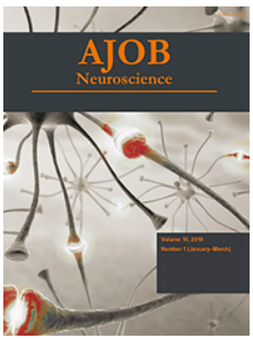

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Target Article

Attitudes Toward Cognitive Enhancement: The Role of Metaphor and Context

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The widespread use of stimulants among healthy individuals to improve cognition has received growing attention; however, public attitudes toward this practice are not well understood. We determined the effect of framing metaphors and context of use on public opinion toward cognitive enhancement. We recruited 3,727 participants from the United States to complete three surveys using Amazon's Mechanical Turk between April and July 2017. Participants read vignettes describing an individual using cognitive enhancement, varying framing metaphors (fuel versus steroid), and context of use (athletes versus students versus employees). The main outcome measure was the difference in respondent-assigned level of acceptability of the use of cognitive enhancement by others and by themselves between the contrasting vignettes. Participants were more likely to support the use of cognitive enhancement by others than by themselves and more when the use of enhancement by others was framed with a fuel metaphor than with a steroid metaphor. Metaphoric framing did not affect participants' attitudes toward their own use. Participants supported the use of enhancement by employees more than by students or athletes. These results are discussed in relation to existing ethical and policy literature.

Keywords: cognitive enhancement; neuroethics; cosmetic neurology; neurology; cognitive neuroscience; nootropics

INTRODUCTION

The use of technology to augment normal cognition is referred to as cosmetic neurology or as cognitive enhancement (CE) (Brühl and Sahakian 2016; Chatterjee 2004; Franke and Lieb 2013; Hamilton et al. 2011). Prescription pharmaceutical use for CE is increasingly common (Babcock and Byrne 2000; Caballero et al. 2016; Dietz et al. 2013; Emanuel et al. 2013; Franke et al. 2013; Garnier-Dykstra et al. 2012; Singh et al. 2014), as recounted dramatically in the recent Netflix documentary "Take Your Pills" (Klayman 2018). Proponents hope that CE will expand individual potential and accelerate social progress. Those wary of CE are concerned about safety (Scheske and Schnall 2012), fairness (Davis 2017), social injustice (Hotze et al. 2011; Whetstine 2015), cheapening of accomplishments (Bostrom and Sandberg 2009), character erosion (Chatterjee 2008; Kass 2003), unnaturalness (Caviola and Faber 2015; Kass 2003; Wolpe 2002), and coercion (Appel 2008; Chatterjee 2006). With these conflicting arguments, the public disagrees on the acceptability of CE, with most surveys demonstrating an overall moderately negative view toward the use of CE, but wide variability in respondents' attitudes (Fitz et al. 2013; Scheske and Schnall 2012; Schelle et al. 2014).

Metaphors are commonly invoked in debates on enhancement, framed as fuel, cosmetics, steroids, and hacking (Austin 2013; Chatterjee 2004; Cakic 2009; Winder and Borrill 1998). Metaphors capture complex arguments succinctly and may convey subtle emotional connotations. Metaphors can affect opinion toward public policy: For example, people exposed to a metaphor of crime as a predator were more likely to support tougher enforcement than those exposed to a metaphor of crime

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as a virus (Thibodeau et al. 2009). How metaphors influence attitudes toward CE is unknown.

Furthermore, the effect of context on attitudes toward CE is poorly understood. Most studies focus on students and athletes (Banjo et al. 2010). Given the increasing use of CE in the workplace, understanding the public's attitude toward this practice and how it compares to CE among students and athletes is important. We aimed to determine the effect of framing metaphors and context on people's attitudes toward CE.

METHODS

Standard Protocol Approvals, Registrations, and Patient Consents

This research was approved by the institutional review board (IRB) of the University of Pennsylvania. Participants waived documentation of informed consent by clicking "Accept" on Mechanical Turk. Written consent was not obtained to avoid storing identified data. The waiver as a PDF and contact information for the lab were made available to participants.

Conditions

Three surveys were conducted. The second and third surveys were performed to probe the mechanisms for the main effects of the first survey. In each survey, subsets of participants were exposed to one of multiple conditions as part of a between-subjects design.

Survey 1 was designed to determine the effect of framing metaphors and context of use on opinion toward CE. We constructed six vignettes by crossing two variables: framing metaphor (fuel versus steroids) and context (athletes versus students versus employees). The vignettes read as follows:

> Cognitive enhancing pills are [**fuel/steroids**] for the brain. People who take these pills may be able to think more quickly and efficiently. [*Athletes sometimes take these pills while training so that they can learn their skills more effectively and perform better/Students sometimes take these pills while studying so that they can learn new information more effectively and perform better/Employees sometimes take these pills at work so that they can learn their duties more effectively and perform better*].

In this survey and subsequent ones, nonitalicized, nonbolded text did not vary. Each participant was randomly assigned to one of the bolded metaphors and one of the italicized contexts.

Survey 2 was designed to probe arguments that might account for the effect of the fuel and steroids framing metaphors found in Survey 1 on opinion toward CE. We constructed six vignettes crossing two variables: framing argument (maximizing potential versus diminishing authenticity) and safety/naturalness (natural pills versus safe pharmaceuticals versus unsafe pharmaceuticals). These vignettes read:

> **[Cognitive enhancing pills boost the brain, helping us to maximize our fullest potential/Cognitive enhancing pills boost the brain's abilities, helping us to minimize effort needed to perform]**. People who take these pills may be able to think more quickly and efficiently. Employees sometimes take these pills at work so that they can conduct their duties more effectively and perform better. [*These pills are natural ingredients from organic sources/These pills are pharmaceuticals that have been shown to be safe in multiple clinical trials/These pills are new pharmaceuticals and their risks and side effects are not well known*].

