyway? Why?

variation in children's beliefs about choosing *impermissible* actions (if one wants to act against moral and social norms, can one do it? i.e. Chernyak et al., 2013, 2019, see also Shtulman & Phillips, 2018). Importantly, permissibility vignettes are the opposite of the free-will desire questions in that they ask whether one can act *in accordance with a desire* and go against a norm. Thus, we reasoned that they would act as a useful contrast. Though responses to these questions can vary across ages and cultures, they do not refer to acting against desires (exerting will or self-control). Thus, we did not expect age and cultural variation in these items to be relevant to our central hypothesis. Self-control tasks were always administered between two blocks of Free Will questions, described in more detail below. The order of the blocks was counterbalanced.

2.2.8. Block A

One block of questions contained the four Free Will Desire items along with two control questions about characters who wanted to do something simple and possible (e.g. using a crayon instead of a pencil to draw) and something physically impossible (e.g. walking through a brick wall). These items were included to ensure that children understood the question format. The Free Will Desire items were modeled after Kushnir et al. (2015). Two Action Free Will items (one item about a disliked activity and one item about a disliked food) asked whether a story character could choose to do something he/she did not want to do (act against a desire) and the other two Inhibition Free Will items (one item about a liked activity and one item about a liked food) asked whether a story character could choose NOT to do something he/she did want to do (inhibit a desire). The order of all 6 items in this block was counterbalanced across participants. The order of the 'choose to' and 'have to' options in each question was counterbalanced within and across participants. Children were also asked to explain their responses.

2.2.9. Block B

The impermissible action questions were modeled after Chernyak et al. (2013). These items presented a story about a character who wants to do something that violates a moral norm (harm, fairness) or a parental rule. There were three such questions – one about choosing to harm, one about choosing not to share, and one about choosing to break a stated rule. An example is shown in Table 1. After each scenario, children were asked (1) a permissibility question (e.g. "Is it okay for him to hit his friend?") and (2) a choice question (e.g. "Even though it is not okay, can he just choose to hit his friend anyway?").

2.3. Coding

2.3.1. Free will questions

For each question, a child would receive a score of 1 if he/she provided a "choose to" response, and a score of 0 if he/she provided a "have to" response.

2.3.2. Explanations

Qualitative explanation coding and data are reported in detail in supplementary materials. We coded children's qualitative explanations to the Free Will Desire questions according to the coding scheme adapted from Kushnir et al. (2015).

Explanations are coded in the context of children's judgments as internal or external (or other/I don't know): For example, if a child said you "have to eat the cookie", then explanations fell into two categories: internal constraints ("because you want to") or external constraints ("because it's yummy"). If a child said you can "choose to not eat the cookie", explanations were similarly tied to their responses - they either reference alternate internal states ("you might not want to this time") or alternate external circumstances ("the cookie might fall on the floor and be dirty") or autonomy ("Because it's yourself and you can just choose what you want to do"). Two coders fluent in Mandarin and English coded all children's explanations. Reliability between coders for qualitative explanations was 91.5%. Additional details and examples are in the supplementary materials.

3. Results

We present descriptive data, followed by results for self-control tasks and free will beliefs separately, and then present analyses of the relations between them.

Descriptive statistics for each Self-Control task and each set of Free Will questions split by culture can be seen in Table 2. We first checked for effects of task order and participant's gender. We performed linear regressions on each Free Will measure and Self-Control measure with task order and participant's gender as predictors. These analyses revealed no significant effects of any of the predictors (p's > 0.14). Thus, we combined data in subsequent analyses.

3.1. Self-control tasks

The Self-Control measures collapsed across cultures formed a reliable scale (Cronbach's alpha = 0.74). Details on overall and culture-specific intercorrelations between measures are shown in supplementary materials.

A Self-Control Composite Score was formed by summing up the z-scores of Day/Night Stroop, Hearts and Flowers, Gift Wrap, and Toy Sort. Higher scores reflect better performance in Self-Control tasks.[1] The mean Self-Control Composite Score was −0.29 (SD = 3.29) in the U.S., −0.02 (SD = 2.70) in Singapore, and 0.38 (SD = 1.71) in China. We ran an ANCOVA with the Self-Control Composite Score as the dependent variable, Culture as a predictor variable and Age as a covariate. We

[1] As the Self-control Composite Score was left-skewed, we conducted supplementary analyses where the Self-control Composite Score was first reverse-scored and then log-transformed for all models involving this variable. Results were very consistent with the analyses on original scores and none of the statistical results were affected by the log-transformed analyses.

Table 2
Descriptive statistics for Self-Control, Free Will split by Culture in Study 1.

	U.S. ($N = 54$)		China ($N = 72$)		Singapore ($N = 50$)		
	Mean(*SD*)	Range	Mean(*SD*)	Range	Mean(*SD*)	Range	Age Effect
Age	6.21 (1.41)	3.97–8.90	6.39 (1.33)	4.39–8.80	6.01 (1.29)	4.00–8.58	
Self-Control Tasks							
Composite Score (Sum of Standardized Scores of four tasks)	−0.29 (3.29)	−9.03-3.44	0.38 (1.71)	−3.95-3.64	−0.02 (2.70)	−9.31-3.38	$r = 0.52$, $p < .001$
Day/Night Stroop (percent correct)	86.12 (18.44)	6.25–100	95.15 (6.89)	69.00–100	85.59 (18.73)	19–100	$r = 0.38$, $p < .001$
Hearts and Flowers							
Incongruent trials (percent correct)	85.99 (18.08)	33.33–100	91.53 (13.28)	16.67–100	84.87 (17.89)	36.36–100	$r = 0.28$, $p < .001$
Mixed trials (percent correct)	80.64 (17.52)	41.38–100	85.18 (14.53)	35.00–100	81.45 (16.96)	35.48–100	$r = 0.37$, $p < .001$
Toy Sort							
Time to complete (ms)	88.57 (51.79)	37–252	88.86 (38.72)	38–232	76.34 (36.65)	36–256	$r = -0.53$, $p < .001$
Number of toys played with	1.85 (3.12)	0–15	0.64 (1.27)	0–7	0.78 (1.92)	0–10	$r = -0.23$, $p = .002$
Gift Wrap							
Latency to 1st peek (sec)	35.44 (26.05)	1–60	23.63 (21.57)	0–60	27.75 (22.35)	1–60	$r = 0.24$, $p = .001$
Free Will Questions							
Desire Questions							
Desire Average	0.72 (0.30)	0–1	0.78 (0.29)	0–1	0.52 (0.33)	0–1	$r = 0.48$, $p < .001$
Inhibition	0.65 (0.41)	0–1	0.72 (0.41)	0–1	0.46 (0.44)	0–1	$r = 0.49$, $p < .001$
Action	0.77 (0.36)	0–1	0.83 (0.33)	0–1	0.57 (0.42)	0–1	$r = 0.25$, $p = .001$
Control Questions							
Possible	0.98 (0.14)	0–1	0.96 (0.20)	0–1	0.86 (0.35)	0–1	$r = 0.17$, $p = .029$
Impossible	0.07 (0.26)	0–1	0.06 (0.23)	0–1	0 (0)	0	$r = -0.19$, $p = .011$
Impermissible	0.27 (0.40)	0–1	0.22 (0.33)	0–1	0.19 (0.30)	0–1	$r = 0.37$, $p < .001$

found only a main effect of Age, $F(1,161) = 55.62$, $p < .001$, $\eta_p^2 = .26$ (see Fig. 1). Culture was not a significant predictor ($p = .11$). There was also no significant interaction between Culture and Age ($p = .17$).[2]

3.2. Free will questions

We first looked at children's answers to the control questions (possible, impossible, impermissible). Replicating prior work, a significant majority of children in all three cultures distinguished between possible and impossible or impermissible choices.[3]

We then focused on children's responses to the Free Will Desire questions. McNemar's tests showed no differences between the food item and activity item for any type of questions (i.e., inhibition or action, $p's > 0.20$). We therefore averaged their scores for the two inhibition questions to form a Free Will Inhibition Score and averaged their scores for the two action desire questions to form a Free Will Action Score. Also, an overall Free Will Desire Score was calculated by averaging their scores for all four desire questions. Descriptive statistics can be seen in Table 1.

