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Will-powered: Synchronic regulation is the difference maker for self-control

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ABSTRACT

Philosophers, psychologists, and economists have reached the consensus that one can use two different kinds of regulation to achieve self-control. Synchronic regulation uses willpower to resist current temptation. Diachronic regulation implements a plan to avoid future temptation. Yet this consensus may rest on contaminated intuitions. Specifically, agents typically use willpower (synchronic regulation) to achieve their plans to avoid temptation (diachronic regulation). So even if cases of diachronic regulation seem to involve self-control, this may be because they are contaminated by synchronic regulation. We therefore developed a novel multifactorial method to disentangle synchronic and diachronic regulation. Using this method, we find that ordinary usage assumes that only synchronic—not diachronic—regulation counts as self-control. We find this pattern across four experiments involving different kinds of temptation, as well as a paradigmatic case of diachronic regulation based on the classic story of Odysseus and the Sirens. Our final experiment finds that self-control in a diachronic case depends on whether the agent uses synchronic regulation at two moments: when she (1) initiates and (2) follows-through on a plan to resist temptation. Taken together, our results strongly suggest that synchronic regulation is the sole difference maker in the folk concept of self-control.

Sujay and Denise are both trying to use Facebook less. With great effort, Sujay resists the temptation to check his feed each time he opens his phone. In contrast, Denise deletes the app to remove the temptation of Facebook entirely. Clearly, both Sujay and Denise take actions to regulate their use of Facebook. Yet the consensus in psychology (Duckworth, Gendler, & Gross, 2016; Hofmann & Kotabe, 2012; Inzlicht, Werner, Briskin, & Roberts, 2020; Sjåstad & Baumeister, 2019), philosophy (Connor, 2014; Haas, 2021; Kennett & Smith, 1996; Mele, 1987; Mele, 2003; Mele, 2014), and economics (DellaVigna & Malmendier, 2004; Duckworth, Milkman, & Laibson, 2018; Laibson, 1996; Thaler & Shefrin, 1981) makes a far more contentious claim: Sujay and Denise both exercise *self-control* to resist the temptations of social media. According to this consensus, Sujay and Denise use different kinds of self-control that depend on different forms of regulation. Sujay uses willpower to effortfully resist the temptations of Facebook. This is *synchronic* regulation because it involves effortfully resisting a current temptation. Denise instead modifies her situation so she won't be tempted by Facebook in the first place. This is *diachronic* regulation because it involves implementing a strategy to reduce future temptations.[1]

Yet this consensus may rest on intuitions that are contaminated in a

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[1] The philosophical literature distinguishes between *synchronic self-control* (an agent's ability to overcome a commitment-contrary desire that is currently active and motivationally dominant) and *diachronic self-control* (the ability to overcome foreseeably, but not currently, dominant commitment-contrary desires). The philosophical discussion centers on whether synchronic self-control is possible, given that it seems to contradict the widely-held principle that agents always act on their strongest desire. In the psychological literature, recent models distinguish between two kinds of self-control strategies: *preventive* or *situational* strategies (anticipatory techniques aimed at minimizing the extent to which strong commitment-contrary desires may arise in the future) and *interventive* or *intrapsychic* strategies (reactive techniques used to cope with currently active, commitment-contrary desires). For our purposes, the situational/intrapsychic, preventative/interventive, and synchronic/diachronic distinctions are equivalent.

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systematic way (Sripada, 2021). Specifically, in cases where the agent uses diachronic regulation to resist a temptation, she typically uses synchronic regulation as well. So even if cases of diachronic regulation seem to involve self-control, this may be because they are contaminated by synchronic regulation. Call this the "Contamination Hypothesis." Consider Denise, who deletes the Facebook app to avoid future temptation. Denise will require considerable willpower to delete the app. She may also need willpower to resist the temptation to reinstall the app later. According to the Contamination Hypothesis, our intuition that Denise exercises self-control may be driven by the synchronic willpower she uses to effortfully implement and follow through on her plan.

So what are the difference-makers for self-control: synchronic regulation, diachronic regulation, or both? Our question is not about which *scientific model* of self-control best predicts and explains results from cognitive psychology. Rather, we ask about the *concept* of self-control. *Self-control* is not merely a technical, scientific concept; it's one that arose from ordinary language. The concept of self-control dates back at least to ancient India (*Kaṭha Upaniṣad*, Verses 1.3 3–11; *The Bhagavad Gītā* 2.60–2.64, *Dhammapada*, Verses 94, 103–4, 281) and Greece (Plato, *Phaedrus*, secs. 256b, 253d–254) and remains integral to how ordinary people conceptualize their lives. We empirically investigate this folk concept of self-control. Specifically, we ask whether the folk concept tracks synchronic and/or diachronic regulation. To answer this question, we cannot look to everyday cases of self-control, because there are vanishingly few ordinary examples of pure, uncontaminated diachronic regulation. We therefore developed a novel factorial method to "decontaminate" self-control by disentangling the contributions of synchronic and diachronic regulation.

Across eight experiments, we find significant and large effects of synchronic regulation on self-control ratings, but no significant effect of diachronic regulation. Our final experiment also tests and finds support for a model on which self-control ratings in diachronic cases are determined by synchronic regulation at two moments: when the agent (1) initiates and (2) follows-through on a plan to resist temptation. Our results strongly suggest that synchronic regulation is the sole difference-maker in the folk concept of self-control. In the Discussion, we argue that these results have three implications in the science of self-control, concerning (a) the nature of self-control and how to (b) communicate and (c) interpret results on the efficacy (or inefficacy) of willpower.

1. Studies 1a–d: Diachronic vs synchronic regulation

Pre-registered predictions, data, and statistical analyses for all studies (1–4) are available on the OSF page for this paper: https://osf.io/qv42r/?view_only=7caf5e80064145c3ac4dda329c0b3acc. Stimuli and supplementary methods are included in the online appendix.

1.1. Participants

Studies 1a–d presented participants with vignettes in which a subject refrains from different kinds of temptations: using a mild drug (coffee) (Study 1a, $N = 177$), eating junk food (Study 1b, $N = 83$), using social media (Study 1c, $N = 83$), or socializing (Study 1d, $N = 82$). We used the software G*Power (Faul, Erdfelder, Lang, & Buchner, 2007) to perform a priori power size calculations. Based on pilot data, we expected our 2 × 2 ANOVAs to have large effects of interest in the mild drug ($F = 0.4$) and other cases ($F = 0.5$). Given power of 95% and significance of $p < .05$, we anticipated that 120 for Study 1a (the mild drug case) and 76 each for Studies 1b–d. We planned to recruit 156 participants for Study 1a and 84 participants each for Studies 1b–d to account for exclusions and recruit an equal number of participants per group. Due to an error in data collection and simultaneous recruitment in Qualtrics, 178 participants enrolled in Study 1a and 85 participants enrolled in Study 1c. Five participants failed attention checks, for the following sample sizes listed above (see Table 1 for demographic information).

Participants were recruited through Amazon MTurk for Study 1a. Three qualification conditions were applied to restrict participation on MTurk: (1) participants needed to be located in the United States, (2) have earned the 'Masters' label and (3) have an approval rate above 90%. Due to concerns about automation on MTurk, we used Prolific for Studies 1b–d. Two qualification conditions were applied to restrict participation on Prolific: participants needed (1) to only speak English and (2) have an approval rate above 95% (Peer, Vosgerau, & Acquisti, 2014). On average, the study took 140 s to complete. Participants were compensated $0.50 for participation ($12.86 per hour). All participants provided electronic consent following the procedures approved by the University of Virginia's Institutional Review Board for the Social and Behavioral Sciences.

Table 1
Demographic information for Studies 1a–d.

