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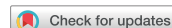


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TARGET ARTICLE



Public Opinion on Cognitive Enhancement Varies across Different Situations

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ABSTRACT

People vary widely in their acceptance of the use of pharmacological cognitive enhancement (CE). We tested the hypothesis that the acceptability of CE is malleable, by varying the context in which CE use takes place, by framing the use of CE with positive and negative metaphors, and by distinguishing between self and other CE use. 2,519 US-based participants completed 2 surveys using Amazon's Mechanical Turk. First, participants responded to vignettes describing a fictional character, which varied by framing metaphor (Pandora's box that releases brain performance vs. key that unlocks brain potential), role/setting (student/educational vs. employee/professional), and activity type (blue vs. white collar). Second, participants viewed personalized vignettes describing their own situations. Across both surveys, participants generally found CE use more acceptable for employees than students, while the effects of framing metaphors were unreliable and smaller than previously reported. People were more accepting of CE use by others than by themselves. Participants also found CE use more acceptable if more peers used CE, the environment was less competitive, and authority figures encouraged CE use. Our findings suggest that opinions about CE are indeed malleable, and concerns that peer pressure, the influence of authority figures, and competition might affect CE use are not unfounded.

KEYWORDS

Bioethics; cosmetic metaphor; neuroethics; neurologyneurology

INTRODUCTION

The use of pharmacological cognitive enhancement (CE) is controversial. People vary widely in how acceptable they think CE use is, and their opinions may shift depending on the specific situation or context in which CE is used. CE use is increasingly prevalent, with reported rates of CE use ranging from 5% to 20% in professional settings and 3% to 35% in educational settings (Bell et al. 2013; Bogle and Smith 2009; Colaneri et al. 2018; Dietz et al. 2013; Franke et al. 2013; Lyon 2017; McCabe 2008; McCabe et al. 2005; Scheske and Schnall 2012; Teter et al. 2006; Wilens et al. 2008). Stimulants like Adderall and Ritalin, often prescribed to treat medical conditions (e.g. Attention Deficit Hyperactivity Disorder), are used by healthy people to improve their cognitive functioning (e.g. alertness, concentration, memory).

CE use may be associated with positive outcomes for society, such as increased work productivity and improved quality of life. However, many people feel uneasy about CE use because of issues around safety,

authenticity, fairness, and coercion (Chatterjee 2004). Despite prior efforts to “propose actions that will help society accept the benefits of [cognitive] enhancement,” (Greely et al. 2013) the public's perception of CE use is not well understood. Specifically, does the language employed in describing CE use sway the public's perception given that metaphors are frequently used in framing enhancement (Austin 2013; Cakic 2009; Chatterjee 2004; Conrad et al. 2019; Winder and Borrill 1998)? Additionally, does the public's opinions on CE use vary across the different contexts where it has been used?

A recent study investigated some of these questions by comparing how participants rated the acceptability of CE use depending on the framing metaphor (fuel vs. steroid) and context (athletes vs. students vs. employees) for CE use (Conrad et al. 2019). Participants were more supportive of CE use by others when presented with the positively connotative metaphor (i.e. fuel) than the negatively connotative metaphor (i.e. steroids). By contrast, the metaphor did not affect participants' acceptability ratings for themselves.

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People were more supportive of an employee using CE than they were for the use of CE by a student or an athlete. This study was replicated by Cova et al. (2019) who failed to observe the same effect of the metaphor. The authors note that their replication study was underpowered (66%) to detect the metaphor effect ($d = .23$) reported in the original study. This failed replication highlights the fact that the effect of metaphors on shaping opinions around CE is quite small, and warrants further investigation with sufficiently powered studies to test its validity and reliability.

Considering these findings, further questions arise. First, even among metaphors used to describe CE with positive (or negative) connotations, the choice of metaphor may highlight different aspects of the issue being framed (Tubig and Simmerman 2019). Do the results of Conrad et al. (2019) generalize to other metaphors? Additionally, views may differ depending on the framing of the questions used to gauge the acceptability of CE use (Cova et al. 2019). For example, opinions seem to differ depending on whether people are asked about the acceptability of their own use or that of someone else. People may also rate the acceptability of CE use differently if asked in the context of their own personal lives, compared to hypothetical scenarios. Finally, several ethical concerns about CE use have been discussed extensively in the neuroethics literature: peer pressure, distributive injustice, and influence by authority figures. The extent to which the public's opinions are influenced by these concerns, described in further detail below, is not well understood.