To investigate potential developmental changes and cultural variation in children's responses to two types of Free Will Desire questions (inhibition and action), we first ran a Repeated Measures MANOVA on children's responses using Question Type (Inhibition, Action) as a within-subject factor, Culture (U.S., Singapore, China) as a between-subject factor, and Age as a covariate. We found a significant main effect of Question Type ($F(1,172) = 14.11$, $p < .001$, $\eta_p^2 = 0.076$), a significant main effect of Culture ($F(2,172) = 10.44$, $p < .001$, $\eta_p^2 = 0.11$), and a significant main effect of Age ($F(1,172) = 48.43$, $p < .001$, $\eta_p^2 = 0.22$). We also found an Age X Question Type interaction ($F(1,172) = 10.05$, $p = .002$, $\eta_p^2 = 0.06$). For the main effect of Question Type, post hoc tests using Bonferroni corrections revealed that children were more likely to endorse freedom of choice for Action items than for Inhibition items ($p = .001$). For the main effect of Culture, post hoc tests using Bonferroni corrections revealed that Singaporean children provided significantly fewer "choose to" responses than U.S. ($p = .004$) and Chinese children ($p < .001$). For interaction between Age and Question type, follow-up analyses revealed that age was positively correlated with both scores, but the correlation was stronger for Inhibition questions ($r = 0.49$, $p < .001$) than for Action questions ($r = 0.25$, $p = .001$).

We also ran an ANCOVA with Free Will Desire Score as the dependent variable, Culture as a between-subject predictor variable and Age as a covariate. The ANCOVA revealed a significant main effect of Age ($F(1,172) = 50.14$, $p < .001$, $\eta_p^2 = 0.23$) and a significant main effect of Culture ($F(2,172) = 10.66$, $p < .001$, $\eta_p^2 = 0.11$). Older children were more likely to say that people could choose to act against or inhibit their desires than younger children. Singaporean children were less likely to say that people could choose to act against or inhibit their desires than both U.S. and Chinese children but there was no difference between Chinese and U.S. children (Singapore vs. U.S.: $p = .002$, Singapore vs. China: $p < .001$, China vs U.S.: $p = 1.00$; using Bonferroni-corrected pairwise comparisons). Fig. 2 shows the relationship between Age and Free Will Desire Score in each culture.

[2] Consistent with previous studies (e.g., Sabbagh et al., 2006), we observed trends that U.S. children scored lower in self-control tasks than Chinese children. However, these differences did not reach significance possibly because of the wide age range or power issues.

[3] See Supplementary Material for details.

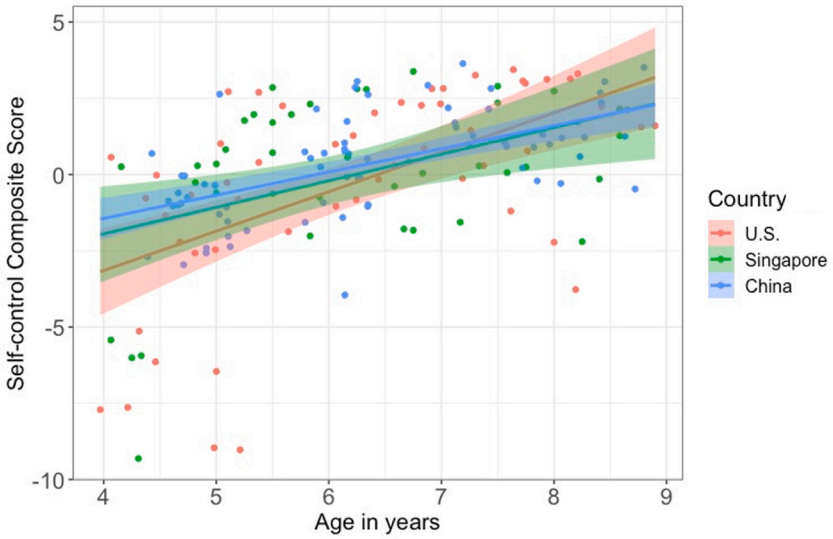

Fig. 1. Relationship between Self-Control score and Age in each culture. Scatterplot shows Self-control Composite Score and age split by culture. Lines show correlations between the two within each culture and 95% confidence intervals.

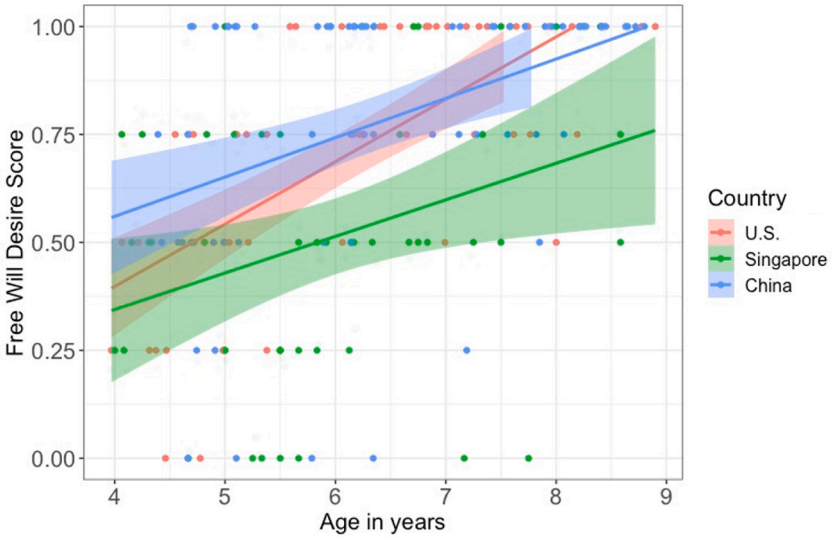

Fig. 2. Relationship between Free Will Desire score and Age in each culture. Scatterplot shows Free Will Desire score and age split by culture. Lines show correlations between the two within each culture and 95% confidence intervals.

3.3. Explanations

A table of percentages of each explanation type can be found in the supplementary materials. Details on analyses can also be found there. A repeated-measures ANOVA for explanations following "have to" responses, shows a significant main effect of Category ($F(1,103) = 5.63$, $p = .020$); children across cultures provided larger percentages of *internal constraints* explanations than *external constraints* explanations. A repeated-measures ANOVA on explanations following "choose to" responses, showed significant main effect of Category ($F(2, 318) = 8.14$, $p < .001$); across cultures, children provided larger percentages of *alternative external* explanations than *alternative internal* explanations ($p < .001$), and larger percentages of *alternative internal* explanations than *autonomy* explanations ($p < .001$).