Survey 3 was designed to determine the effect of competition on opinion toward CE. We constructed two vignettes varying the level of workplace competition (high versus low). These vignettes read:

> Cognitive enhancing pills are fuel for the brain. People who take these pills may be able to think more quickly and efficiently. Employees sometimes take these pills at work so that they can learn their duties more effectively and perform better. [*Tom is an employee in a contentious office where he and his co-workers compete for raises and promotions. His success means that he gets ahead/Tom is an employee in a collaborative office where he and his co-workers cooperate toward a common goal. His success means that the company gets ahead*].

Participants

Participants were recruited using Amazon's Mechanical Turk and completed Web-based surveys between April and July 2017. Our power analysis, based on Fitz and colleagues (Fitz et al. 2013), had 90% power and an alpha of 0.05 to detect an anticipated effect size of η^2 of 0.01 in Surveys 1 and 2, and d of 0.2 in Survey 3. In Survey 1 we estimated needing 210 participants in each of six conditions and recruited 1,400 participants (assuming 10% exclusion for failing validation question). In Survey 2 we estimated needing 210 participants for each of six conditions and recruited 1,350 participants (assuming 5% exclusion for failing the validation question, reduced from 10% based on the Survey 1 responses). In Survey 3 we estimated needing 522 participants for each of two conditions and recruited 1,100 participants (assuming 5% exclusion for failing the validation question).

Each survey was titled "Survey about cognitive enhancement," and paid $0.50. We restricted participants to adults in the United States who completed more than 500 Mechanical Turk studies and had an approval rate greater than 95%. Requiring a minimum approval rating produces higher quality responses as measured by attention checks and internal response consistency (Peer et al. 2014). In Surveys 2 and 3, we restricted the survey to participants who had not participated in the prior

surveys to prevent bias from exposure to the first surveys. We excluded subjects whose IDs could not be verified on Mechanical Turk (3 in Survey 1, 26 in Survey 2, 6 in Survey 3) and subjects who answered the validation question incorrectly (46 in Survey 1, 39 in Survey 2, 23 in Survey 3).

Procedure

Participants were instructed that they would read a paragraph on CE pills and then be asked their opinion. This paragraph was a vignette (described in the Conditions subsection) to which participants were randomly assigned. After 15 seconds, a button appeared. They could then continue reading, or advance to the question by clicking the button. Once they advanced, two questions appeared below the vignette:

Do you think it is fine for [***] to use these pills?

(the asterisks corresponded to the condition to which they had been assigned), and

Would you use these pills yourself?

The phrasing "Do you think it is fine …" was chosen to capture a range of potential reasons for acceptability, in an attempt to limit the number of main effects being tested. Participants selected responses on a 7-point Likert scale: Absolutely Not; No; Probably Not; Not Sure; Probably Yes; Yes; or Absolutely Yes. A 7-point Likert scale was chosen, as this gradation is thought to sufficiently capture the underlying discrimination of a respondent's opinion (Green and Rao 1970). Participants then answered demographics questions. In Surveys 2 and 3 we asked two additional demographics questions regarding technology adoption and the participant's work environment. As a validation question, participants were finally asked to recall who was described to be using cognitive enhancing pills.

Data Analysis

Analysis was performed in Matlab version R2017b (The Mathworks). We converted Likert scores to a range from −3 to +3, where higher numbers indicated greater approval of CE. Paired *t*-tests were used to determine difference in overall Likert scores between use by others and use by the participants themselves. Mixed analyses of variance (ANOVAs) were used to determine whether there was a main effect of factors tested in the vignettes and whether the effect of factors depended on whether participants were judging self's or others' use. For significant ANOVA findings, we used post hoc independent *t*-tests to test for intergroup differences. Effect sizes are reported as Cohen's d for *t*-tests, $\eta^2_{partial}$ for mixed ANOVA, and ω^2 for between-subjects ANOVA. The robustness of ANOVA to skewed distributions permits the application of this test to ordinal Likert data, which may have nonuniform spacing between choices (Norman 2010; Sullivan and Artino 2013).

RESULTS

Demographic information for participants is shown in Table 1. There were 1400 participants recruited for Survey 1, 1350 for Survey 2, and 1100 for Survey 3. The number of participants excluded because we could not verify their identities on Mechanical Turk or because they failed the validation question was 46 in Survey 1, 49 in Survey 2, and 28 in Survey 3. The final number of participants entered in analyses was 1354 in Survey 1, 1301 in Survey 2, and 1072 in Survey 3.

Acceptability of CE

Means and standard deviations of the Likert scores of responses are shown in Table 2. Participants were more likely to approve of others' use of CE than their own use (Survey 1: $p < 0.001$, $d = 0.27$; Survey 2: $p < 0.001$, $d = 0.53$; Survey 3: $p < 0.001$, $d = 0.49$) (Figure 1).

Fuel/Steroids Metaphor

A mixed ANOVA compared the effects of metaphor and context on acceptability of CE use by others and by self. The effect of the metaphor was stronger when respondents rated others' use than when they rated use by self ($p = 0.002$, $\eta^2_{partial} = 0.007$). Participants were more likely to support the use of CE by others when framed by the "fuel" metaphor than the "steroids" metaphor ($p < 0.001$, $d = 0.23$). By contrast, metaphoric framing did not affect participants' attitudes toward use by self ($p = 0.19$, $d = 0.07$) (Figure 2).