Study	Temptation	N	Gender	Age (years)
Study 1a	Mild Drug	177	108 male, 70 female	$M = 40.8$; $SD = 11.0$
Study 1b	Junk Food	83	29 male, 53 female, 1 other	$M = 32.7$; $SD = 10.8$
Study 1c	Social Media	83	21 male, 62 female	$M = 32.9$; $SD = 12.0$
Study 1d	Socializing	82	37 male, 45 female	$M = 37.0$; $SD = 14.6$

1.2. Materials and procedures

In a between-subjects design, each participant was presented with a written vignette in which a character Mo successfully refrains from an action. Studies 1a–d included different types of temptation: coffee, junk food, social media, or socializing. In a 2 × 2 factorial design for each study, we manipulated, (a) synchronic regulation and (b) diachronic regulation. See Table 2 for vignettes from Study 1b (junk food condition) and the Appendix for vignettes from other studies.

We manipulated synchronic regulation by altering whether Mo had to exert effort in the moment to not give into the temptation. In the synchronic regulation vignettes, Mo experiences a "strong craving" or "strong urge" to give into his temptation, which is "very hard—it requires enormous effort [to resist]." We specify that synchronic regulation requires *effort* because this is a central assumption of the standard models of synchronic regulation. In the vignettes without synchronic regulation, Mo feels a sudden (but temporary) aversion to the stimuli in question. In Study 1a, we did not explain *why* Mo suddenly becomes averse to coffee, which could have led participants to conclude that he does not usually like the beverage. Studies 1b–d therefore provided a backstory to explain why Mo's aversion is temporary. For example, in Study 1b, Mo experiences a temporary aversion to his favorite flavor of chips because he feels nauseous.

We manipulated diachronic regulation by altering whether Mo took action to avoid a current temptation (no diachronic regulation) or implemented a plan to avoid future temptation (diachronic regulation). Specifically, Mo's diachronic plans ensure that he doesn't even think about the temptation later (e.g. "Mo doesn't even think about going on Facebook later because it's not open on his computer.") To ensure that our results generalized to both actions and omissions, we varied whether Mo resists temptation via an action (in Study 1c) or omission (in all other Studies).

Participants read one vignette and then were asked, "How much self-control did Mo exercise?" to refrain from the action in question (1 = none; 4 = some; 7 = a lot). We also included manipulation checks to ensure that our conditions altered beliefs about synchronic and diachronic regulation. For synchronic regulation, we asked "how much effort did it take" for Mo to refrain from temptation ("zero effort" or "enormous effort"). For diachronic regulation, we asked whether Mo's actions avoided a lapse right now (no diachronic regulation) or later (diachronic regulation). See Appendix for the full text of all questions.

Table 2
Vignettes for Study 1b (junk food condition). In a 2 × 2 design, we manipulated synchronic regulation—no synchronic (italics) vs synchronic (<u>underline</u>)—and diachronic regulation—no diachronic (small caps) vs diachronic (**bold**).

Junk food	No synchronic	Synchronic
No Diachronic	Mo is trying to stop eating chips and sees his favorite flavor, sour cream and onion, on the menu while ordering lunch. As it happens, he is feeling pretty nauseous (he ate some bad tuna yesterday), so he suddenly feels a *strong aversion* to the chips; imagining the intense onion flavor makes him want to vomit. Mo doesn't order any chips because he wants to stop eating them, which is *very easy to do—it requires zero effort—because chips sound incredibly gross* to him right now. As a result, Mo doesn't eat chips with lunch.	Mo is trying to stop eating chips and sees his favorite flavor, sour cream and onion, on the menu while ordering lunch. Mo suddenly feels a <u>strong craving</u> for chips; imagining the sour cream and onion flavor makes his mouth water. Mo doesn't order any chips because he wants to stop eating them, which is <u>very hard to do—it requires enormous effort—because chips sound incredibly delicious</u> to him right now. As a result, Mo doesn't eat chips with lunch.
Diachronic	Mo is trying to stop eating chips and **sees his favorite flavor, sour cream and onion, at the supermarket. Mo knows he'll eat chips later if he buys them.** But as it happens, he is feeling pretty nauseous (he ate some bad tuna yesterday), so he suddenly feels a *strong aversion* to the chips; imagining the intense onion flavor makes him want to vomit. Mo doesn't buy chips because he wants to stop eating them, which is *very easy to do—it requires zero effort—because chips sound incredibly gross* to him right now. **Later today, Mo doesn't even think about eating chips because he has none in the house.** As a result, Mo doesn't eat chips **later.**	Mo is trying to stop eating chips and **sees his favorite flavor, sour cream and onion, at the supermarket.** Mo suddenly feels a <u>strong craving</u> for chips and **knows he'll want some later**; imagining the sour cream and onion flavor makes his mouth water. Mo doesn't buy chips because he wants to stop eating them, which is <u>very difficult to do—it requires enormous effort —because chips sound incredibly delicious</u> to him right now. **Later today, Mo doesn't even think about eating chips because he has none in the house.** As a result, Mo doesn't eat chips **later**.

1.3. Results

For each study, we conducted a 2 (synchronic regulation) x 2 (diachronic regulation) between-subjects ANOVA to assess whether judgments of self-control varied based on synchronic or diachronic regulation. The findings are illustrated in Fig. 1. We found large and significant effects of synchronic regulation regardless of whether the temptation was coffee (Study 1a; $F(1,173) = 210.74$, $p < 0.001$; $\eta^2 = 0.54$) junk food (Study 1b; $F(1,79) = 123.53$, $p < 0.001$; $\eta^2 = 0.60$), social-media (Study 1c; $F(1,79) = 31.5$, $p < 0.001$; $\eta^2 = 0.28$), or socializing (Study 1d; $F(1,78) = 54.7$, $p < 0.001$; $\eta^2 = 0.22$). In contrast, diachronic regulation did not have a significant effect for coffee ($p = .301$), junk food ($p = .522$), social media ($p = .170$), or socializing ($p = .651$). Similarly, the interaction between diachronic and synchronic regulation was not significant for coffee ($p = .125$), junk food ($p = .117$), social media ($p = .486$), though the interaction was trending for socializing ($F(1,78) = 7.52$, $p = 0.081$; $\eta^2 = 0.03$).[2]

The null effects of diachronic regulation cannot be attributed to participants not understanding our diachronic condition, since chi-squared tests of independence confirmed that our interventions manipulated beliefs about synchronic and diachronic regulation for coffee (diachronic: $\chi^2(1, n = 177) = 133, p < .001$; synchronic: $\chi^2(1, n = 177) = 173, p < .001$), junk food (diachronic: $\chi^2(1, n = 83) = 39.2, p < .001$; synchronic: $\chi^2(1, n = 83) = 79.1, p < .001$), social media (diachronic: $\chi^2(1, n = 83) = 14.8, p < .001$; synchronic: $\chi^2(1, n = 83) = 64.5, p < .001$), and socializing (diachronic: $\chi^2(1, n = 82) = 17.8, p < .001$; synchronic: $\chi^2(1, n = 82) = 57.9, p < .001$).

Our results strongly suggest that self-control judgments are driven by synchronic, rather than diachronic, regulation. That is, whether agents implement a strategy to eliminate future temptation has no effect on self-control judgments, which are driven solely by whether agents effortfully resist temptation.

2. Study 2: Odysseus and the cheese

Study 2 examined whether our results generalize to a different kind of diachronic self-control case, modelled on a classic example of self-control: Odysseus and the Sirens. In the story, Odysseus knows that he will have to sail by the Sirens, mythical creatures who sing an irresistibly beautiful song to lure passing sailors. Odysseus implements a diachronic strategy to avoid the sirens: his crew plugs their ears with wax (so that they cannot hear the Sirens) and then ties Odysseus to the mast. Odysseus can therefore listen to the Sirens without giving into temptation, because even if he "beg[s] and pray[s for] the men to unloose [him], then they must bind [him] faster" (Wilson, 2018, p. Book XII 19–20). Study 2 included a non-mythological version of the Odysseus case, in which Mo "ties himself to the mast" by giving his cheese to a roommate so he can't eat it.