Peer Pressure

The claim that CE use may be increasing is disputed (Aikins 2011; Baylis and Robert 2004; Bell et al. 2013; Chatterjee 2004, 2006; DeSantis and Hane 2010; Farah et al. 2004; Forlini and Racine 2009; Greely et al. 2013; Lucke et al. 2010, 2015; McCabe et al. 2005; Mohamed 2014; Outram 2010; Outram and Racine 2011; Partridge 2013; Partridge et al. 2011; 2012; Racine and Forlini 2010; Sattler et al. 2013; Turner and Sahakian 2006; Weyandt et al. 2009; Wiegel et al. 2016). Nonetheless, perhaps non-users experience peer pressure to use CE when they otherwise would not feel compelled to do so (Bell et al. 2013; Bostrom and Sandberg 2009; Cakic 2009; Chatterjee 2006; Colaneri et al. 2018; DeGrazia 2000; Dubljević et al. 2014; Forlini and Racine 2009; Goodman 2010; Kass 2003; Maher 2008; Partridge et al. 2012; Sattler and Wiegel 2013; Schelle et al. 2014;

Scheske and Schnall 2012; Warren et al. 2009; Wiegel et al. 2016). In previous surveys, participants felt it important to respect the decisions of others to use or not use CE (Bell et al. 2013; Forlini and Racine 2009; Greely et al. 2013). In line with the bioethics principle of autonomy, people felt that this choice is a personal one, regardless of their own choices.

Distributive Injustice

Given the advantages that some populations have over others (e.g. wealthy students can afford private tutors vs. poor students attending poorly resourced inner city public schools), increased CE could allow socioeconomic disparities to persist (Cakic 2009; Chatterjee 2006; Colaneri et al. 2018; DeGrazia 2005; Farah 2011; Goodman 2010; Hyman 2011; Levy and Levy 2011; Mohamed 2014; Parens 2000). Health insurers are unlikely to pay for CE use, which means that only populations that can pay will have access to CE (Chatterjee 2006; Hotze et al. 2011; Hyman 2011). If CE use is here to stay, society may have a responsibility to ensure that the neediest populations are not left behind (Wilens et al. 2008). Some researchers even suggest that CE use may help to narrow the gap between the socioeconomically advantaged and disadvantaged (Bruckamp 2013; Greely et al. 2013; Ray 2016). On the other hand, it has been argued that the liberal provision of CE could result in increased expectations and demands on workers and students, leading to increased stress (Brühl et al. 2019). Thus, peer pressure (see above) and social coercion could increase if enhancers were broadly available.

Influence by Authority Figures

One final worry is that authority figures may influence CE use by their subordinates. While this view seems untenable, given the apparent concern for autonomy by respondents in previous surveys, the literature suggests that in some settings, CE use can be reasonably expected or even mandated (Appel 2008; Bostrom and Sandberg 2009; Cakic 2009; Chatterjee 2006; Farah et al. 2004; Forlini and Racine 2009; Greely et al. 2013; Kass 2003; Warren et al. 2009). For example, Santoni de Sio and colleagues write:

[T]he availability of such enhancers might evoke new duties for certain people. In particular, it may impact on the professional duties of people engaged in jobs where the lives of other people are directly at risk (e.g., surgeons and pilots)—i.e., it may impact on

what we can (legally) demand these professionals to do. (Santoni de Sio et al. 2014)

Widespread pressure to use CE has been found in the military, where military personnel may be more likely to be coerced by authority figures because of a culture of obedience. During the Second World War, military leaders found that amphetamine reduced fatigue, increased alertness, and enhanced performance. In 1942, the British Royal Air Force recommended a dose of 10 mg of Benzedrine per mission. The British Army also recommended doses of 20 mg Benzedrine per day for five consecutive days for troops fighting in El Alamein (Brühl et al. 2019; Rasmussen 2011).