Athlete/Student/Employee Context

The effect of context on acceptability of CE use depended on whether participants were rating use by self or others' use ($p < 0.001$, $\eta^2_{partial} = 0.037$). Separate one-way ANOVAs were conducted to determine the effect of context on acceptability of CE use by others and use by the participants themselves. Context affected whether participants would support CE use by others ($p < 0.001$, $\omega^2 = 0.015$) and by themselves ($p = 0.036$, $\omega^2 = 0.003$) (Figure 3). For others' use, participants were more likely to support employees using CE than either students or athletes (employee–athlete $p < 0.001$, $d = 0.26$, employee–student $p < 0.001$, $d = 0.29$, athlete–student $p = 0.67$, $d = 0.028$). For use by self, participants were more likely to say they would use CE themselves when presented with the athlete context than with either the employee or the student context (employee–athlete $p = 0.037$, $d = -0.14$, employee–student $p = 0.72$, $d = 0.023$, athlete–student $p = 0.018$, $d = 0.16$).

Positive (Maximize Fullest Potential)/Negative (Minimize Effort) Framing Argument

A mixed ANOVA compared the effects of nonmetaphorical framing argument and safety/naturalness in

Table 1. Demographic variables of participants.

Demographics, number (%)	Survey 1 ($n = 1354$)	Survey 2 ($n = 1301$)	Survey 3 ($n = 1072$)
Gender			
Men	755 (55.8)	610 (46.9)	446 (41.6)
Women	567 (41.9)	663 (51.0)	600 (56.0)
Ethnicity			
Asian	107 (7.9)	106 (8.1)	50 (4.7)
Black/African American	70 (5.2)	97 (7.5)	79 (7.4)
Hispanic/Latino	62 (4.6)	59 (4.5)	42 (3.9)
White	1003 (74.1)	933 (71.7)	820 (76.5)
Political orientation			
Very conservative	63 (4.7)	46 (3.5)	71 (6.7)
Conservative	261 (19.3)	232 (17.8)	214 (20.0)
Moderate	350 (25.9)	363 (27.9)	276 (25.7)
Liberal	478 (35.3)	441 (33.9)	361 (33.7)
Very liberal	201 (14.8)	217 (16.7)	149 (13.9)
Education			
High school or less	164 (12.1)	147 (11.3)	141 (13.1)
Some college	436 (32.2)	422 (32.4)	351 (32.7)
4 Years of college	499 (36.9)	457 (35.1)	364 (34.0)
>4 Years of college	255 (18.8)	275 (21.1)	216 (20.1)
Age (mean (SD))	35.8 (11.6)	36.0 (11.6)	38.5 (12.5)
Technology adoption			
Early adopter		302 (23.2)	235 (21.9)
Mid adopter		869 (66.8)	695 (64.8)
Late adopter		127 (9.8)	140 (13.1)
Work environment			
Very competitive		107 (8.2)	104 (9.7)
Moderately competitive		509 (39.1)	400 (37.3)
Noncompetitive		477 (36.7)	371 (34.6)
Unemployed		206 (15.8)	195 (18.1)
Prescription stimulant usage			
Ever used for treatment	141 (10.4)	147 (11.3)	107 (10.0)
Ever used for enhancement	182 (13.4)	167 (12.8)	107 (10.0)
Know someone who used for enhancement	574 (42.4)	581 (44.7)	498 (46.5)

conditions of CE use by others and by self. There was no main effect of framing on acceptability judgements ($p = 0.77$, $\eta^2_{\text{partial}} < 0.001$), and the effect of framing did not depend on whether participants were rating use by others or by themselves ($p = 0.77$, $\eta^2_{\text{partial}} < 0.001$).

Safety and Naturalness

There was a main effect of safety/naturalness on acceptability judgments ($p < 0.001$, $\eta^2_{\text{partial}} = 0.08$) (Figure 4). The effect of safety/naturalness on Likert scores did not depend on whether participants were rating use by others or by themselves ($p = 0.16$, $\eta^2_{\text{partial}} = 0.003$). There was no significant difference between natural pills and safe pharmaceuticals ($p = 0.27$, $d = 0.043$). Natural pills were more acceptable than unsafe pills ($p < 0.001$, $d = 0.27$), and safe pills were more acceptable than unsafe pills ($p < 0.001$, $d = 0.23$).

Competition

A mixed ANOVA compared the effect of competition in conditions of CE use by others and by self. There was no main effect of competition on acceptability judgments ($p = 0.27$, $\eta^2_{\text{partial}} = 0.001$), and the effect of competition did not depend on whether participants were rating use by self or others' use ($p = 0.56$, $\eta^2_{\text{partial}} < 0.001$).

Demographics

The means and standard deviations of Likert scores for different demographic variables are shown in Table 1 in the Supplementary Material.

Participant's Work Environment (Surveys 2 and 3). For Surveys 2 and 3, mixed ANOVAs compared the effect of the participant's work environment on

Table 2. Mean and standard deviation Likert scores for acceptability of cognitive enhancement use by others and self according to different survey factors.

Factor	Approval of use by others, mean (SD)	Approval of use by self, mean (SD)
Overall		
Survey 1	0.07 (1.6)	−0.40 (1.8)
Survey 2	0.33 (1.6)	−0.59 (1.8)
Survey 3	0.45 (1.6)	−0.41 (1.9)
Metaphor		
Fuel	0.26 (1.6)	−0.33 (1.8)
Steroids	−0.11 (1.6)	−0.46 (1.8)
Nonmetaphorical frame		
Positive	0.35 (1.6)	−0.58 (1.8)
Negative	0.31 (1.6)	−0.60 (1.8)
Context		
Employees	0.37 (1.5)	−0.46 (1.8)
Students	−0.09 (1.6)	−0.51 (1.9)
Athletes	−0.05 (1.6)	−0.21 (1.8)
Level of competition		
High	0.51 (1.6)	−0.36 (1.8)
Low	0.38 (1.6)	−0.45 (1.9)
Safety and naturalness		
Natural	0.78 (1.6)	−0.24 (1.8)
Safe pharmaceutical	0.56 (1.6)	−0.35 (1.8)
Unsafe pharmaceutical	−0.34 (1.5)	−1.18 (1.7)