2.1. Participants

We used G*Power (Faul et al., 2007) to perform an a priori power size calculation. Based on pilot data, we expected large effects of interest (F = 0.5). Given a power of 95% and significance of $p < .05$, we anticipated that 76 participants were required for an adequately powered analysis of variance. We planned to recruit 86 participants to allow for exclusions and to recruit an equal number of participants per group.

[2] One suggestive difference between conditions is this: self-control ratings in the no synchronic conditions were significantly below the midpoint for Studies 1a–b, but not Studies 1c–d. A post hoc explanation of this difference is that Studies 1c–d were about social temptations (social media and a party) whereas Studies 1a–b were about bodily temptations (coffee and junk food). People may therefore believe that it takes more self-control to resist social than bodily temptations. Future research is needed to specifically test this hypothesis.

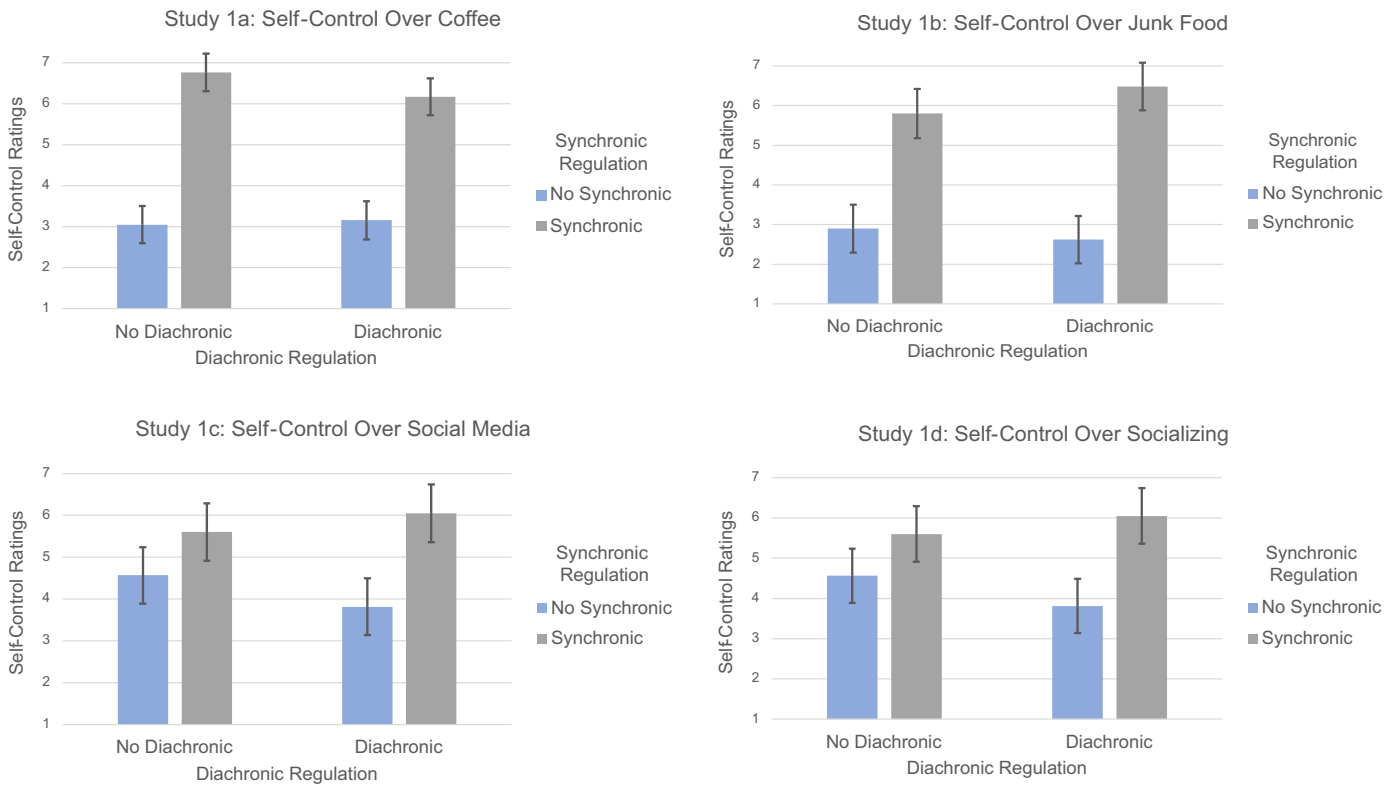

Fig. 1. Self-control judgments in the mild drug (Study 1a), junk food (Study 1b), social media (Study 1c), and socializing (Study 1d) conditions depend on synchronic regulation, but not diachronic regulation. Error bars represent 95% confidence intervals.

Eighty-six participants (60 male, 24 female, 2 other; $M_{age} = 34.1$ years; $SD_{age} = 11.2$ years) enrolled in the study and none failed an attention check. Participants were recruited through Prolific using the same procedures for qualification conditions, compensation, and consent as Study 1. On average, the study took 107 s to complete.

2.2. Materials and procedures

In a between-subjects design, each participant was presented with a written vignette, in which Mo refrains from eating cheese. In a 2 × 2 design, we varied whether Mo exercises synchronic or diachronic regulation (Table 3).

Crucially, in the diachronic regulation condition, Mo "ties himself to the mast" by giving his cheese away to his roommate so that he will not eat it tomorrow. The next day, Mo "begs and pleads" for his roommate to return the cheese, but she can't because it's gone. We therefore reproduce a crucial part of Odysseus and the Siren's story: Odysseus begs the sailors to allow him to give into his temptation, but they refuse to do so. We included this feature of the Odysseus story to tease apart which forms of regulation make a difference to self-control judgments. If diachronic and synchronic regulation are both difference-makers for self-control, our diachronic manipulation should *increase* self-control ratings, because it shows that Mo has implemented a plan to overcome an especially strong temptation (one he "begs and pleads" to give into). In contrast, if synchronic regulation is the sole difference-maker for self-control, our diachronic manipulation should *decrease* self-control ratings, because Mo's "begging and pleading" is evidence of a failure of synchronic regulation, not a success. On this interpretation, Mo succeeds not through self-control, but rather by his roommate's good graces.

Participants read one vignette and were then asked, "How much self-control did Mo exercise in order to not eat cheese?" (1 = none; 4 = some; 7 = a lot). Participants also answered two questions to ensure that our manipulations altered perceptions of synchronic and diachronic regulation. For synchronic regulation, we asked "How much effort did it take to not eat cheese" (zero effort, because cheese sounds gross or enormous effort, because cheese sounds delicious). For diachronic regulation, we asked "At the beginning of the story, is Mo preparing lunch for right now or tomorrow?" (right now or tomorrow).

2.3. Results

We conducted a 2 (synchronic regulation) x 2 (diachronic regulation) between-subjects ANOVA to assess whether judgments of self-control varied based on synchronic or diachronic regulation. The findings are illustrated in Fig. 2. We found a large and significant effect of synchronic regulation ($F(1, 82) = 102.91$, $p < 0.001$; $\eta^2 = 0.50$). Diachronic regulation also showed a significant, but *negative*, correlation with self-control ratings ($F(1, 82) = 17.26$, $p < 0.001$; $\eta^2 = 0.08$). We should find the opposite result—a positive correlation between diachronic regulation and self-control ratings—if synchronic and diachronic regulation were both difference-makers for self-control. Yet this negative correlation is consistent with the hypothesis that synchronic regulation is the sole difference-maker, because in the diachronic condition, Mo displays a synchronic regulation failure when "he begs and pleads with his roommate to let him eat the cheese" (§2.2).