Through a survey, the present study addressed some of these questions about the public's perception of CE use. We tested the hypothesis that opinions on the acceptability of CE are malleable and investigated factors that contribute to this malleability. To assess the generalizability of previous metaphor research (see critique in Tubig and Simmerman 2019) we replicated and extended Conrad et al. (2019) by using new positive and negative framing metaphors (a key that unlocks brain potential vs. a Pandora's box that releases brain performance). The previous metaphors (fuel/steroid) used an external framing- things taken into our body, whereas the new metaphors are internally driven- revealing inner capacities. We investigated whether participants find CE use more acceptable for blue vs. white collar activities and in some roles/settings compared to others (i.e. student/educational vs. employee/professional), and probed how opinions were influenced by the three ethical concerns outlined above (peer pressure, distributive injustice, and influence by authority figures).

METHODS

Standard Protocol Approvals, Registrations, and Patient Consents

The Institutional Review Board (IRB) of the University of Pennsylvania approved this study. By selecting "Accept" on Amazon Mechanical Turk, participants waived documentation of informed consent. Participants were provided with the waiver in PDF form and the contact information for the lab.

Experimental Design

Participants were randomly assigned to one of multiple conditions as part of a between-subjects design (Supplemental Materials 1).

The first part of the survey was designed to determine the effect of framing metaphors, activity type, and role/setting on participant attitudes toward CE. Eight vignettes (Supplemental Material 2) were constructed by crossing three variables: framing metaphor (Pandora's box that releases brain performance vs. a key that unlocks brain potential), activity type (blue vs. white collar), and role/setting (student/educational vs. employee/professional). The vignettes read as follows:

Cognitive enhancement pills such as Adderall and Ritalin are [**a Pandora's box that releases brain performance OR a key that unlocks brain potential**]. People who take these pills may be able to focus better and work efficiently.

M. Miller is a [**student OR employee**] [**in a vocational school for manufacturing cars OR in a master's program to design cars OR in a factory for manufacturing cars OR in an office that designs cars**]. The activities in M. Miller's [**educational OR professional**] setting are [**blue collar OR white collar**]. This means that the activities are [**physically, but not mentally OR mentally, but not physically**] demanding.

The bolded text varied according to which one of the eight vignettes participants were randomly assigned.

The second part of the survey was designed to determine the effect of framing metaphors, activity type, and setting on participant attitudes toward CE, but specifically in the context of participants' own studies or employment (if any). After participants answered questions about their own activities, they read a personalized second vignette specifically about themselves, which included the same framing metaphor as in the first vignette (a Pandora's box that releases brain performance vs. a key that unlocks brain potential) and described their own respective activity type (blue vs. white collar) in their own respective role/setting (student/educational vs. employee/professional) and the work as being physically and/or demanding. The vignette read as follows:

Cognitive enhancement pills such as Adderall and Ritalin are [**a Pandora's box that releases brain performance OR a key to unlock potential**] for the brain. People who take these pills may be able to focus better and work efficiently.

You are [**a student OR an employee**]. Your [**educational OR professional**] activities are [**blue collar OR white collar**]. Your activities are [**physically, but not mentally, demanding OR mentally, but not physically, demanding OR neither physically nor mentally demanding OR both physically and mentally demanding**].

The bolded text varied according to which framing metaphor participants were randomly assigned in the first vignette, as well as their responses to questions about their own activities.

Participants

The authors recruited participants using Amazon Mechanical Turk, who completed web-based surveys in October 2018. Based on a similar study (Conrad et al. 2019), the authors estimated needing 375 participants for each of the 8 vignettes and therefore recruited a total of 3,000 participants.

The survey was titled “Answer Questions about Cognitive Enhancement Pills like Adderall and Ritalin (5-15 min),” and participants were paid \$1.50 each. Participants were required to be adults in the United States who had completed at least 500 studies on Amazon Mechanical Turk and whose approval rating was at least 95%. Previous research found that approval rating was correlated with responses of higher quality (Peer et al. 2014).

Procedure

In the first part of the survey, participants were shown the vignette for the condition to which they had been randomly assigned. After 15 s elapsed, participants could advance to the first question:

In general, is it acceptable for people to use cognitive enhancement pills?