3.4. Relationship between self-control and free will beliefs

To investigate relationships between self-control behaviors and free will beliefs, we ran a linear regression on Self-Control Composite Score with Age, two dummy variables for Culture (Dummy 1: Singapore vs. U.S., Dummy 2: China vs. U.S., using U.S. as the reference group), Free Will Desire Score, and the interactions between Free Will Desire Score and each of the two dummy variables as predictors. The results are summarized in Table 4. Among U.S. children, Free Will Desire Score significantly predicted their Self-Control Score ($\beta = 0.54$, $t(160) = 4.27$, $p < .001$). We also found significant interactions between each of the two dummy variables and Free Will Desire Score. Specifically, the effect of free will beliefs on self-control performance was significantly larger among U.S. children than Chinese children ($\beta = -0.80$, $t(160) = -3.67$, $p < .001$) or Singaporean children ($\beta = -0.65$, $t(160) = -3.87$, $p < .001$).[4] We then ran partial correlations between Self-Control Composite Score and Free Will Desire Score (controlling for age) in each culture and

[4] Similar results were found when outliers in the Self-control tasks were removed from analyses.

Table 4
Column one shows results of linear regression analyses predicting overall self-control performance from free will beliefs across cultures controlling for age. Culture is coded with two dummy variables with US as reference category (Singapore vs US = Dummy 1, China vs US = Dummy 2) and interactions represent slope differences between cultures in the relationship between self-control performance and free will beliefs. Additional columns represent results of the same regression model on each self-control task separately. Asterisks represent significant effects of predictors. *: $p < .05$, **: $p < .01$, ***: $p < .001$.

	Self-Control Composite	Individual self-control tasks			
		Day/ Night	Hearts & Flowers	Toy Sort	Gift Wrap
Age	0.41***	0.30***	0.28**	0.33***	0.20*
Mean difference, Singapore vs U.S. (Coefficient of Dummy 1)	0.71***	0.42*	0.56**	0.68**	0.020
Mean difference, China vs U.S. (Coefficient of Dummy 2)	0.77***	0.82***	0.82***	0.68**	−0.19
Predicting Self-Control Score from Free Will Desire Score, controlling for age: U.S. children (reference category)	0.54***	0.38**	0.50**	0.49**	0.19
Slope difference in the Free Will/Self-Control relationship between Singapore and U.S. (Interaction of Dummy 1 and Free Will Score)	−0.65***	−0.41*	−0.50**	−0.41*	−0.13
Slope difference in the Free Will/Self-Control relationship between China and U.S. (Interaction of Dummy 2 and Free Will Score)	−0.80***	−0.65**	−0.79**	−0.67**	−0.09
R^2	0.36***	0.26***	0.23**	0.26***	0.12*

found that the two were positively correlated only in the U.S. ($r = 0.43$, $p = .002$), but not in Singapore ($r = -0.17$, $p = .29$) or China ($r = -0.05$, $p = .68$). See Fig. 3 for the relationship between Self-Control Score and Free Will Desire Score (after controlling for age and cultural effects) in each culture.

We conducted additional analyses to examine the individual predictive relationships between the Free Will Desire Score and each self-control task separately. We had two reasons for doing this: first, though the tasks formed a reliable scale, we also found slight differences in the intercorrelations across cultures (see supplementary analyses). Second, as mentioned earlier, the tasks cover a range of situations in which children must practice self-control – from inhibiting a prepotent response (Hearts and Flowers, Day/Night Stroop) to resisting a temptation (Toy Sort, Gift Wrap). For both reasons, we checked whether the cultural moderation above was found consistently across tasks.

Results of linear regression analyses predicting each self-control task with Age, two dummy variables for Culture, Free Will Desire Score and the interactions between Free Will Desire Score and two dummy variables as predictors are shown in Table 4. Follow-up partial correlations controlling for age are shown in Table 5. The analyses together show that children's Free Will Desire Score positively correlated with performance on most of the Self-Control tasks separately for U.S. children, and on none for children in Singapore and China. The strongest correlations were found for Hearts & Flowers and Toy Sort. Day/Night Stroop performance was marginally correlated with Free Will Desire Score, and Gift Wrap was uncorrelated in each culture.

We also checked for the relationship between children's responses to the Free Will Control questions and their Self-Control Score. We ran three regressions (one for the possible choice item, one for impossible items, one for impermissible items) on children's responses to the free will control questions with Age, Culture, Self-control Composite score as predictors. We found no significant effect of Self-control Composite Score for any control question (p's = n.s.).

4. Discussion

The results from Study 1 show a culturally moderated relationship between self-control abilities and beliefs about the "free will" to act against or inhibit strong desires. Though we found similar self-control performance across the three cultures, Singaporean children reported weaker belief in the free will than Chinese and U.S. children. These findings on their own indicate that free will beliefs and self-control abilities do not necessarily align, at least when contrasting samples across cultures. Second, controlling for age, U.S. children who held a stronger belief in their ability to act against or inhibit strong desires performed better on tasks requiring self-control. No such correlations were observed in the two East Asian cultures, again despite overall similarities in the main developmental trajectory of both their self-control abilities and their free will beliefs.

These results raise two further questions. First, what is the nature of the correlation among US children? Does it reflect the influence of self-control on free will beliefs, the influence of free will beliefs on self-control, or the influence of some further common cause of both abilities? Second, how do we explain the fact that this correlation did not emerge in the East Asian children? These results challenge a simple view that the belief-behavior link we investigate here is a byproduct of a general, and culturally universal, correlation between theory of mind and executive functioning (Sabbagh et al., 2006). They also offer evidence against two other hypotheses regarding the causal relationship underlying the correlation: beliefs about free will do not universally result from improvements in children's capacity to practice self-control, nor do free will beliefs universally cause behavioral change. The cross-cultural comparisons suggest that these causal hypotheses are at best incomplete, and another explanation is needed.

One explanation for the culturally moderated link between beliefs and abilities is that it reflects both cultural and experiential influences. If children in our U.S. sample experience their self-control as internally guided, then they may interpret their first-person experiences in situations that require self-control as evidence in support of the possibility that they can successfully control impulses and desires at will. As they get older, they more readily endorse the idea that agents have the free will to act against their desires because they actually see themselves get better at practicing self-control. On the other hand, children from Singapore and China may experience their self-control as externally guided, caused by social norms or external influences without the intermediary influence of an internal "will". In that case, the experience of self-control might have no effect on beliefs about free will.

Notably, we did not find direct evidence for an immediate causal influence in either direction. In Study 1, U.S. children who answered free will questions before engaging in the self-control tasks performed no differently in self-control tasks than children assigned to the opposite ordering. Similarly, children who engaged in the self-control tasks prior to answering free will questions showed no differences in the free will judgments from children assigned to the opposite ordering. This could indicate that the correlations are due to other factors unmeasured in our design.

Another possibility is that, in the U.S. cultural context, the responses to the free will questions change slowly over time as a result of

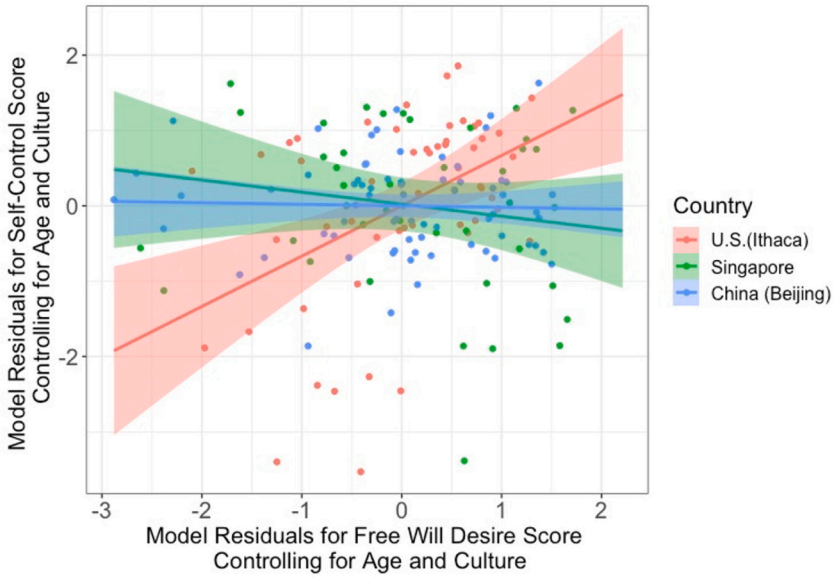

Fig. 3. Relationship between Free Will Desire Score and Self-Control Score in each culture after controlling for Age and Cultural differences. Scatterplot shows model residuals for each variable – Free Will Desire Score and Self-Control Composite Score – controlling for age and culture. Lines show correlations between the two within each culture and 95% confidence intervals.