acceptability of CE use by others and by self. In both Surveys 2 and 3, the effect of the participant's work environment depended on whether participants were rating use by others or by themselves (Survey 2: $p = 0.009$, $\eta^2_{partial} = 0.009$; Survey 3: $p = 0.007$, $\eta^2_{partial} = 0.011$). In Survey 2, participant work environment did not affect acceptability of CE use by others ($p = 0.42$, $\omega^2 < 0.001$) or by the participants themselves ($p = 0.19$, $\omega^2 = 0.001$). In Survey 3, participant work environment did not affect acceptability of use by others ($p = 0.25$, $\omega^2 = 0.001$) but did affect acceptability of use by self ($p = 0.003$, $\omega^2 = 0.010$). Those who worked in very competitive environments were more willing to take CE than those who worked in noncompetitive environments ($p = 0.004$, $d = 0.31$) or those who were unemployed ($p = 0.002$, $d = 0.38$). Those who worked in moderately competitive environments were also more willing to take CE than those who were unemployed ($p = 0.015$, $d = 0.21$). Other comparisons were nonsignificant (very competitive–moderately competitive: $p = 0.11$, $d = 0.17$, moderately competitive–noncompetitive: $p = 0.08$, $d = 0.13$, noncompetitive–unemployed: $p = 0.26$, $d = 0.10$).

Technology Adoption (Surveys 2 and 3). For Surveys 2 and 3, mixed ANOVAs compared the effect of technology adoption on acceptability of CE use by others and by self. In Survey 3 but not in Survey 2, the effect of technology adoption depended on whether participants were rating use by others or by themselves (Survey 2: $p = 0.13$, $\eta^2_{partial} = 0.003$, Survey 3: $p = 0.002$, $\eta^2_{partial} = 0.011$). In Survey 2, there was a main effect of technology adoption ($p < 0.001$, $\eta^2_{partial} = 0.019$). Early adopters were more supportive than mid adopters ($p < 0.001$, $d = 0.11$) and late adopters ($p < 0.001$, $d = 0.13$). There was no significant difference between mid adopters and late adopters ($p = 0.067$, $d = 0.062$). In Survey 3, technology adoption affected attitudes toward the use of CE by others ($p < 0.001$, $\omega^2 = 0.014$) and by the participants themselves ($p < 0.001$, $\omega^2 = 0.031$). For use of CE by others, early adopters of technology were more supportive than mid adopters ($p < 0.001$, $d = 0.30$) or late adopters ($p = 0.008$, $d = 0.28$). There was no significant difference between mid adopters and late adopters ($p = 0.96$, $d = -0.005$). For use by the participants themselves, early adopters were also more supportive than mid adopters ($p < 0.001$, $d = 0.43$) or late adopters ($p < 0.001$, $d = 0.45$). There was no significant difference between mid adopters or late adopters ($p = 0.74$, $d = 0.03$).

Gender. In each survey, mixed ANOVAs compared the effect of gender on acceptability of CE use by others and by self. The effect of gender did not depend on whether participants were rating use by others or by themselves in any survey (Survey 1: $p = 0.87$, $\eta^2_{partial} < 0.001$; Survey 2: $p = 0.77$, $\eta^2_{partial} < 0.001$; Survey 3: $p = 0.19$, $\eta^2_{partial} = 0.002$). In all three surveys, there was a main effect of gender where men were more supportive of CE than women (Survey 1: $p < 0.001$, $\eta^2_{partial} = 0.027$, Survey 2:

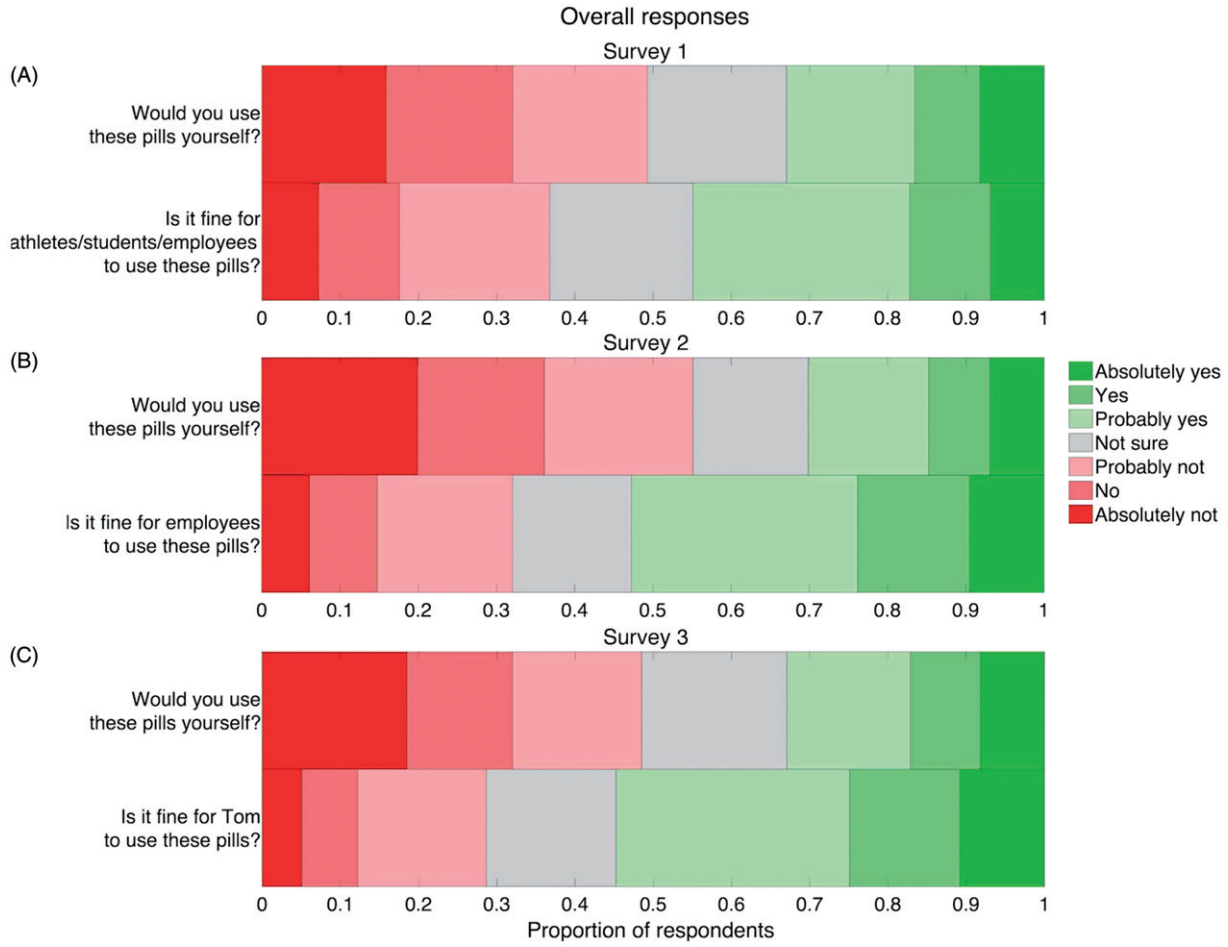

Figure 1. Overall acceptability of the use of CE by others and self. (A–C) Likert scores representing attitudes toward the use of CE by others and by the participants themselves, averaged across all vignettes. The horizontal width of each different color bar represents the proportion of respondents who selected the corresponding Likert score in the legend.

$p < 0.001$, $\eta^2_{partial} = 0.015$, Survey 3: $p < 0.001$, $\eta^2_{partial} = 0.017$).

Race. In each survey, mixed ANOVAs compared the effect of race on acceptability of CE use by others and by self. The four most common responses for race were used in each survey (in order, these were "White," "Asian," "Black or African American," and "Hispanic/Latino" in Surveys 1 and 2, and "White," "Black or African American," "Asian," and "Hispanic/Latino" in Survey 3; see Table 1 for details), and all other responses were categorized as "other." The effect of race did not depend on whether participants were rating use by others or by themselves in any survey (Survey 1: $p = 0.76$, $\eta^2_{partial} = 0.001$, Survey 2: $p = 0.62$, $\eta^2_{partial} = 0.002$, Survey 3: $p = 0.59$, $\eta^2_{partial} = 0.003$). There was no main effect of race in any survey (Survey 1: $p = 0.050$, $\eta^2_{partial} = 0.007$, Survey 2: $p = 0.081$, $\eta^2_{partial} = 0.006$, Survey 3: $p = 0.78$, $\eta^2_{partial} = 0.002$).

Politics. In each survey, mixed ANOVAs compared the effect of politics on acceptability of CE use by others and by self. The effect of politics did not depend on whether participants were rating use by others or by themselves in any survey (Survey 1: $p = 0.68$, $\eta^2_{partial} = 0.002$; Survey 2: $p = 0.90$, $\eta^2_{partial} < 0.001$; Survey 3: $p = 0.93$, $\eta^2_{partial} < 0.001$). There was a main effect of politics in Survey 1, but not in Surveys 2 or 3 (Survey 1: $p = 0.020$, $\eta^2_{partial} = 0.009$, Survey 2: $p = 0.26$, $\eta^2_{partial} = 0.004$, Survey 3: $p = 0.57$, $\eta^2_{partial} = 0.003$). In Survey 1 there was a graphical trend in which more liberal respondents appeared more accepting of CE (Supplementary Figure S1).

Education. In each survey, mixed ANOVAs compared the effect of education on acceptability of CE use by others and by self. Years of education were binned into four groups, where 12 or fewer years of education was categorized as "high school or less," 13–15 years was categorized as "some college," 16 years was categorized

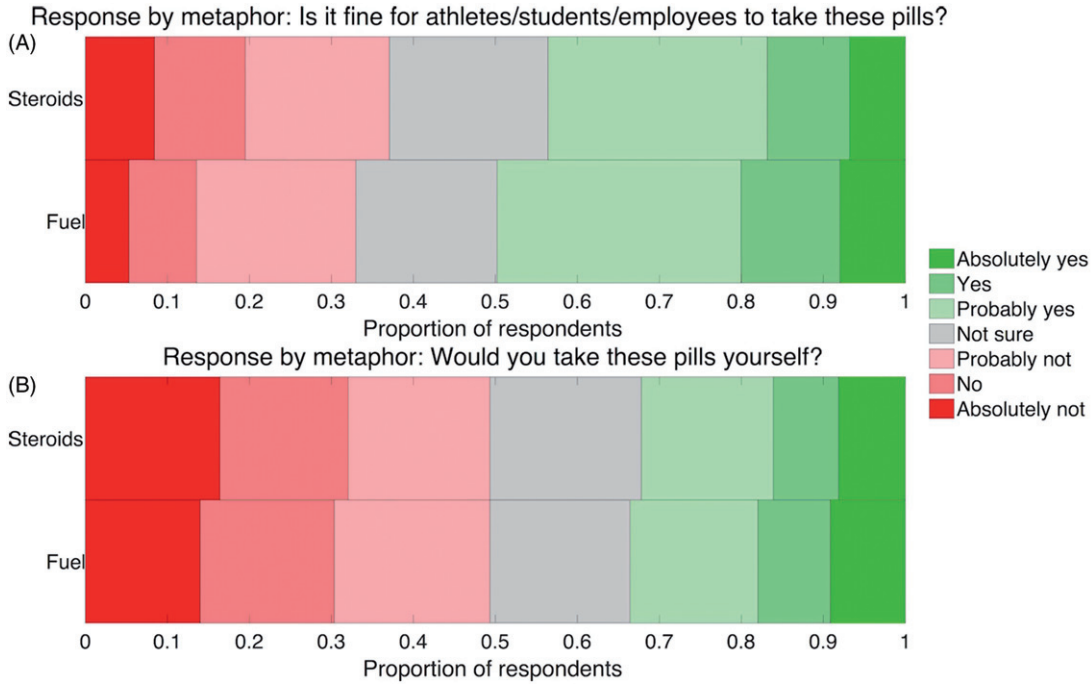

Figure 2. Acceptability of CE by metaphor. (A,B) Likert scores representing attitudes toward the use of CE by others and by the participants themselves, when presented with a framing metaphor of fuel or steroids.