After answering this question, participants advanced to three sets of questions which corresponded to the three main ethical concerns outlined in the introduction. We manipulated the number of M. Miller’s peers who already used CE (peer pressure), the degree of competition for jobs and promotions in M. Miller’s environment (distributive injustice), and the number of authority figures in M. Miller’s environment who encourage CE use (influence of authority figures). The question text read as follows:

[*Very few/Half/Most*] of M. Miller’s [**classmates OR coworkers**] use cognitive enhancement pills. Is it acceptable to you for M. Miller to use cognitive enhancement pills?

[*Very few/Half/Most*] of M. Miller’s [**classmates OR coworkers**] are guaranteed [**job placement OR a promotion**], which means the environment is [*very/somewhat/not*] competitive. Is it acceptable to you for M. Miller to use cognitive enhancement pills?

[*Very few/Half/Most*] of M. Miller’s [**teachers OR supervisors**] encourage the use of cognitive enhancement pills. Is it acceptable to you for M. Miller to use cognitive enhancement pills?

The italicized text differed on each question, and each participant answered all three versions. The bolded text varied according to which one of the 8 vignettes participants were randomly assigned.

The wording of “Is it acceptable to you...” was selected to be inclusive of the many reasons for which participants may consider CE use ethical. Participants selected one of 7 responses on a Likert scale: (1) Absolutely Not (2) No (3) Probably Not (4) Not Sure (5) Probably Yes (6) Yes (7) Absolutely Yes. This 7-point Likert scale was selected to enable the detection of fine-grained differences in participants’ beliefs (Green and Rao 1970).

In the second part of the survey, participants were presented with a second personalized vignette specifically about themselves, described in the *Experimental Design* subsection. After 15 seconds elapsed, participants advanced to the first set of questions.

In general, is it acceptable for people to use cognitive enhancement pills?

In general, is it acceptable for you to use cognitive enhancement pills?

Would you consider using cognitive enhancement pills?

Next, participants repeated the same set of questions as in the first survey, which now referred to “you” rather than to “M. Miller”:

[*Very few/Half/Most*] of your [**classmates OR coworkers**] use cognitive enhancement pills. Is it acceptable for you to use cognitive enhancement pills?

[*Very few/Half/Most*] of your [**classmates OR coworkers**] are guaranteed [**job placement OR a promotion**], which means the environment is [*very/somewhat/not*] competitive. Is it acceptable for you to use cognitive enhancement pills?

and

[*Very few/Half/Most*] of your [**teachers OR supervisors**] encourage the use of cognitive enhancement pills. Is it acceptable for you to use cognitive enhancement pills?

At the end of the survey, participants were asked whether they, or people they knew, had previously used CE. Participants also reported basic demographics.

Data Analysis

The data were analyzed using JASP (Version 0.9.1). Likert scores were converted to a range from 1 to 7, with higher numbers corresponding to greater perceived acceptability of CE use. *T*-tests were used to test for differences between the manipulated factors (i.e. framing metaphor, activity type, role/setting) on the perceived acceptability of CE use, and mixed ANOVAs were used to test for possible interactions between these factors. Where there were significant ANOVA findings, post-hoc independent *t*-tests were performed to test for inter-group differences. Effect sizes were reported as follows: Cohen's *d* for *t*-tests and ω^2 for between-subjects ANOVA.

RESULTS

3,007 participants completed the survey, of which 488 were excluded for failing an attention check, resulting in 2,519 participants whose data were analyzed for part 1 of the survey. In part 2, from these 2,519 participants, respondents who were neither employees nor students were further excluded. In addition, an error in the survey meant that some participants were not correctly assigned to conditions in part 2, and these data were also excluded. Following these exclusions, the responses from 1,083 participants were retained in part 2. Demographic information is provided in Table 1.

General Acceptability

We examined how the factors Metaphor (Pandora's box that releases brain performance vs. key that unlocks brain potential), Roles/Setting (student/educational vs. work/professional), and Activity Type (blue vs. white collar), affected four acceptability ratings:

Following the first vignette which described a fictional character (M. Miller):

1. "In general, is it acceptable for people to use cognitive enhancement pills?"