The interaction between synchronic and diachronic control was not significant, though there was a trend at the 10% level ($F(1, 82) = 3.14$, $p = 0.08$; $\eta^2 = 0.02$). This interaction suggests that Mo's failure of synchronic regulation reduced self-control ratings more when he previously displayed synchronic regulation than when he did not (see Appendix). Chi-square tests confirmed that our manipulations altered beliefs about synchronic ($\chi^2(1, n = 86) = 71.4$, $p < .001$) and diachronic regulation ($\chi^2(1, n = 86) = 74.5$, $p < .001$). Our results strongly support the hypothesis that synchronic regulation is a difference-maker for self-control judgments, but diachronic regulation is not.

Table 3
Vignettes for Study 3. In a 2 × 2 design, we manipulated synchronic regulation—no synchronic (italics) vs synchronic (underline)—and diachronic regulation—no diachronic (SMALL CAPS) vs diachronic (bold).

	No Synchronic	Synchronic
No Diachronic	Mo is trying to stop eating cheese but discovers some leftover cheddar when he is preparing lunch. Mo's roommate asks if she can use the cheddar to make a grilled cheese sandwich. *As it happens, Mo is feeling pretty nauseous (he ate some bad tuna yesterday), so he suddenly feels a strong aversion to the cheese; imagining the sharp flavor of cheddar makes him want to vomit.* Mo gives the cheddar to his roommate because he wants to stop eating cheese, which is *very easy to do—it requires zero effort—because cheese sounds incredibly gross to him right now.* As a result, Mo doesn't eat cheese with lunch.	Mo is trying to stop eating cheese but discovers some leftover cheddar when he is preparing lunch. Mo's roommate asks if she can use the cheddar to make a grilled cheese sandwich. Mo suddenly feels a strong craving for the cheese; imagining the sharp flavor of cheddar makes his mouth water. Mo gives the cheddar to his roommate anyways because he wants to stop eating cheese, which is very hard to do—it requires enormous effort—because cheese sounds incredibly delicious to him right now. As a result, Mo doesn't eat cheese as a snack.
Diachronic	Mo is trying to stop eating cheese but discovers some leftover cheddar when he is **preparing lunch for tomorrow**. Mo's roommate asks if she can use Mo's cheddar to make a grilled cheese sandwich. *As it happens, Mo is feeling pretty nauseous (he ate some bad tuna earlier), so he suddenly feels a strong aversion to the cheese; imagining the sharp flavor of cheddar makes him want to vomit.* Mo gives the cheddar to his roommate because he wants to stop eating cheese, which is *very easy to do—it requires zero effort—because cheese sounds incredibly gross to him right now.* **At lunchtime tomorrow, Mo is feeling better and has an intense craving for cheddar. He begs and pleads with his roommate to let him eat the cheese because he can't stop thinking about how delicious it would be. His roommate says, "No, sorry," because she already ate her sandwich, so Mo sulks back to his room** and doesn't eat cheese for lunch.	Mo is trying to stop eating cheese but discovers some leftover cheddar when he is **preparing lunch for tomorrow**. Mo's roommate asks if she can use Mo's cheddar to make a grilled cheese sandwich. Mo suddenly feels a strong craving for the cheese; imagining the sharp flavor of cheddar makes his mouth water. Mo gives the cheddar to his roommate anyways because he wants to stop eating cheese, which is very hard to do—it requires enormous effort—because cheese sounds incredibly delicious to him right now. **At lunchtime tomorrow, Mo's craving for cheddar returns and it's intense. He begs and pleads with his roommate to let him eat the cheese because he can't stop thinking about how delicious it would be. His roommate says, "No, sorry," because she already ate her sandwich, so Mo sulks back to his room** and doesn't eat cheese for lunch.

3. Study 3a–b: Explicit planning

Studies 1 and 2 described diachronic regulation scenarios where Mo implements a plan to avoid a future temptation. Yet we did not explicitly use the word 'plan', so it is possible that participants did not understand that we were describing diachronic regulation. We therefore conducted conceptual replications of our junk food (Study 3a; $N = 84$) and Odysseus (Study 3b; N = 84) conditions that included explicit planning information.

3.1. Participants

We used the software G*Power (Faul et al., 2007) to perform an a priori power size calculation. Based on pilot data, we expected large effects of interest (F = 0.5). Given a power of 95% and significance of $p < .05$, we anticipated that 76 participants per study were required for an adequately powered analysis of variance. We recruited 84 participants per study to allow for exclusions and to recruit an equal number of participants per group. No participants failed an attention check for a total sample size of 84 in Study 3a (29 male, 55 female, $M_{age} = 35.7$ years; $SD_{age} = 11.7$ years) and Study 3b (17 male, 67 female, $M_{age} = 35.3$ years; $SD_{age} = 12.1$ years).

Participants were recruited through Prolific using the same procedures for qualification conditions, compensation, and consent as Studies 1 and 2. On average, the study took 87.60 s to complete.

3.2. Materials and procedures

Vignettes were identical to the junk food condition in Study 1b and the Odysseus condition from Study 2, except we explicitly specified that Mo "made a decision" to resist a current temptation in the no diachronic condition and that he "implemented a plan" to resist a future temptation in the diachronic condition. See supplementary materials for the complete vignettes. We asked participants the same questions as in the corresponding conditions from Studies 1 and 2.

3.3. Results

For each type of scenario, we conducted a 2 (synchronic regulation) x 2 (diachronic regulation) between-subjects ANOVA to assess whether judgments of self-control varied based on synchronic or diachronic regulation. Both studies replicated our findings from Studies 1 and 2 (Fig. 3). For Study 3a (the junk food scenario), we found large and significant effects of synchronic regulation ($F(1,80) = 58.1$, $p < 0.001$;)$\eta^2 = 0.41$) and no effect of either diachronic regulation ($p = .156$) or the interaction between synchronic and diachronic regulation ($p = .295$). For Study 3b (the Odysseus scenario), we found a large and significant effect of synchronic regulation ($F(1,80) = 40.4$, $p < 0.001$; $\eta^2 = 0.31$). Consistent with Study 2, we also found significant effects of diachronic regulation ($F(1,80) = 21.95$, $= 0.004$; $\eta^2 = 0.07$), which indicated that self-control ratings were *higher* in the no-diachronic scenario. The interaction between synchronic and diachronic regulation was not significant ($p = 0.141$). Chi-squared tests of independence confirmed that our manipulations altered beliefs about synchronic and diachronic regulation in the junk food (synchronic:$\chi^2(1, n = 84) = 72.5$, $p < .001$; diachronic:$\chi^2(1, n = 84) = 65.4$, $p < .001$) and Odysseus conditions (synchronic:$\chi^2(1, n = 83) = 71.8$, $p < .001$; diachronic:$\chi^2(1, n = 83) = 68.4$, $p < .001$).

4. Study 4: The Dynamics of contamination

Studies 1 through 3 suggest that diachronic regulation involves self-control only when it is contaminated by synchronic regulation. Study 4 investigated the dynamics of contamination. Specifically, we hypothesized that diachronic regulation involves self-control only when it is contaminated by synchronic regulation at the moment one (1)

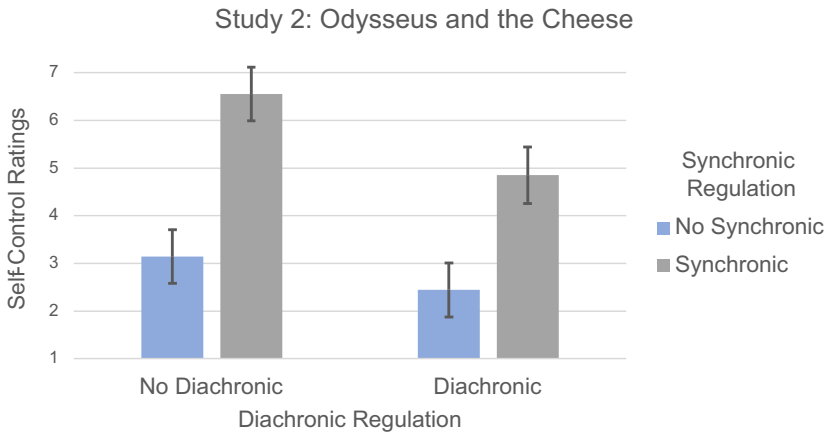

Fig. 2. Self-control ratings in Study 2 are positively correlated with synchronic regulation, but negatively correlated with diachronic regulation.