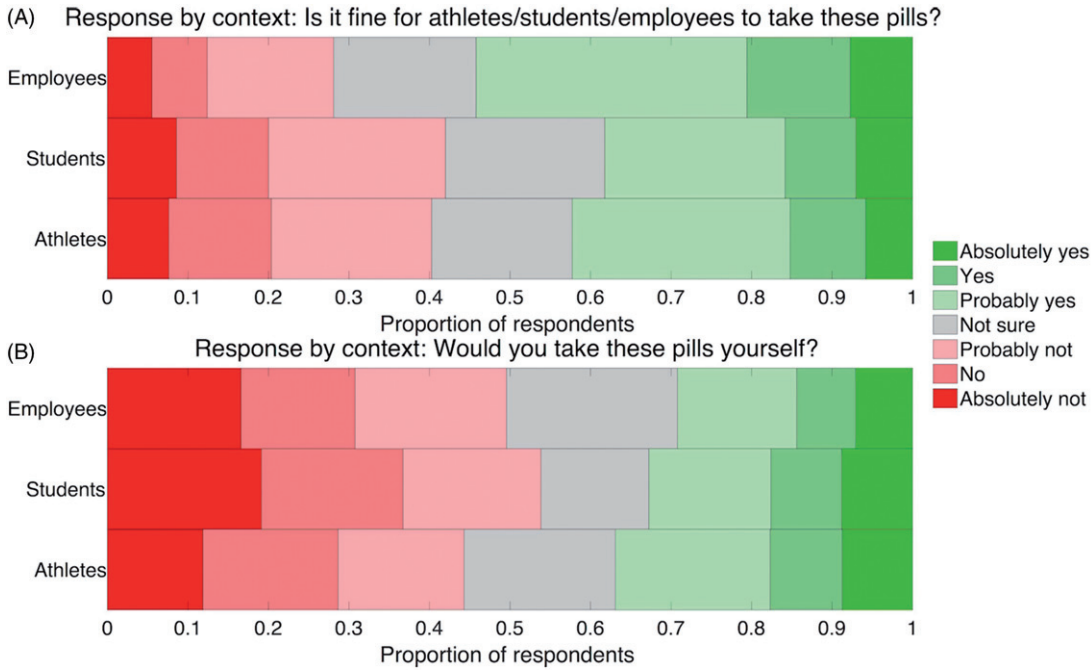

Figure 3. Acceptability of CE by context. (A,B) Likert scores representing attitudes toward the use of CE by others and by the participants themselves when presented with a hypothetical use of CE among athletes, students, or employees.

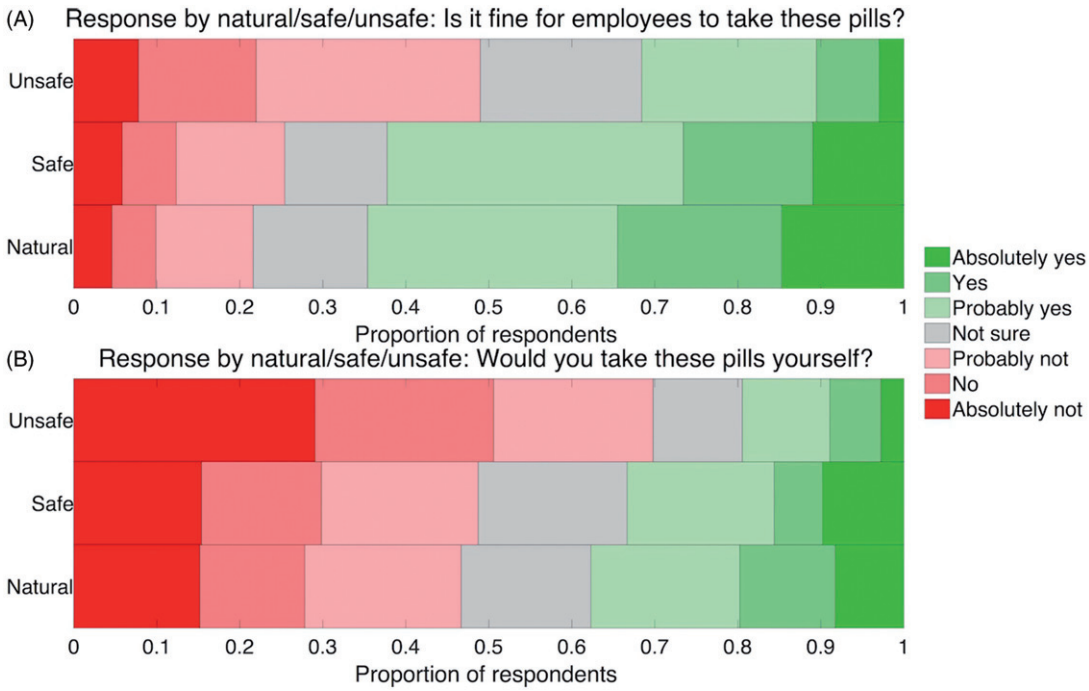

Figure 4. Acceptability of CE by safety/naturalness. (A,B) Likert scores representing attitudes toward the use of CE by others and by the participants themselves, when the form of CE is described to be a natural supplement, a safe pharmaceutical, or a potentially unsafe pharmaceutical.