Table 5
Partial correlations between Free Will Desire Score and Self-control Composite Score and individual self-control task controlling for age in each culture (Asterisks represent significance of partial correlations. †: $p < .10$, *: $p < .05$, **: $p < .01$, ***: $p < .001$).

	U.S.	Singapore	China
Composite Score	0.43**	−0.17	−0.05
Day/Night	0.26†	−0.27	−0.06
Hearts & Flowers	0.45**	−0.22	−0.14
Toy Sort	0.34*	0.03	−0.06
Gift Wrap	0.12	0.02	0.09

accumulated first-hand experience with self-control interpreted through the Western cultural lens of "willpower" and overriding internal urges and desires. This suggests that the effects we document here are more enduring, and less tied to a single experience, and thus are not detectable in a laboratory setting just by varying the order of tasks. Relatedly, asking third-person questions rather than asking children to reflect on their own experience of choosing is more likely to probe abstract social-cognitive knowledge. In general, third-person social-cognitive judgments are easier for children, perhaps due to increased psychological distance from the self (e.g. Lee & Atance, 2016). Indeed, prior work has found that endorsements of free will for the self are both more variable at younger ages and consistently lower at all ages than third-person free-will endorsements (Kushnir et al., 2015; Wente et al., 2016). Study 2 explores whether changing to this more self-reflective, more variable version of the free will questions would show any immediate causal influences in either direction. We focus our investigation on younger (4- and 5-year-old) U.S. children who are at the early stages of developing self-control abilities, free will beliefs, and cultural frameworks that tie them together.

4.1. Study 2

Study 2 was designed to directly examine the competing explanations for the belief-behavior link found in the U.S. children in Study 1. We aimed to replicate the findings in a new sample, and also to create a scenario in the lab to investigate causal influences in both directions. To this end, children were divided into two conditions; they either answered free will questions first and then completed self-control tasks or completed the self-control tasks first and then answered questions about their own free will.

Our new sample of children were 4- to 5-years of age, the age where there is the most variability in free will beliefs and thus the most potential for self-control experiences to have an immediate influence. This restricted age range meant that we were likely to find greater individual differences in self-control abilities based on individual differences in cognitive abilities rather than age differences (or, that, at least, that variation between individual children based on cognitive ability would equal variation based on age-related change). Because of this we included a Piagetian conservation of number task as an additional control for general cognitive developmental differences.

As stated above, we also used a version of the free will questions in Study 2 that asked children to reflect on their own choices and desires, rather than asking about the choices and desires of another hypothetical story character (from Kushnir et al., 2015, Exp. 6). This first-person variation followed the same structure as the questions in Study 1 (one food item, one activity item), and the questions making reference to the child's own stated desires did as well (e.g. "Can you just choose to do X or do you have to not to X"). Due to the addition of the conservation task and in order to keep the laboratory experience short, children completed only the "delay" self-control tasks from the two categories of self-control tasks used in Study 1: gift wrap and toy sort.

There were several possible outcomes for this study. One possibility is that we would replicate our correlational findings but find no causal influence in either direction. This would support the idea that the correlation found in Study 1 arises from unmeasured common factors. Another possibility is that priming children to think about free will could directly change their subsequent performance on self-control tasks. This *second* outcome would indicate that free will questions could be used as a kind of self-control training, similar to how both children and adults can be trained to feel invigorated by using "willpower" and become more effective at self-control (Haimovitz et al., 2019; Job et al., 2010; Savani & Job, 2017). Alternatively, the experience of self-control may influence performance on the free-will tasks. This might suggest that self-control experiences that are interpreted through a cultural framework of personal agency provide the relevant evidence to help children answer abstract questions about free will. If this third possibility holds, our design allows us to further analyze effects of both self-control

success and self-control failure to see which type of experiences, positive or negative, exert the most influence on free will beliefs.

5. Methods

5.1. Participants

Experiment 2 included 149 4- and 5-year-olds (3.92–6.02 years old, $M = 5.01$, $SD = 0.51$) from the U.S. Seventy-six children completed the self-control tasks first (3.92–6.02 years old, $M = 4.99$, $SD = 0.55$) while 73 answered the free will and conservation questions first (4.08–5.97 years old, $M = 5.03$, $SD = 0.47$). Additionally, 4 U.S. children were tested and not included in this final sample. Two were dropped due to experimenter error and 2 due to a lack of English language fluency. Children were recruited and tested at university affiliated preschools, or other private preschools in the San Francisco Bay Area. The racial makeup of the city population was 53.80% White, 20.04% Asian, 6.90% Black or African American, 0.46% Native American, 0.23% from other races, and 5.90% from two or more races. Hispanic or Latino of any race were 11.4% of the population. The median income for a household was $80,912, and the median income for a family was $134,708. Most parents (72.99%) hold a bachelor degree or above. The participants represented the diversity of the local area.

5.2. Procedure and measures

All children were tested in private office spaces at their preschool. Children were placed into one of two conditions based on the order in which they completed the tasks (Condition 1: Self-Control First, Condition 2: Free Will beliefs First). Within each of these two conditions, the order of the two self-control (gift wrap and toy sort) tasks and the order of individual free will questions was counterbalanced. Conservation tasks were counterbalanced with the Free Will questions in both conditions. Testing sessions were videotaped and each session lasted approximately 20 min.

5.2.1. Self-control tasks

We used two of the self-control tasks from Study 1: Toy Sort task and Gift Wrap task. The procedure of these two tasks is the same as in Study 1. For Toy Sort, we coded 1) time taken to complete sorting the toys and 2) the number of toys each child played with. In Gift Wrap, we coded the time elapsed until children first peeked (i.e. either moving their eyes to sneak a peek or turning their head to peek) during the gift-wrapping phase. The reliability between two independent coders was 96.35% for Toy Sort and 83.05% for Gift wrap. In addition, we also coded overall success or failure using a binary code (0/1) for each measure, which served as a conservative measure of combined overall success. In the Toy Sort task, success would mean children played with *no* toys while they were sorting them. In the Gift Wrap task, success would mean they didn't peek *at all* during the gift-wrapping phase.

5.2.2. Conservation of number

The Conservation of Number task served as a control for general cognitive capacity. Originally developed by Piaget (1952), children were shown two rows containing 5 pennies a piece. The procedure began with pennies equally spaced across the two rows. The experimenter asked, "Does this row have more pennies? Does this row have more pennies? Or do they both have the same number of pennies?" while pointing to the appropriate row(s). Then the rows were expanded and contracted so that one row was longer than the other, although the two still contained an equal number of pennies. The experimenter gave the same prompt. This was done one more time, resulting in a total of 3 prompts. Children were scored on whether they stated that the rows contained an equal number of pennies, or if they believed that one row had more pennies than the other (for a total of 3 possible correct).