Following the second vignette which described the respondents' own situation:

1. "In general, is it acceptable for people to use cognitive enhancement pills?"
2. "In general, is it acceptable for you to use cognitive enhancement pills?"
3. "Would you consider using cognitive enhancement pills?"

Table 1. Summary of demographic information of study sample.

	Study sample ^a (<i>n</i> = 2,519)
Age, mean (SD)	36.4 (11.5)
Years of education, mean (SD)	15.2 (2.7)
Sex assigned at birth, No. (%)	
Female	1,296 (51.5)
Male	1,155 (45.9)
Do not wish to say	65 (2.6)
Intersex	1 (0.04)
Race, No. (%)	
White only	1,898 (75.4)
Black/African American only	201 (8.0)
Asian only	147 (5.8)
Hispanic only	130 (5.2)
Political orientation, No. (%)	
Very conservative	118 (4.7)
Conservative	465 (18.5)
Moderate	708 (28.1)
Liberal	857 (34.0)
Very liberal	370 (14.7)
CE pills usage, No. (%)	
Ever prescribed for treatment	394 (15.6)
Educational setting	49 (1.9)
Professional setting	300 (11.9)
Ever used for enhancement	503 (20.0)
Educational setting	82 (3.3)
Professional setting	375 (14.9)
Knows someone who was prescribed for treatment	1,637 (65.0)
Knows someone who used for enhancement	1,230 (48.8)

^aOnly participants who correctly answered the attention check.

Metaphor

The choice of framing metaphor did not significantly affect opinions after people read the first vignette about M. Miller ($t(2517) = 1.07$, $p = 0.29$, $d = 0.04$, 95% CI = -0.06 to 0.19). After reading a personalized vignette about their own situation, the framing metaphor did not affect whether they thought it was acceptable for others to use CE ($t(1079) = 0.36$, $p = 0.72$, $d = 0.02$, 95% CI = -0.18 to 0.26), or whether they thought it was acceptable for themselves to use CE ($t(1079) = 1.57$, $p = 0.12$, $d = 0.13$, 95% CI = -0.05 to 0.10). However, we found the framing

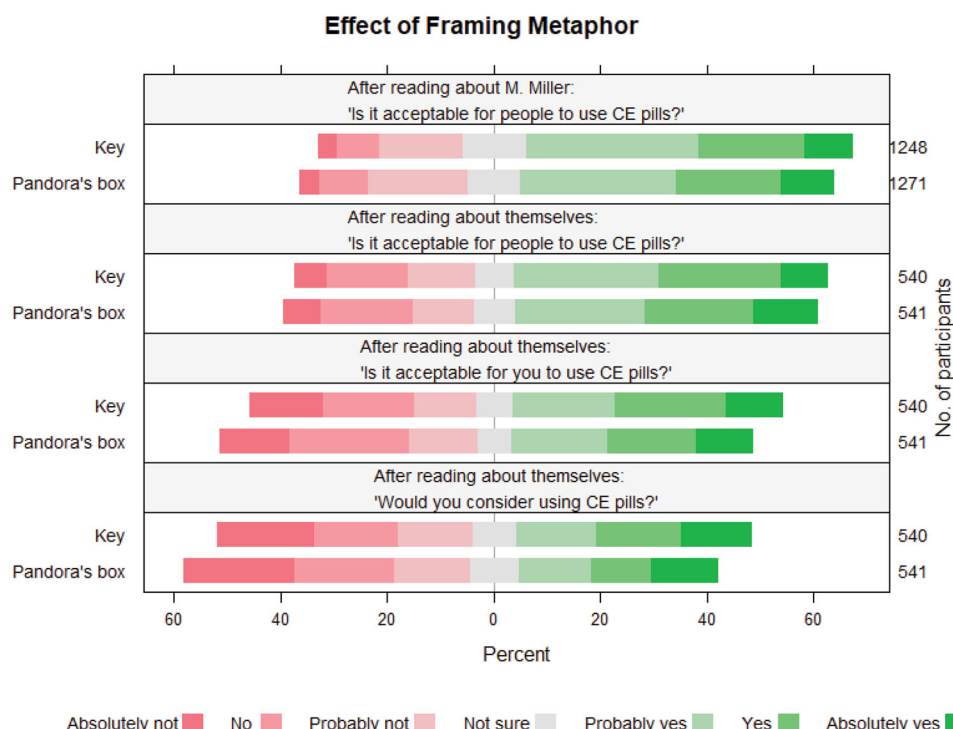


Figure 1. The distribution of acceptability ratings according to the framing metaphor participants were exposed to. Positive ratings are in green, and negative ratings are in red. The size of each colored section indicates the proportion of respondents who selected that option.