as "four years of college," and more than 16 years was categorized as "more than four years of college." The effect of education did not depend on whether participants were rating use by others or by themselves in any survey ($p = 0.36$, $\eta^2_{partial} = 0.002$; Survey 2: $p = 0.35$, $\eta^2_{partial} = 0.003$; Survey 3: $p = 0.81$, $\eta^2_{partial} < 0.001$). There was a main effect of education in Survey 3 but not in Surveys 1 or 2 (Survey 1: $p = 0.23$, $\eta^2_{partial} = 0.003$, Survey 2: $p = 0.076$, $\eta^2_{partial} = 0.005$, Survey 3: $p = 0.048$, $\eta^2_{partial} = 0.007$). In Survey 3 there was a graphical trend in which those with "some college" were more supportive of CE than other groups (Supplementary Figure S2).

Age. There was a correlation between age and opinion toward CE in each survey, with younger people more supportive of the use of CE by others (Survey 1: $r(n = 1354) = -0.15$, $p < 0.001$; Survey 2: $r(n = 1301) = -0.20$, $p < 0.001$; Survey 3: $r(n = 1072) = -0.17$, $p < 0.001$) and by themselves (Survey 1: $r(n = 1354) = -0.15$, $p < 0.001$; Survey 2: $r(n = 1301) = -0.16$, $p < 0.001$; Survey 3: $r(n = 1072) = -0.12$, $p < 0.001$).

DISCUSSION

Relationship to Prior Studies

Most studies exploring attitudes toward CE surveyed students, and not the broader public (Aikins 2011; Bell et al. 2013; Dodge et al. 2012; Desantis and Hane 2010; Dijkstra and Schuijff 2016; Forlini et al. 2015; Franke et al. 2012; Maier et al. 2015; Partridge et al. 2013; Schelle et al. 2014; Sattler et al. 2013a, 2013b; Sabini and Monterosso 2005; Scheske and Schnall 2012). Two exceptions are by Fitz and colleagues and Partridge and colleagues (Fitz et al. 2013; Partridge et al. 2012). To our knowledge, this study is novel in (1) examining the effect of framing metaphors on attitudes toward CE, (2) contrasting the public's acceptance of CE use by others to use by self, and (3) comparing public opinion regarding CE use by students, workers, and athletes.

Effect of Framing

The framing metaphors influenced whether participants thought it was acceptable for other people to use CE. The "fuel" metaphor increased and the "steroids" metaphor decreased the acceptability of CE use. We considered two hypotheses for these effects. First, the fuel metaphor advocates maximizing potential, whereas the steroid metaphor advocates minimizing effort, thus rendering achievements inauthentic. Maximizing potential and inauthenticity are, respectively, commonly invoked arguments for and against the use of CE. CE may expand our ability to learn, engage socially, recover from stress, and even to act as autonomous agents (Brand et al. 2016; Brignell et al. 2007; Clewis 2017; Pitman et al. 2002; Schaefer et al. 2014). On the other hand, opponents of CE argue that it cheapens our accomplishments,

erodes our character through easier gains, and harms the human essence by altering our cognition (Bostrom and Sandberg 2009; Fukuyama 2002; Greely et al. 2008; Kass 2003; President's Council on Bioethics (U.S.) 2003). Second, fuel is regarded as necessary to function, whereas steroids are not and have unwanted side effects. The importance of safety in modulating attitudes toward CE in our article and others highlights the importance of this aspect of the metaphors (Fitz et al. 2013; Scheske and Schnall 2012).

The nonmetaphorical frames did not affect attitudes. The positive nonmetaphorical frame of CE "helping us to maximize our fullest potential" was designed to capture the "improving individual potential" pro-CE argument, whereas the negative frame of CE "helping us to minimize effort needed to perform" was meant to capture the "inauthentic success" anti-CE argument. What accounts for the ineffectiveness of these explicit frames in modulating opinion? Perhaps these frames failed to express the intended arguments. Or these arguments may not adequately convey the core meaning of the metaphors. For example, our expression of inauthenticity as minimizing effort might have been interpreted as supplementing effort, a move that might not be regarded as problematic. More intriguingly, perhaps metaphors derive their force by guiding thought implicitly, a force dissipated when the meaning is made explicit.

Self–Others Difference

Participants were more likely to support the use of CE by others than themselves. This difference persisted even when safety was held constant. The self–others difference may simply be because people overall oppose CE, but are also liberal regarding the actions of others. Alternatively, people may use entirely different reasoning when considering CE for themselves than for others. This latter possibility is supported by our finding that while framing metaphors influenced whether participants thought it was acceptable for others to use CE, the metaphors did not affect participants' willingness to use CE themselves. Decisions about use by self may be comparatively fixed. This self–others difference in the effect of metaphors could have important policy implications if generalizable. Metaphors may be more likely to sway people's opinion toward public policy even if they do not change individual behavior.

Competition

We hypothesized that CE would be considered less acceptable in more competitive situations based on concerns of fairness. We recognize that people may be ambivalent and acknowledge economic and social pressures that might drive the use of CE (Forlini and Racine 2012). Opponents of CE have argued that achievements produced with the aid of CE are inauthentic, amounting to cheating in competitive contexts (Bostrom and Sandberg 2009; Chatterjee 2008; Goodman 2010; Greely et al. 2008; Sahakian and Morein-Zamir 2007). In a survey of the public, the competitive advantage conferred by CE was viewed as one of the biggest moral concerns (Scheske and Schnall 2012). Similar views and sensitivity to social pressure were expressed in the comments of our own participants:

> If people are allowed to enhance it puts pressure on everyone to enchance [*sic*]. It's not a level playing field.

and:

> I think that there is an epidemic of students using these stimulants when they do not need them. It's almost gotten to the point of cheating.