5.2.3. Free will questions

The free will questions included 2 possible control questions, 2 impossible control questions and 4 desire questions. The questions were structured as in Study 1 except that all the questions were about the children themselves rather than other story characters. See Table 6 for examples. In the focal Free Will questions about choosing to act against or inhibit desires, the experimenter first prompted children to name a food and activity that they "really don't like" or "really like." Then the experimenter drew the item, and asked children if they could choose to act in opposition to their desires (e.g. "even though you really like [X], can you choose not to do [X] or do you have to do it?". For example, if a child said they really liked cookies, the experimenter drew a cookie on a piece of paper, then asked the child, "Can you just choose to not eat the cookie, or do you have to eat the cookie?". Order of the phrases (choose to/have to) was randomized. All questions included a phrase stating that the participant's parents said either option was ok. This was to encourage children to answer in accordance with their perceived internally driven self-control abilities.

5.3. Coding

5.3.1. Free will questions

Children's responses to the Free Will questions were coded similarly to Study 1. All qualitative explanations to the desire questions were coded by a primary English-Spanish bilingual coder (who also coded responses in Study 3). A subset of responses (57 children, or 228 responses) were coded by a *sec*ond bilingual coder. Reliability between coders for qualitative explanations was 91.67%. Discrepancies were resolved through a meeting between the two coders and the second author.

5.3.2. Explanations

Explanations were coded as in study 1. More details on reliability and coding categories can be found in the supplementary materials.

6. Results

Descriptive statistics for each Self-Control task and each Free Will

Table 6
Examples of First-Person Free Will questions and controls used in Study 2 and 3.

Free Will Action (food item)	Can you think of a food that you really don't like? What is a food you really think tastes yucky? (e.g. child says "peppers"). OK, let's pretend that peppers are right here on the table. You really don't like eating peppers; you think peppers taste really yucky. And your parents say it's okay for you to eat the peppers or not. Can you **just choose to** eat the peppers or do you **have to not** eat them?
Free Will Inhibition (food item)	Can you think about something fun that you really like to do? What's something that you really want to do? (e.g. child says "playing with blocks"). OK, so let's pretend this is you and these are your blocks. You really like playing with blocks, you think playing with blocks is a lot of fun. And your parents say it's okay for you to play with your blocks or not. Can you just **choose not to** play with your blocks or do you **have to** play with them?
Possible action	So, let's say that you are standing in the kitchen and there's a doorway into the living room. You don't want to be in the kitchen, you want to be in the living room. And your parents say it's okay for you to go into the living room or not. Can you just **choose to** go into the living room or do you **have to** stay in the kitchen?
Impossible action	You know how every time you jump up in the air, you always come back down. Let's say that today you want it to be different. You want to just float in the air, not touching anything. You don't ever want to come back down. And your parents say it's okay for you to float in the air or not. Can you just **choose to** float in the air or do you **have to** come back down?

question can be seen in Table 7.

6.1. Self-control tasks

A Self-Control Composite Score was formed by summing up the z-scores of Gift Wrap and Toy Sort. Higher scores reflect better performance in self-control tasks. To explore whether age and condition (Self-Control Tasks First, Free Will Questions First) had effects on children's self-control performance, we ran an ANCOVA with the Self-Control Composite Score as the dependent variable, Condition (Self-Control Tasks First, Free Will Questions First) as a between-subject factor and Age as a covariate. We found a significant effect of Age ($F(1,146) = 5.64$, $p = .019$, $\eta_p^2 = 0.037$); older children performed better than younger children. Also, we found no effect of Condition ($p = .66$).

6.2. Free will questions

As in Study 1, a significant majority of children passed the control questions indicating that they understood the language of the task and the difference between a free action and a physical constraint (see Table 7). We then looked at responses to the focal Free Will Action and Inhibition questions. McNemar's tests showed no differences between the food item and activity item for any type of questions (i.e., inhibition or action, p's > 0.86). We therefore averaged their scores for the two inhibition questions to form a Free Will Inhibition Score and averaged their scores for the two action desire questions to form a Free Will Action Score. Descriptive statistics can be seen in Table 7. A Repeated Measures MANOVA on children's Free Will scores using Question Type (Inhibition, Action) as a within-subject factor, Condition (Self-Control Tasks First, Free Will Questions First) as a between-subject factor and Age as a covariate revealed a main effect of Age ($F(1,146) = 10.52$, $p = .001$, $\eta_p^2 = 0.07$) but no effects of Question Type or Condition (p's > 0.31). We therefore combined questions for a total Free Will Desire score (proportion out of 4, see Table 7).

Table 7
Descriptive statistics for Self-Control and Free Will split by Culture in Study 2 and 3.

	U.S. ($N = 149$)		Peru ($N = 116$)	
	Mean (*SD*)	Range	Mean (*SD*)	Range
Age	5.01 (0.51)	3.92–6.02	6.79 (0.89)	4.32–7.99
Self-control tasks				
Composite Score (Sum of Standardized Scores of two tasks)	−0.28 (1.35)	−5.95-1.72	0.36 (1.66)	−6.46-1.83
Toy Sort				
Time to complete (ms)	78.42 (39.04)	30–275	70.08 (55.30)	19–387
Number of toys played with	1.36 (2.69)	0–18	1.06 (2.79)	0–16
Gift Wrap Score				
Latency to 1st peek (sec)	33.43 (21.12)	1–60	43.98 (20.65)	1–60
Free will questions				
Desire questions				
Inhibition	0.55 (0.43)	0–1	0.23 (0.36)	0–1
Action	0.50 (0.44)	0–1	0.39 (0.38)	0–1
Total	0.53 (0.38)	0–1	0.31 (0.31)	0–1
Control questions				
Possible	0.89 (0.25)	0–1	0.85 (0.24)	0–1
Impossible	0.26 (0.33)	0–1	0.17 (0.28)	0–1

6.3. Explanations

Explanation details are included in supplementary table, and patterns are consistent with Study 1.

6.4. Conservation of number

The mean score for Conservation of Number was 1.64 ($SD = 0.94$, scale = 0–3). An ANCOVA with the Conservation score (0–3) as the dependent variable, Condition (Self-Control Tasks First, Free Will Questions First) as a between-subject factor and Age as a covariate revealed a significant effect of Age ($F(1,146) = 9.89$, $p < .001$, $\eta_p^2 = 0.063$); older children performed better than younger children. We found no effect of Condition on conservation score ($p = .63$).

6.5. Relationship between self-control and free will beliefs

Replicating Study 1, the correlation between free will beliefs and self-control abilities controlling for age and conservation score was positive and significant (*partial* $r(145) = 0.174$, $p = .035$), indicating that children who scored higher on the self-control measures also held stronger beliefs about free will. To investigate whether the relationship varied by condition, we then ran a linear regression on Self-Control Composite Score, with Age, Free Will Desire Score, Conservation Score, Condition and the interaction between Condition and Free Will Desire Score as predictors. We found a significant effect of age ($\beta = 0.17$, $t(143) = 2.03$, $p = .044$) and no other significant main effects (p's > 0.063). Importantly, we also found a significant interaction between Condition and Free Will Desire Score ($\beta = 0.33$, $t(143) = 2.16$, $p = .033$). To further investigate the interaction, we then ran the correlation for each Condition separately. There was no correlation between self-control abilities and responses to the free will questions for children who answered the free will questions first (*partial* $r(69) = 0.011$, $p = .925$). There was however a significant correlation between self-control ability and subsequent responses to free will questions for the children who completed the self-control tasks first (*partial* $r(72) = 0.336$, $p = .003$). For these children, self-control success or failure predicted higher or lower free will scores (respectively). Splitting the free will questions by type showed that the correlation with self-control was especially strong for beliefs about desire inhibition (Inhibition Questions: *partial* $r(72) = 0.363$, $p = .001$; Action Questions: *partial* $r(72) = 0.211$, $p = .071$).