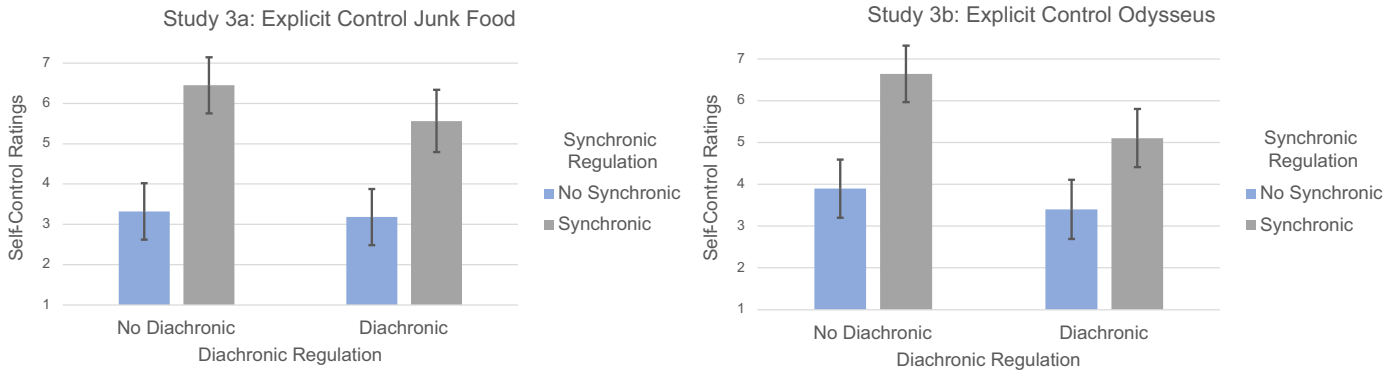

Fig. 3. Self-control ratings in Study 3.

implements a plan to avoid future temptation and/or (2) follows through on this plan.

4.1. Participants

We calculated a sample size for our secondary analysis, which was a linear regression. Based on pilot data, we expected the independent variables of that regression to interact with a ß of −0.062. Using the *pwr.r.test* function in R, given a power of 90% and significance of $p < .05$, we anticipated that 327 participants were needed for an adequately linear regression. We planned to recruit 340 participants through Prolific to account for exclusions and recruit an equal number of participants per group. We had 341 participants enrolled in the study because of simultaneous recruitment in Qualtrics. One participant failed an attention check for a total sample size of 340 (215 male, 123 female, 2 other; M_{age} = 34.4 years; SD_{age} = 11.9 years). Participants were recruited through Prolific using the same procedures for qualification conditions, compensation, and consent as Studies 1 through 3. On average, the study took 101 s to complete.

4.2. Materials and procedures

We presented participants with a case of diachronic regulation in which an agent, Mo, implements a plan to avoid drinking coffee in the future. In a 2 × 2 design, we orthogonally manipulated whether Mo uses synchronic regulation at the moment he (1) implements and (2) follows through on that plan (Table 4). Specifically, Mo follows through without synchronic regulation when he "doesn't even think about drinking coffee [later]," and follows through with synchronic regulation when he "considers walking to the nearest Starbucks [for coffee]," and has to exert "tremendous effort" in order to refrain from doing so.

Participants read one vignette and were asked, "How much self-control did Mo exercise in order to not drink coffee?" (1 = none; 4 = some; 7 = a lot). We then used a novel method to measure whether participants believed that Mo exercised self-control at the moment he initiates and follows through on his plan. To do so, we emphasized the appropriate part of the story (in bold and italics) and asked, "How much self-control did Mo exercise **at the [supermarket/home]** (the part of the story in ***italics***)" (1 = none; 4 = some; 7 = a lot). This allowed us to test whether overall self-control judgments decompose into temporally-specific judgments.

4.3. Results

We conducted a 2 (implementation) x 2 (follow-through) between-subjects ANOVA to assess whether overall judgments of self-control varied based on whether Mo used synchronic regulation (SR) to implement and follow-through on his plan. The findings are illustrated in Fig. 4. We found large and significant effects of SR at implementation ($F(1,336) = 146.6$, $p < 0.001$; $\eta^2 = 0.24$) and follow through ($F(1,336) = 158.80$, $p < 0.001$; $\eta^2 = 0.17$). We also found a significant and medium-sized effect of the interaction between SR at implementation and SR at follow-through ($F(1,336) = 47.09$, $p < 0.001$; $\eta^2 = 0.05$). This interaction indicates that SR at implementation and SR at follow-through are individually sufficient to generate high overall self-control ratings (see Fig. 4 and post hoc tests in the Appendix). The conjunction of both generates slightly higher self-control ratings than either individually, but this effect is considerably less than the difference between having SR

Table 4
Vignettes for Study 4. In a 2 × 2 design, we manipulated whether Mo uses synchronic regulation (SR) at the moment he implements — -SR implementation (italics) vs + SR implementation (underline)—and follows through on a plan–– + SR follow-through (SMALL CAPS) vs -SR follow-through (**bold**).

	-SR follow-through	+ SR follow-through
-SR Implementation	Mo is trying to quit drinking coffee and sees ground coffee at the supermarket. Mo knows he'll drink coffee later if he buys the grounds now. *But as it happens, he is feeling pretty nauseous (he ate some bad tuna salad yesterday), so he suddenly feels a strong aversion to coffee.* Mo doesn't buy ground coffee because he wants to quit, *which is very easy to do—it requires zero effort—because coffee sounds incredibly gross to him right now.* Later today, Mo doesn't even think about drinking coffee because he has none in the house. As a result, Mo doesn't drink coffee later.	Mo is trying to quit drinking coffee and sees ground coffee at the supermarket. Mo knows he'll drink coffee later if he buys the grounds now. *As it happens, he is feeling pretty nauseous (he ate some bad tuna salad yesterday), so he suddenly feels a strong aversion to coffee.* Mo doesn't buy ground coffee because he wants to quit, *which is very easy to do—it requires zero effort—because coffee sounds incredibly gross to him right now.* **Later today, Mo is feeling better and has a strong coffee craving, but he can't make any because he has none in the house. Mo considers walking to the nearest Starbucks (which is 20 min away) for coffee, but he stays home instead because he wants to quit. This is very difficult to do and requires tremendous effort, because Mo now thinks that coffee would be super delicious.** As a result, Mo doesn't drink coffee.
+SR Implementation	Mo is trying to quit drinking coffee and sees ground coffee at the supermarket. He suddenly feels a strong craving for coffee and knows he'll drink coffee later if he buys the grounds now. Mo doesn't buy ground coffee because he wants to quit, which is very difficult to do—it requires enormous effort—because coffee sounds incredibly delicious to him right now. Later today, Mo doesn't even think about drinking coffee because he has none in the house. As a result, Mo doesn't drink coffee later.	Mo is trying to quit drinking coffee and sees ground coffee at the supermarket. He suddenly feels a strong craving for coffee and knows he'll want some later. Mo doesn't buy ground coffee because he wants to quit, which is very difficult to do—it requires enormous effort—because coffee sounds incredibly delicious to him right now. **Later today, Mo's coffee craving returns, but he can't make any because he has none in the house. Mo considers walking to the nearest Starbucks (which is 20 min away) for coffee, but stays home instead because he wants to quit. This is very difficult to do—it requires tremendous effort—because Mo still thinks that coffee would be super delicious.** As a result, Mo doesn't drink coffee.

at only one moment vs none.