Contrary to our prediction, the level of workplace competition did not influence people's opinions. In fact, some respondents explained that they used the opposite logic in forming their opinion. One wrote:

> I'm very competitive and always worried about losing my "mental edge," so honestly, the pill gives me pause for thought.

Another wrote:

> I have considered taking Adderall or Sudafed to keep up with the young people in my office.

These participants appear to consider CE more acceptable in highly competitive environments because of the relative cost of not being a user. Our finding in Survey 3 that participants who work in more competitive environments are more willing to take CE also suggests that some participants believe that a more competitive environment makes the use of CE more acceptable. This split regarding the use of CE in competition was also reported in prior small curated focus groups (Forlini and Racine 2012, 2009).

The finding that the competitive advantage conferred by CE creates appeal for some but aversion for others may be because different participants have different definitions of cheating (Dubljević et al. 2014). The participants may also have envisioned different scenarios of distributive justice. Distributive justice is a prominent concern among both opponents and proponents of CE. When CE is more easily available to the wealthy, then economic advantages become cognitive advantages (Bostrom and Sandberg 2009; Hyman 2011). On the other hand, were CE freely available to the public, it may mitigate rather than exacerbate inequalities by creating cognitive opportunities for the socially disadvantaged (Ray 2016). The public is sensitive to distributive justice surrounding CE: When CE is described as available only to the wealthy, it is judged to be less fair (Fitz et al. 2013).

We did not specify the availability of the drugs in our survey, so different participants may have assumed different levels of availability, and thus drawn different conclusions while still being influenced by normative justice concerns.

Context

Cognitive enhancement by employees was reported as more acceptable than by students or athletes. Given the pervasive negative publicity surrounding the use of enhancement by athletes, we were surprised that student and athlete contexts were judged similarly unacceptable. This result differs from a survey of male university students, who felt that enhancement use in athletics was less acceptable than in test-taking (Dodge et al. 2012). The 2012 study finding may be partially explained by the fact that the students were considering the use of CE by people like themselves. We had originally hypothesized that a higher perceived level of competition in athletics and school than in the workplace may explain the difference in acceptability of CE in these contexts; however, Survey 3 demonstrated no effect of competition on acceptability of CE. Athletics and school contexts may be less acceptable than the workplace context because of the perceived higher gain to society in the latter. Performance on a test or in a sporting event is arguably a zero-sum game, but when the workforce is enhanced, everyone stands to benefit (Chatterjee 2008; Chandler and Dodek 2016; Maslen et al. 2015). Another possibility is that the difference is driven by preexisting social connotations: A student or an athlete using CE to succeed evokes "cheater," but an employee doing the same evokes "go-getter."

The effect of context on use by self was the opposite; here, exposure to the athlete context increased acceptability of CE. One participant wrote:

> I would not use these kinds of enhancements if I were in any kind of a competition, such as athletics. However, my field is intellectual and not competitive.

Participants exposed to the athlete vignette may be comparing the competitive zero-sum environment of athletics to their own workplace environment, and conclude that CE amounts to cheating in the former context but not in the latter.

Naturalness/safety

Natural pills were regarded more favorably than pharmaceuticals, as reported previously (Schelle et al. 2014; Scheske and Schnall 2012). Participants rated natural supplements and pharmaceuticals the same when the pharmaceuticals were explicitly stated to be safe and no similar claim was made for natural supplements. Participants may distrust the safety claims made by pharmaceutical companies (Bergström and Lynöe 2008). Perhaps natural supplements are perceived as less harmful to human essence than pharmaceuticals, with "supplement" itself being a metaphor.

Demographics

A strong predictor of positive attitudes toward CE was technology adoption. A person's enthusiasm or distrust toward technology in general appears to drive their consideration of the ethics of enhancement. Men and younger people were also more permissive in their attitudes toward CE use.

Limitations

We used Mechanical Turk (MTurk) because of its large participant pool and because it provides more demographically diverse sampling and more reliable data collection than other internet-based sampling methods (Buhrmester et al. 2011). However, it has potential sources of bias. MTurk workers might be more enthusiastic of technology, and thus favor CE, compared to the general population. Also, these participants often rely on MTurk as their primary source of income, so their attitudes toward the use of CE in the workplace might not reflect the attitudes of a more traditionally employed population (Ross et al. 2010). We note that any putative sampling bias is more likely to affect the overall attitudes toward the use of CE, rather than differences in responses based on vignette contrasts.

CONCLUSION

The relatively widespread use of prescription stimulants in the United States suggests that outright prohibition of CE would be infeasible (Cakic 2009; Kayser et al. 2007; Savulescu et al. 2004). There are numerous proposed approaches for regulating CE, all fraught with challenges. These include defining CE as cheating in university honor codes, incorporating taxation and age restriction, and requiring users to obtain licenses demonstrating an understanding of the risks of CE. None of these approaches would preclude abuse within or outside of the legal system, and they may disproportionately discourage the use of CE by those who most stand to benefit (Bostrom and Sandberg 2009; Dubljević 2013; Lucke et al. 2015; Sattler et al. 2013b).

The results of this survey inform potential CE policy in multiple ways: First, our survey suggests that many more people would approve of the use of CE by others than would use it themselves. Second, policy might distinguish between the use of CE in different contexts in order to address the greater perceived acceptability of CE in the workplace relative to school or athletics. Third, policy should address the public's concerns of safety and naturalness. Finally, the language used by health care

providers and policymakers in discussing CE should be carefully considered, as the choice of metaphor may sway attitudes toward CE. Involving the public in discussions about new technologies, such as attitudes toward CE, ensures the inclusion of diverse opinions to help inform socially responsive public policy (Chatterjee 2017).

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