We also examined whether the causal link in the Self-Control First condition was driven by experience of success, of failure, or some amount of both. We did this by dividing children into groups based on whether they passed both self-control tasks, passed one task, or failed both tasks. Fig. 4 shows a comparison of the average proportion of free will endorsements for children in both Conditions (Self-Control Tasks First, Free Will Questions First) grouped by how many self-control tasks they passed. A glance at the figure reveals that the experience of failure, rather than success, influenced free will beliefs. Two analyses confirmed this finding. First, children who failed both self-control tasks and then answered free will questions had lower free will beliefs than children who failed both tasks in the opposite order ($t(39) = 2.59$, $p = .014$). Second, children who failed both tasks and then answered free will questions had lower free will beliefs than children who passed both ($t(30) = 2.51$, $p = .018$) or failed only one ($t(63) = 2.96$, $p = .004$). Children who passed both or one task were not different from each other, and were not different from their counterparts in the opposite order (all p-values n.s.).

7. Discussion

The results of Study 2 replicated and extended our findings from Study 1 in a new sample of 4- to 5-year-old children. Controlling for age and general cognitive ability, U.S. children who were better at self-

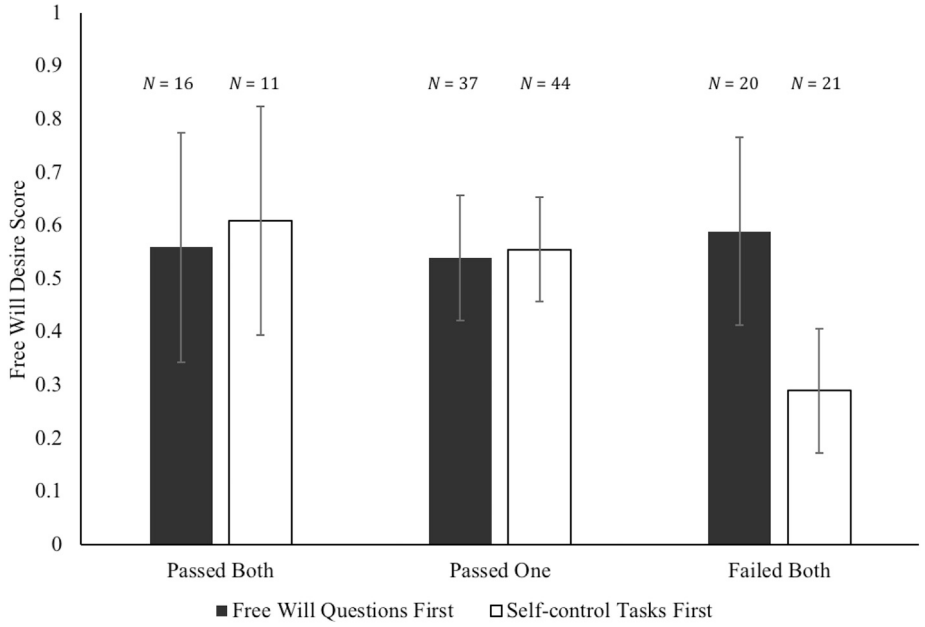

Fig. 4. Free Will Desire Score split by Condition (Self-Control Tasks First, Free Will Questions First) and performance on self-control tasks (error bars represent 95% Confidence Interval).

control were also more likely to endorse the possibility of acting against their own desires and inhibiting desires. The magnitude of the correlation in Study 2 was lower than Study 1 (0.173 vs 0.49), but notably falls in the range between the two individual correlations of Toy Sort (0.39) and Gift Wrap (0.12) in Study 1, so is consistent with our previous findings. However, the number of changes between the two studies – procedural differences and a restricted age range – suggest a cautious interpretation of effect size.

This finding lends further support to the idea that, in U.S. children, there is a link between what children believe about their own self-control and what they are capable of doing. Our results further suggest a causal direction of influence, driven by evidence of self-control failure. Children who experienced two failed attempts at self-control in the laboratory setting had significantly reduced beliefs about free will compared to children who succeeded even once. There was no indication that success at self-control increased children's belief in free will in a similar way. We consider several possibilities and implications for this asymmetry in the general discussion.

7.1. Study 3

In Study 3, we extend our research to a new population of children from Peru. Peruvian children were tested as part of a broader effort to extend developmental research to a lesser studied population of children. Given that the children in Asian cultures showed a more protracted development of free will beliefs, we included a broader age range than Study 2, sampling children from age 4 to age 7. Other than that, we followed the exact procedure from Study 2 above, in order to make the comparison as straightforward as possible. We investigated children's first-person free will beliefs, self-control abilities, and correlations between the two, to see if the cross-cultural moderation found in Study 1 would hold in this different cultural context. We also investigated the causal hypotheses as in Study 2 by randomly assigning children to two conditions (Self-Control Tasks First, Free Will Questions First) and looking at influences in both directions.

8. Methods

8.1. Participants

Participants included 116 Peruvian 4- and 7-year-olds (4.32–7.99 years old, $M = 6.79$, $SD = 0.89$). Fifty-eight of these children completed the self-control tasks first (4.41–7.99 years old, $M = 6.74$, $SD = 0.87$), and 58 completed the free will tasks first (4.32–7.99 years old, $M = 6.83$, $SD = 0.91$). Two additional Peruvian children were excluded from analysis due to experimenter error. Peruvian children were recruited and tested at Innova schools in Lima, Peru. Innova schools is a chain of private schools that serves families from emerging middle-class backgrounds (families transitioning from lower SES to middle SES). Schools were located in lower income neighborhoods in central Lima, or in the outskirts of the city. In general, the average income of families across all the Innova schools is around $1200 per month. Most parents have a high school degree but do not have access to higher education, and most are independent workers or small business owners. Spanish was the native language of the children, but most children were second or third generation internal immigrants from the Andean highlands and were from indigenous familial backgrounds.

8.2. Procedure and measures

Children were tested in a private office in their school. Study procedure and measures were identical to those in Study 2; however, the experiment was conducted in Spanish. Materials were translated from English to Spanish, and then back translated by bilingual members of the research team, including an experienced Peruvian linguist who specializes in language acquisition. For the free will questions, "have to" was translated to "tienes que" and "just choose to" was translated to "puedes simplemente escoger". Testing sessions were videotaped and each session lasted approximately 20 min. The coding procedures were the same as those in Study 2. The reliability between two coders was 97.25% for Toy Sort and 80.06% for Gift wrap.

9. Results

Descriptive statistics for each self-control task and each free will

question can be seen in Table 7.

9.1. Self-control tasks

As in Study 2, we summed up children's standardized scores for two self-control tasks and formed a Self-Control Composite score. To explore whether age and condition had effects on children's self-control performance, we ran an ANCOVA with the Self-Control Composite score as the dependent variable, Condition (Self-Control Tasks First, Free Will Questions First) as a between-subject factor and Age as a covariate. We found a significant effect of Age ($F(1,113) = 19.34, p < .001, \eta_p^2 = 0.15$); older children performed better than younger children, similar to U.S., Chinese, and Singaporean children in Study 1.[5] Also, we found no effect of Condition ($p = .54$).