We next conducted a linear regression to model overall self-control with ratings of self-control at implementation and follow-through as covariates. We found that implementation ratings ($b = 0.84$; $SE = 0.05$; $p < .001$), follow-through ratings ($b = 0.82$; $SE = 0.06$; $p < .001$), and the interaction between them ($b = -0.09$; $SE = 0.01$; $p < .001$) were all significant predictors of overall ratings (Fig. 5). Visual inspection of Fig. 5 suggests that the interaction represents that implementation and follow-through have larger effects on overall ratings when the other receives a low rating, consistent with the interaction we found in our ANOVA.

We next conducted two ANOVAs to ensure that our manipulations altered beliefs about self-control at each moment. First, we conducted a 2 (implementation) x 2 (follow-through) between-subjects ANOVA to assess whether ratings of self-control at the moment of implementation depend on whether Mo used synchronic regulation at various points in the story. We found large and significant effects of SR at implementation ($F(1,336) = 292.60, p < 0.001; \eta^2 = 0.47$) but no significant effects of SR at follow-through and interaction between SR at the two moments.

Second, we conducted a 2 (implementation) x 2 (follow-through) between-subjects ANOVA with follow-through ratings as the dependent variable (Fig. 6). Here, we found a large and significant effect of follow-through ($F(1,336) = 322.42$, $p < 0.001$; $\eta^2 = 0.48$) on follow-through ratings. We also found significant but much smaller effects of initiation ($F(1,336) = 6.03$, $p = 0.015$; $\eta^2 = 0.009$) and the interaction between initiation and follow-through ($F(1,336) = 8.27$, $p = 0.004$; $\eta^2 = 0.012$). Visual inspection of Fig. 6 suggests that these latter effects may represent a mild form of "self-control tracing". Philosophers have extensively studied *responsibility tracing*, where an agent's responsibility for a later act (e.g. a drunken fight) traces back to their responsibility for a past act (e.g. the choice to drink) (Fischer & Ravizza, 1998; Khoury, 2012; Smith, 2015; Vargas, 2005). Our results similarly suggest that someone's self-control over a later act (when she follows through on a plan to reduce temptation) can be traced back to her synchronic self-control over an earlier act (when she implements that plan). The interaction indicates that tracing occurs only during the "no follow-through" condition, where, "Mo *doesn't even think about drinking coffee* because he has none in the house" (see Online Appendix for post hoc analyses that confirm this interpretation). This is similar to the responsibility tracing, which is prominent when agents unthinkingly commit negligent acts (Murray, 2020).

5. Discussion

Prominent psychologists (Duckworth, Gendler, & Gross, 2016; Galla & Duckworth, 2015; Hofmann & Kotabe, 2012; Inzlicht et al., 2020; Sjåstad & Baumeister, 2019), philosophers (Connor, 2014; Haas, 2021; Kennett & Smith, 1996; Mele, 1987; Mele, 2003, 2014), and economists (DellaVigna & Malmendier, 2004; Duckworth et al., 2018; Laibson, 1996; Thaler & Shefrin, 1981) have converged on the thesis that one can use different kinds of regulation to achieve self-control. Synchronic regulation uses willpower to effortfully resist current temptation, while diachronic regulation implements a plan to avoid future temptation. We hypothesize that this consensus rests on contaminated intuitions, since agents typically use willpower (synchronic regulation) to achieve their plans to avoid temptation (diachronic regulation).

We therefore developed a novel factorial method to "decontaminate" self-control, systematically pulling synchronic and diachronic regulation apart. We find that when they are disentangled, ordinary usage assumes that only synchronic regulation—not diachronic regulation—counts as self-control. We find this pattern across four different kinds of temptation (Studies 1a–d and 3a) and a self-control scenario based on the classic story of Odysseus and the Sirens (Studies 2–3b). Finally, we find that self-control in a diachronic case depends on synchronic regulation at two moments: when the agent (1) initiates and (2) follows-through on her plan to resist temptation (Study 4). Taken together, our results

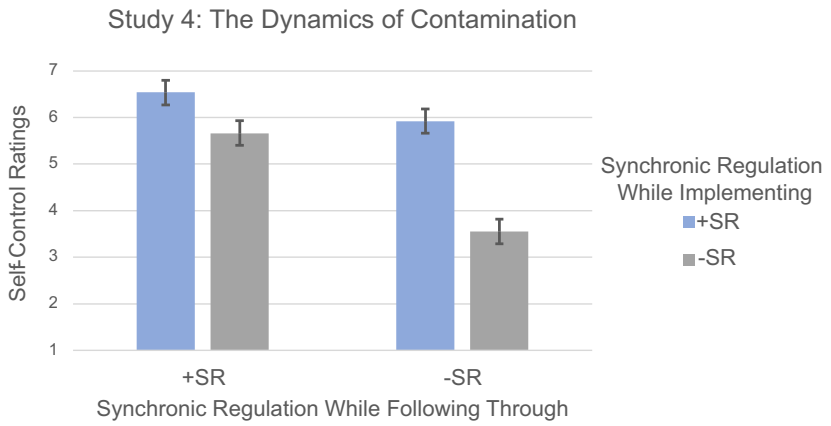

Fig. 4. Overall self-control ratings in Study 4 by synchronic regulation (SR) at implementation and follow-through.

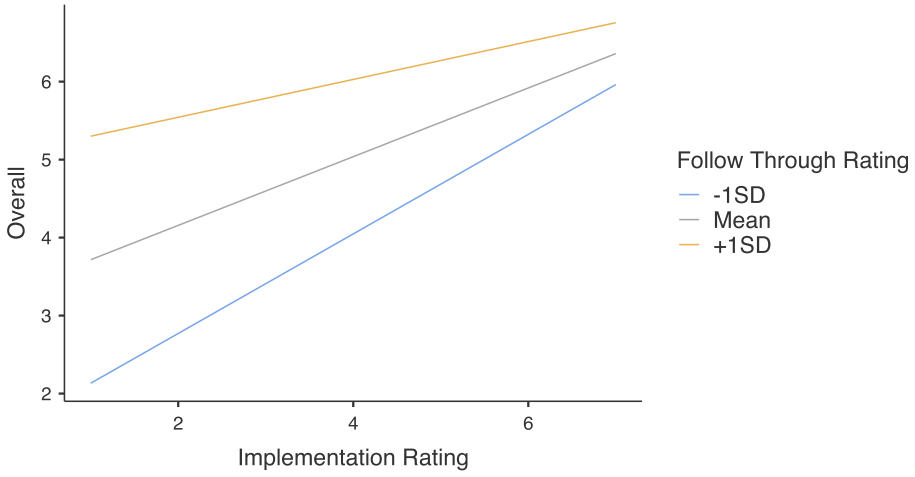

Fig. 5. Linear regression to predict overall self-control ratings by initiation and follow-through ratings.

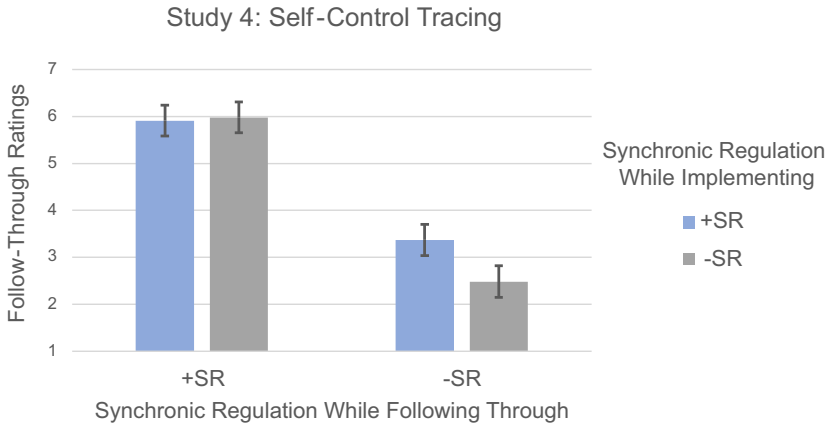

Fig. 6. Ratings of self-control when Mo follows through on his plans, by condition. We found a mild form of "self-control tracing" in the no-follow-through condition.

strongly suggest that synchronic regulation is the sole difference-maker in the folk concept of self-control.