metaphors had a relatively weak effect on whether people would consider using CE ($t(1079) = 2.15$, $p = 0.03$, $d = 0.13$, 95% CI = 0.02 to 0.52), with those exposed to the Key metaphor ($M = 3.87$) more likely to consider using CE than those exposed to the Pandora's box metaphor ($M = 3.59$), although this result would not survive multiple-comparison correction. The distribution of ratings depending on metaphor framing is illustrated in Figure 1.

Role/Setting

In the first vignette, M. Miller's role/setting (student/educational vs. employee/professional) significantly influenced acceptability ratings, with people finding CE use more acceptable when M. Miller was described as an employee ($M = 4.61$) compared to a student ($M = 4.43$) ($t(2517) = 2.98$, $p = 0.003$, $d = 0.12$, 95% CI = 0.06–0.31). In the analysis of the second (personalized) vignette, the respondent's own role was used as the independent variable. There were many more employees (946) than students (137) in our study sample. The independent samples- t -test does not assume equal sample sizes but does assume equal variances. Levene's test for equality of variances was not significant in any comparisons between employees and students ($p = .61-.85$) suggesting that the

variances were similar in each group. We found that the respondent's own role did not influence whether they thought it was acceptable for other to use CE ($t(1079) = 1.07$, $p = 0.29$, $d = 0.1$, 95% CI = -0.5 to 0.15), or whether they thought it was acceptable for themselves to use CE ($t(1079) = 0.75$, $p = 0.45$, $d = 0.07$, 95% CI = -0.5 to 0.22). However, the respondent's role significantly influenced whether they would consider using CE ($t(1079) = 2.64$, $p = 0.008$, $d = 0.24$, 95% CI = $0.13-0.88$), with students more likely to consider using CE ($M = 4.17$) than employees ($M = 3.67$). This result was confirmed by a Welch's t -test, which does not assume equal variances ($t = 2.64$, $p = .009$, and a Mann Whitney U -test, which does not assume normality ($U = 55150$, $p = .009$). The distribution of ratings depending on role is illustrated in Figure 2.

Activity Type

The type of activity (blue vs. white collar) M. Miller was described as doing did not significantly influence acceptability ratings ($t(2517) = 0.3$, $p = 0.76$, $d = 0.01$, 95% CI = -0.1 to 0.14). In vignette 2, we asked participants whether their own activities were blue collar or white collar, but we also allowed participants to select "both" or "neither" to account for activities that