9.2. Free will questions

We first looked at children's answers to the control questions (possible, impossible). As with children in the U.S., China and Singapore, a significant majority of children in Peru distinguished between possible and impossible choices (see Table 7).

We then looked at children's responses to the free will desire questions. McNemar's tests showed no differences between the food item and activity item for any type of questions (i.e., inhibition or action, p's $>$ 0.52). We therefore averaged their scores for the two inhibition questions to form a Free Will Inhibition Score and averaged their scores for the two action desire questions to form a Free Will Action Score. Also, an overall Free Will Desire Score was calculated by averaging their scores for all four desire questions. Descriptive statistics can be seen in Table 7.

To investigate whether age and condition had effects on children's responses to two types of free will desire questions (Inhibition and Action), we first ran a Repeated Measures MANOVA on children's responses using Question Type (Inhibition, Action) as a within-subject factor and Age as a covariate. We found only a main effect of age ($F(1,113) = 12.60, p = .001, \eta_p^2 = 0.10$); older children had a stronger belief in free will to act against or inhibit desires. We found no effect of Question Type ($p = .80$) or Condition ($p = .08$).

9.3. Explanations

Explanation details are included in a supplementary table. Supplement also includes a comparison between explanations in Study 2 (U.S.) and Study 3 (Peru).

9.4. Conservation of number

The mean conservation score was 1.95 ($SD = 0.98$, scale = 0–3). One child did not complete the conservation task. An ANCOVA with the Conservation score (0–3) as the dependent variable, Condition as a between-subject factor and Age as a covariate revealed a significant effect of Age ($F(1,112) = 6.97, p = .009, \eta_p^2 = 0.059$); older children performed better than younger children. Again, we found no effect of Condition ($p = .81$).

[5] To compare Gift Wrap and Toy Sort performance of Peruvian children in Study 3 with performance on those same two tasks given to U.S., Chinese, and Singaporean children in Study 1, we calculated a total Self-Control Score for the two tasks (Gift Wrap and Toy Sort) used in both studies and ran an ANCOVA on the total Self Control score with Age, Culture, and Age X Culture interaction as independent variables. The results reveal significant effects of Age ($F(1, 282) = 51.78, p < .001, \eta_p^2 = 0.16$) and no other effects. We thus confirmed that children across cultures in this age range performed comparably on our self-control tasks.

9.5. Relationship between self-control and free will beliefs

There was not a significant correlation between Peruvian children's self-control abilities and free will beliefs, controlling for age and conservation score (*partial* $r(111) = 0.084, p = .38$). Controlling for children's age and conservation scores, the correlations did not approach significance for either Condition (Free Will Questions first, $r(53) = 0.091, p = .51$, Self-Control Tasks first, $r(54) = 0.061, p =. 66$). We therefore did not conduct any further analyses of order differences.

9.6. Additional exploratory comparisons between Peruvian and U.S. children

U.S. and Peruvian children's self-control scores were comparable (see footnote). Peruvian children's responses to free will questions in this study were noticeably lower than those of U.S. children in Study 2, despite the fact that they increased with age, and the Peruvian children were older than the U.S. children on average. Because Peru is a new cultural context for studies on free will beliefs, we explored the cultural comparison with additional analyses. We ran a Repeated Measures MANOVA on children's Free Will responses with Culture (U.S., Peru) as a between-subjects factor, Question Type (Inhibition, Action) as a within-subject factor, and Age, Conservation Score and Self-Control score as covariates to control for general age-related cognitive change. The model yielded expected significant main effects of Age ($F(1,259) = 8.70, p = .003, \eta_p^2 = 0.03$), Conservation Score ($F(1,259) = 8.33, p = .004, \eta_p^2 = 0.03$) and Self-Control score ($F(1,259) = 4.14, p = .043, \eta_p^2 = 0.02$); older and more cognitively advanced children in both cultures were more likely to endorse their own free will. Controlling for these influences, however, the model also yielded a significant main effect of Culture ($F(1, 259) = 38.65, p < .001, \eta_p^2 = 0.13$) and a significant Culture X Question Type interaction ($F(1,259) = 5.82, p = .017, \eta_p^2 = 0.02$). Post-hoc tests show that Peruvian children had lower belief in free will for both action and inhibition than U.S. children's (p's < 0.001), so the interaction reflects a significant magnitude difference only. Table 7 shows the means side-by-side for comparison.

10. Discussion

Study 3 yielded several main findings. In this new cultural context, we found that children's beliefs about the freedom to act against and inhibit desires increased between ages 4 to 7. However, like the Singaporean children in Study 1, they were markedly lower than free will beliefs of U.S. children. Peruvian children's self-control abilities and cognitive abilities advanced over this age range but were uncorrelated with free will beliefs. Neither were there causal effects of one set of measures on the other.

10.1. General discussion

We investigated links between self-control behavior and developing belief in our own and others' free will – specifically, beliefs about the freedom to choose acting against and inhibiting strong desires – in children ages 4 through 9. Across three studies, we found age-related changes in children's free will beliefs in four cultures – U.S., China, Singapore, and Peru, extending prior work in this age range to new cultural contexts (Kushnir et al., 2015; Wente et al., 2016). With age, children increasingly endorsed the possibility of acting against and inhibiting strong desires both for people in general (Study 1) and for themselves in particular (Studies 2 and 3). Moreover, free will beliefs had a culturally variable time course, even though they showed age-related change in all cultures. In contrast, we found a common developmental time-course for improvements in children's self-control and inhibitory control abilities as would be expected given developments in general cognition and executive functioning (Davidson et al., 2006; Zelazo & Carlson, 2012). Despite these similarities, however, the link

between self-control behaviors and free will beliefs was culture-specific. In the U.S. samples in Studies 1 and 2, children who had better self-control also believed more strongly in the possibility of controlling desires. We found this same positive correlation between self-control abilities and free will beliefs whether we asked about the general ability to exercise free will as in Study 1, or asked children to reflect on their own free will as in Study 2. However, we did not find such links in China, Singapore or Peru.

These data suggest that the Western causal-explanatory framework–which include an emphasis on internal mental states – frame children's experience of their own self-control. As further support for this idea, we found some indication that the culturally-moderated link has a causal basis. In Study 2, self-control behaviors influenced children's free will beliefs, at least in the short-term. In particular, children who failed two self-control tasks had a lower belief in free will compared to children who completed one or both self-control tasks successfully. We did not find a causal influence in the opposite direction, suggesting that improving or depleting self-control in the short term involves more than simply affirming that one believes it is possible.

Our results stand in contrast to prior work showing a culturally universal link between Theory of mind (as measured by scales of basic belief-desire reasoning, e.g. Wellman & Liu, 2004) and Executive functioning (which includes tasks measuring inhibition and self-regulation but also working memory and task-switching, Sabbagh et al., 2006). However, we do not see our results as challenging the basic findings of this prior work, nor do we view them as incompatible with it. Executive functioning and Theory of mind are linked in large part because increasingly sophisticated abilities to engage in belief-desire reasoning and perspective taking rely on the ability to engage cognitive control and response inhibition mechanisms. Our data suggests that beliefs about our ability to "choose" are top-town, culture-dependent interpretations of self-regulatory actions. Thus the findings of the current study offer a more nuanced picture of bi-directional links between cognitive processes and social-cognitive beliefs: Our basic belief-desire psychology extends and changes in middle childhood to incorporate cultural knowledge of mind, self, and agency (Markus & Kitayama, 1991, 2003, 2010; Miller et al., 2011; Savani et al., 2010), and developments in self-regulation and executive functioning influence what we learn about ourselves and our social world both directly and indirectly. We therefore join a growing number of researchers who have argued for the importance of probing developments in Theory of mind beyond age four (see Lagattuta et al., 2015). This study adds to this literature by underscoring the cultural origins and behavioral consequences of many of our later-developing social-cognitive beliefs.