Our results have implications for both descriptive and normative debates about self-control. In cognitive science, there is a lively debate between "mechanism" and "results" models of self-control. Mechanism models characterize self-control as a unified cognitive mechanism, such as the skilled use of cognitive control to effortfully suppress temptations (Bermúdez, 2021; Hofmann, Schmeichel, & Baddeley, 2012; Holton, 2009; Shenhav, 2017; Sripada, 2021). In contrast, results models (Duckworth et al., 2018; Fujita, Orvell, & Kross, 2020; Mele, 1987) assume that self-control can be realized by many disparate processes, which are unified only by their outcomes. Examples of the results that self-control produces include mastering desires that are inconsistent with one's all-things-considered judgments (Mele, 1987; Mele, 2003)

and choosing larger, later rewards over smaller, sooner ones (Laibson, 1997).

Our findings suggest that the folk view of self-control is inconsistent with results models. Across eight studies, we found that when agents successfully avoid temptation while bypassing synchronic regulation, the folk deny that this is an exercise of self-control. For instance, in one example of pure diachronic regulation, Mo masters his desire for cheese by tying himself to the proverbial mast. On Mele's results model, this is a straightforward case of self-control. Yet the folk believe the opposite: Mo does not exercise self-control because he eschews synchronic regulation.

In contrast, folk intuition is consistent with mechanism models, on which self-control relies on distinctive, effortful psychological mechanisms, such as the skilled use of "top-down" cognitive control. Pure cases of diachronic control bypass these mechanisms. For example, in Study 2, Mo does not require cognitive control to implement or follow through on his strategy to avoid eating cheese. Rather, he effortlessly implements the strategy because he is temporarily nauseous and because of an external constraint (the cheese is gone). So consistent with the folk view, mechanism models predict that pure diachronic regulation is not self-control.

Results-based views lump synchronic and diachronic regulation together because they achieve the same result. This has a theoretical cost: the views don't pick out unified psychological, computational, or neural processes. Consider the diverse processes that can lead one to use Facebook less. One can use executive processes to effortfully suppress temptations. Or one can use an app that limits screen time. Both processes lead to the same result, less Facebook. Yet an app has nothing in common with executive processes at the phenomenological, psychological, computational, or neural level. If the study of "self-control" is to include both processes, it's unlikely that researchers will find unified explanations, laws, mechanisms, computations, etc. for all cases of self-control (Adams & Aizawa, 2001; Bermúdez, Murray, Chartrand, & Barbosa, 2021; Herdova, 2017).

Of course, intuitive psychological categories don't always pick out unified processes. For example, Allport (2011) argues that the folk concept of *attention* picks out a set of processes unified only by their common *result*: selection for action. Similarly, if the folk concept of self-control picked out a disjunctive set of processes that achieve a common result, this would motivate a results model of self-control. Yet we find the opposite. The folk use 'self-control' to refer to only one process: synchronic regulation.

Our data also bear on how to frame and interpret normative findings about whether self-control is effective. Psychologists and economists have increasingly argued that diachronic regulation is more effective than synchronic regulation (Duckworth et al., 2018; Hofmann et al., 2012; Wilkowski, Ferguson, Williamson, & Lappi, 2018). For example, Nancy Regan's "Just Say No" campaign urged children to use synchronic regulation to refuse drugs and had no measurable effects on youth tobacco, alcohol, or drug use (West & O'Neal, 2004). In contrast, diachronic regulation has proven effective in contexts ranging from meeting writing deadlines to quitting smoking to saving money (Ariley & Westenbroch, 2002; Ashraf, Karlan, & Yin, 2006; Giné, Karlan, & Zinman, 2010). Furthermore, evidence suggests that long-term goal attainment is correlated not with resisting temptation, but with feeling tempted less frequently (Hofmann et al., 2012; Milyavskaya & Inzlicht, 2017).

Self-control researchers have widely taken such results to show that diachronic regulation is a *more effective kind of self-control* than willpower. "Use willpower!" may make for a good slogan, they say, but diachronic regulation is self-control that *works*. Popular diachronic "self-control" strategies include (a) selecting and modifying your situation (Duckworth et al., 2018; Gross, 2015; Hennecke & Bürgler, 2020; Williamson & Wilkowski, 2020) and (b) cultivating habits that allow you to avoid temptation (de Ridder, Lensvelt-Mulders, Finkenauer, Stok, & Baumeister, 2012; Galla & Duckworth, 2015).

Our results suggest that this way of framing the literature invites confusion. To the folk, self-control just is willpower; that's why synchronic regulation is the sole difference-maker for self-control judgments. To ordinary ears, researchers will therefore sound incoherent when they make recommendations like, "If you want to exercise self-control, don't use willpower." "Self-control" is not a technical concept that was introduced by scientists; rather, this concept has a deep historical lineage and remains central to how ordinary people understand their own and others' behavior. Cognitive scientists may attract public interest by using ordinary concepts, but if we use these ordinary concepts in a heterodox way, we invite confusion.

The Contamination Hypothesis also suggests that we should be cautious when interpreting results about the ineffectiveness of willpower. Many cases of diachronic regulation are contaminated by synchronic regulation. Indeed, we had to introduce highly artificial scenarios to "decontaminate" diachronic regulation. Given this, empirical studies of diachronic regulation may also be contaminated by willpower.

Consider three representative studies. One found that highschoolers use technology less if they are instructed to "remov[e] temptations from sight" using reminders, app-blockers, and turning off their phones rather than "try[ing] to resist [temptations] directly" (Duckworth, White, Matteucci, Shearer, & Gross, 2016). But a teenager would require considerable willpower to, say, block her favorite website and keep it blocked for the week of the study. Another study found that smokers experienced less intense cravings after chewing nicotine gum (Shiffman, Hughes, Di Marino, & Sweeney, 2003). But smokers likely required willpower to chew gum for at least fifteen minutes, several times a day. A final study found that mindfulness is a form of diachronic regulation that reduces temptations associated with substance abuse disorders (Garland, Roberts-Lewis, Tronnier, Graves, & Kelley, 2016). But participants would need considerable willpower to attend *ten* mindfulness classes and practice on their own for fifteen minutes *per day*. Indeed, some of the earliest philosophical discussions of effortful self-control are from Indian accounts of how to cultivate a meditative practice (*Dhammapada*, Verses 94, 103–4, 281; *The Bhagavad Gītā* 2.60–2.64; Kachru, 2022). In studies like these, diachronic regulation tacitly relies on willpower.

If empirical studies of diachronic regulation are contaminated, it's not clear whether they show that willpower is ineffective. The evidence certainly suggests that willpower alone is often ineffective (Inzlicht & Friese, 2021). But it's likely that willpower *is* effective, and indeed required, when incorporated into the right kind of diachronic regulation strategy. Specifically, willpower may help us implement and follow through on situational strategies to avoid temptation (Fig. 7). Contra the willpower skeptic, this alternative interpretation predicts that diachronic regulation strategies are not (usually) an *alternative* to willpower; rather, they *amplify* willpower's effectiveness.