These results also raise important questions about the causal pathways through which cultural values, as they are transmitted by caregivers and communities, interact with opportunities to practice self-control, and with children's emerging ability to reflect on their own desires, accomplishments, and goals. The results of Studies 1 and 2 can be understood in light of well-documented cultural differences in causal attributions between East and West (Markus & Kitayama, 2003; Miller et al., 2011; Morris & Peng, 1994). These cultural differences emerge in parent-child conversation (Wang & Fivush, 2005), are found in books and other media children consume (Goyal, Wice, Aladro, Kallberg-Shroff, & Miller, 2019), and have implications for their developing knowledge of themselves and the social world (Shtulman, Foushee, Barner, Dunham, & Srinivasan, 2019; Wang, 2006). Our findings suggest that these attributional biases may similarly influence how children interpret their own actions.

Our results imply that developing beliefs about internal struggles between desire and "will" are only one of many possible cultural models for action understanding. U.S. children are socialized to connect their emerging understanding of desires – how they operate, how they conflict and how they can be overridden – with the struggles of the will. Thus, they may naturally interpret the experience of self-control as an internal struggle of conflicting desires, and learn to attribute self-control performance to an act of will. Children in Singapore, China, (and perhaps Peru) may be learning to view the same struggle in the same type of self-control task through a different attributional framework. Speculatively, experiences of successful and failed self-control experiences might lead to attributions about norm compliance, without necessarily invoking internal "will" as an intermediary. In China, for example, parents place a strong emphasis on consequences towards others (e.g. family members) and group norm-following as causal explanations for actions (Wang, 2006; Yau & Smetana, 2003). In Singapore, children reference punishment for norm violations as an explanation for why norms must necessarily limit the possibility of acting on desires (Chernyak et al., 2019). Thus, for children in these cultures, beliefs that matter most for self-regulation, and thus the beliefs that are most influenced by evidence from self-control success and/or failure, may be those that govern the extent to which social norms constrain personal autonomy. With regards to Peruvian children, our findings here are necessarily preliminary. More background is needed about socio-cognitive development of young children in Peru and how it connects to the transmission of cultural values. Thus, the variety of causal-explanatory frameworks, and how they emerge in development, and how (or whether) they connect to children's self-control remain open questions for future research.

We also hope that future work can address the limitations of the current study, in particular to overcome methodological challenges that limit generalizability. Replication with larger samples of children and across more diverse cultural contexts is needed. Moreover, as self-control is always context-dependent, more work is needed to assess whether our results depend on the nature of the self-control task itself. In particular we suggest contrasting tasks that reward compliance with rules (our gift wrap and toy sort tasks are prime examples) with temporal discounting tasks that "reward" the future self (Metcalf & Atance, 2011). Both present challenges that have to be overcome, but they involve different motivational structures.

The causal influence found in Study 2 suggests that the Western emphasis on internal mental states as explanations for action may have shaped U.S. children's interpretation of their self-control experiences. A fruitful direction for self-control research could include thinking about how, over the long term, children's self-control experiences contribute to their developing cultural models of self.

Interestingly, the finding that failure drove differences in free will beliefs rather than success runs counter to the beneficial training effects found in prior work with young children (Haimovitz et al., 2019), and is the only such finding we are aware of that shows that children's self-beliefs are asymmetrically affected by their own struggles and failure (though similar results have been found for relative failure in comparison to peers, e.g. Rhodes & Brickman, 2008). One possibility is that failure is simply a more salient experience than success. On this view, U.S. children who struggle more (and fail more often) at self-control will end up with beliefs that desires determine actions, no matter what. This intriguingly suggests that individual differences in our adult belief in free will might have origins in our self-regulatory abilities as children.

Another possibility is that this asymmetry is underpinned by prediction error at an unexpected result – children may have been confident they could succeed, surprised that they didn't, and therefore were driven to explain the failure by appealing to internal mental causes. In fact, in previous studies, U.S. children have been more likely to attribute failure at self-control to internal factors, such as preferences or desires, and success at self-control to external sources (Kushnir et al., 2015; Wente et al., 2016). Along these lines, it follows that in tasks where children predict they will fail, but they unexpectedly succeed, this may drive them to explain success with a positive view of their own free will. The prediction error account also suggests that that the pattern of results relies on children's ability to monitor their own performance. In our tasks, failure was relatively easy to monitor (children could see themselves failing to wait) but success (waiting until the experimenter returned or waiting until the gift was wrapped) had no tangible

outcome. Future work could explore whether explicit predictions of success or failure, or explicit rewards for either, change beliefs differently. Moreover, any self-control task in which one's performance is difficult to monitor (such as Hearts & Flowers, which we did not use in Study 2) would likely lead to different patterns of change (or no change) to beliefs. Future empirical work, therefore, is needed to test a prediction error explanation more directly and including a wider range of self-control measures and circumstances is an important first step.

There is a third possibility, that children combine evidence from their own actions with social input from their parents and caregivers. In recent years, there has been an enormous interest in the effects of praise for success or hard work on young children's self-beliefs and on their persistence and determination in the face of difficulty (e.g., Bian, Leslie, Murphy, & Cimpian, 2018; Cimpian, Arce, Markman, & Dweck, 2007; Mueller & Dweck, 1998; Rhodes, Leslie, Yee, & Saunders, 2019). Comments made about children's self-control actions from parents and caregivers might enhance children's salient or unexpected action experiences.

Of course like many laboratory studies showing the effects of praise on persistence, our results are only a proof-of-concept for potential causal links, and the enduring influence of social-cognitive knowledge on behavior, and of behavioral competencies on social-cognition, within the Western cultural framework emphasizing "will" and desires is likely to unfold in interesting ways over the long term. Further work, including longitudinal studies tracking belief-behavior links over time, will shed light on how children learn to reflect on their actions, framed by social input and cultural knowledge, and how this may make all the difference to creating enduring self-beliefs.

Credit author statement

TK and AG conceptualized project and obtained funding. Design of studies and execution of research by AZ and AW. Research execution and resources in China by AZ, supervision of Singapore research by AZ and TK. Research execution and resources in Peru by AW, MF and DS. AZ and TK analyzed data and drafted first draft of manuscript; all authors contributed to the writing of the final manuscript.

Author NOTE

We have no known conflicts of interest to disclose.

Declaration of Competing Interest

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

Acknowledgment

This work was supported by FSU and John Templeton Foundation on the Philosophy and Science of Self-Control (to A.G. and T.K.), Bezos foundation (to A.G.), the Harold Feldman, Flemmie Kittrell, Flora Rose, and Ethel Waring Fellowship (to X.Z.) and Carlos Rodríguez-Pastor. The authors would like to exdent a special thanks to Carissa Kang for collecting data in Singapore and Ithaca, and Liqi Zhu for help with data collection in Beijing. The authors would also like to thank research assistants Cindy Wu, Teresa Garcia, Emily Anne Shultz, and Sophie McMullen for help with data collection and coding, as well as the parents, children, teachers and administrators in Beijing, Singapore, Lima, Berkeley and Ithaca.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cognition.2021.104609.

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