Consider an analogy. If a construction worker uses a manual lever to lift heavy beams, we cannot conclude that she is weak or isn't using her strength. Rather, she skillfully uses the lever to amplify her strength, which is still a necessary input. Similarly, synchronic regulation may be a crucial input into many diachronic regulation strategies. Willpower skeptics might object that diachronic self-regulation can be achieved effortlessly and automatically via good habits (Carden & Wood, 2018; de Ridder et al., 2012; Galla & Duckworth, 2015). However, it plausibly requires willpower to monitor, form, and maintain good habits (Ainslie, 2021). Researchers should therefore exercise caution when interpreting empirical results about diachronic regulation; for diachronic regulation may be "will-powered."

Our studies are also the first to document *self-control tracing*. Responsibility tracing occurs when responsibility for a later behavior (e.g., falling asleep at the wheel) "traces" back to responsibility for a past action (e.g., staying up the night before) (Fischer & Ravizza, 1998; Khoury, 2012; Murray, 2020). Study 3 documents a similar effect for self-control. Self-control over a later act (following through on a plan to reduce temptation) can be traced back to synchronic willpower during

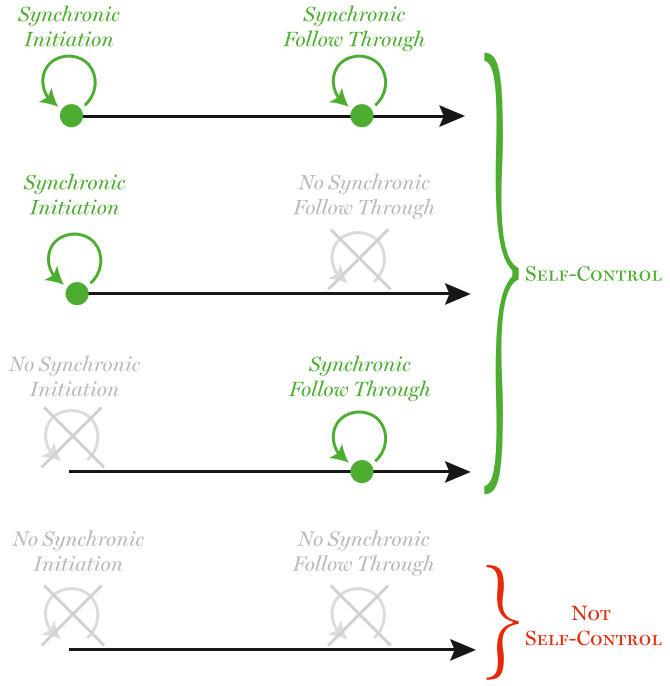

Fig. 7. Diachronic regulation can be contaminated with synchronic regulation at two moments: when the agent (1) initiates or (2) follows through on a plan to reduce temptation. Without this contamination, diachronic regulation is not rated as self-control.

an earlier act (implementing that plan). A deep parallel between responsibility and self-control tracing is that both appear when the characteristic furniture of voluntary action—e.g., conscious choice and control—are absent. Responsibility tracing is common in cases of negligence (Murray, 2020) and we find evidence of self-control tracing when Mo unthinkingly follows through on his plan: "Mo *doesn't even think about drinking coffee* because he has none in the house" (Fig. 8).

We can think of two explanations for these parallels between responsibility and self-control tracing. First, self-control tracing may be a mechanism that (at least partially) *explains* responsibility tracing. Self-control is arguably sufficient for responsibility (Murray & Vargas, 2020). If so, responsibility may trace back to earlier actions *because* self-control traces back to earlier actions. Second, self-control and responsibility tracing may be instances of a more general phenomenon of moral attribute tracing. When an agent acts unthinkingly, he may acquire many morally salient attributes through tracing. Responsibility and self-control are two such attributes, but others may be acquired through tracing as well (intentions, beliefs, reactive attitudes, etc.). Our studies weren't designed to choose between these explanations, so future research is necessary. Yet by documenting the phenomenon of self-control tracing, we open up new questions for moral psychology.

Self-control is one of the oldest concepts in moral psychology. One might expect such an ancient concept to be a mess, to bear knots and burls after growing in popular culture for thousands of years. We find the opposite. The folk concept arguably picks out a *more unified* process than "results" accounts of self-control popular among academic theorists. The folk concept clarifies how we should interpret studies on willpower's efficacy and lead us to discover the phenomenon of self-control tracing. The folk concept of self-control is coherent, clean, and philosophically interesting. We doubt that this is an accident. Ordinary people may be unable to identify the neural mechanisms behind

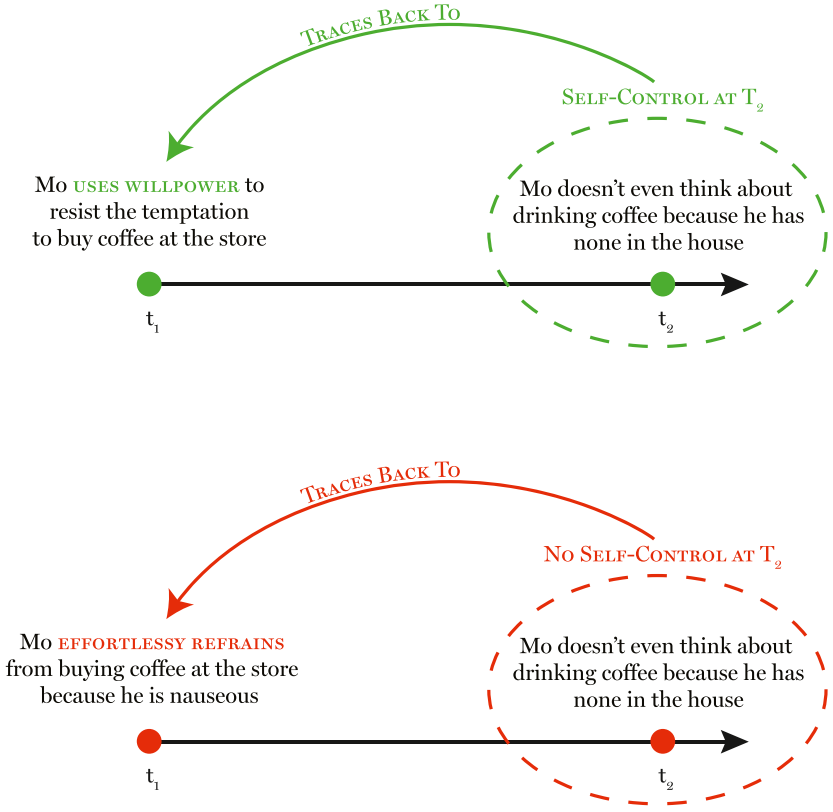

Fig. 8. Self-control tracing in Study 4. Subject's judgments about whether Mo exercised self-control when he was at home in his house (at time t_2) trace back to whether Mo exercised synchronic self-control (willpower) at an earlier time t_1.

synchronic regulation, but they are deeply familiar with how it *feels*. At the phenomenological level, synchronic regulation involves the exertion of mental effort to resist temptation (Sripada, 2021). We hypothesize that the folk concept of self-control evolved to capture that experience and understand its role in our moral lives. At least in this context, folk wisdom should not be ignored.

Author contribution statement

Zachary C. Irving: Conceived of the project, designed the stimuli, analyzed the data, characterized the project's contribution to the literature, and was the lead author while writing all sections of the paper.

Jordan Bridges: Resurrected a dormant project, designed the stimuli, analyzed the data, did background research on the literature, and made significant contributions to writing the paper, especially the discussion and introduction.

Aaron Glasser: Made major contributions to stimuli design, wrote sections of the discussion section, and did background research on the literature.

Juan Pablo Bermúdez: Conceived of the project, commented on stimuli design, edited the paper, and contributed background research on the literature.

Chandra Sripada: Conceived of the project and its main hypothesis, made major contributions to stimulus design, edited and wrote parts of the introduction and discussion, characterized the project's contribution to the literature, contributed background research on the literature.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cognition.2022.105154.

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