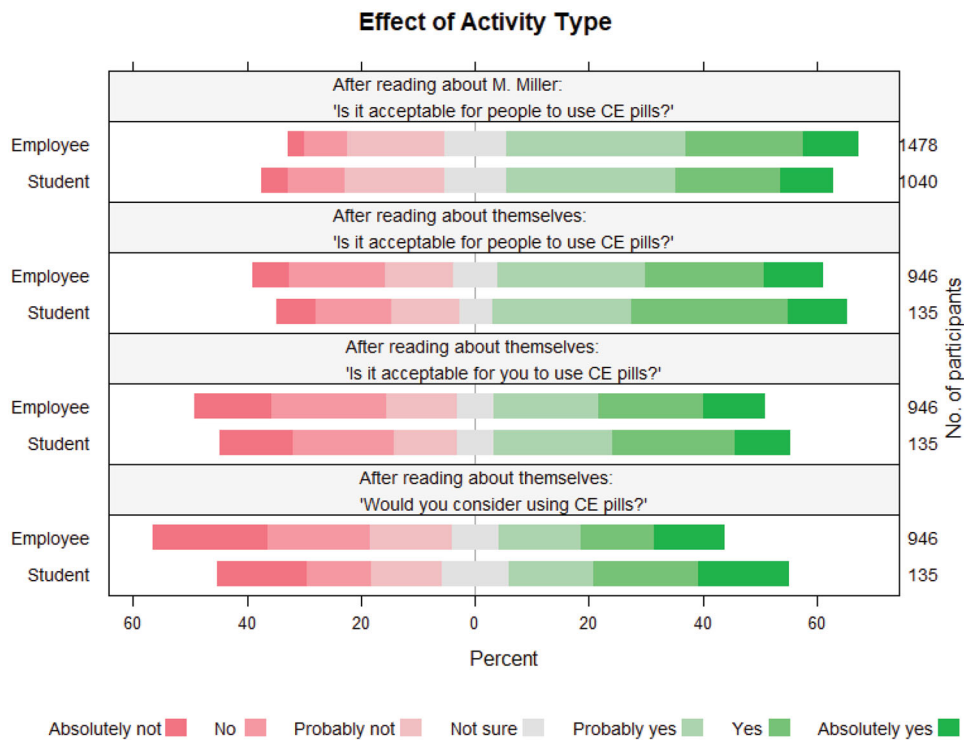


Figure 2. The distribution of acceptability ratings according to the role (employee or student) of either the fictional character (top panel) or of the participant themselves (bottom three panels). Positive ratings are in green, and negative ratings are in red. The size of each colored section indicates the proportion of respondents who selected that option.

did not fit neatly into these categories (e.g. work in customer service and entertainment industries). We also asked participants whether their activity was physically demanding, mentally demanding, both, or neither. However, whether respondents performed blue collar, white collar, physically demanding, or mentally demanding activities did not influence any of the acceptability ratings (Supplemental Results 1).

Metaphor × Role/Setting × Activity Type

A between-subjects ANOVA was conducted to test for potential interactions among the predictors. When analyzing the acceptability ratings from the first vignette, the factors of framing metaphor (Pandora's box that releases brain performance vs. a key that unlocks brain potential), M. Miller's role/setting (student/educational vs. employee/educational) and M. Miller's type of activity (blue vs. white collar) were entered. Confirming the results of the previously reported *t*-test, role/setting emerged as a significant main effect after controlling for the other factors ($F(1,2511) = 8.76, p = 0.003$). There were no other significant main effects or interactions.

For the second, personalized vignette, framing metaphor and the respondent's own role were entered as predictors. For simplicity, we did not include

respondent's own activity type as a factor because of the large number of potential categories and because the *t*-test results suggested this was not a significant predictor of ratings. Consistent with the *t*-tests reported above, we found no main effects of metaphor or respondent-role and no interaction when participants rated the acceptability others' use of CE or self-use of CE, but when participants rated whether they would consider using CE, there was a significant main effect of the respondent's own role ($F(1,1077) = 6.97, p = 0.008$). The main effect of metaphor was no longer significant after role was controlled for ($F(1,1077) = 0.5, p = 0.48$).

Peers' Use of CE

We asked participants to rate the acceptability of M. Miller's and their own use of CE while imagining that varying numbers of M. Miller's and their own peers already used CE. When more of M. Miller's peers used CE, people found it more acceptable for M. Miller to also use CE ($F(2,5030) = 310.54, p < 0.001, \eta^2 = 0.11$). Metaphor did not affect the peers' use ratings ($F(1,2515) = 2.95, p = 0.09, \eta^2 = 0.001$) but there was a significant main effect of role, with increased acceptability when M. Miller was an



Figure 3. The main effects of Role (whether M. Miller was framed as a student or as an employee) and the number of CE using peers affected how acceptable people thought it was for M. Miller to use CE pills.

employee at all three levels of peers' use ($F(1,2515) = 10.16$, $p = 0.001$, $\eta^2 = 0.004$) (Figure 3).

When imagining that more of their own peers used CE, participants also found their own use of CE more acceptable ($F(2,2154) = 45.1$, $p < 0.001$, $\eta^2 = 0.04$). However, neither metaphor ($F(1,1077) = 0.5$, $p = 0.48$, $\eta^2 < 0.001$) or the respondent's own role (student or employee) ($F(1,1077) = 0.2$, $p = 0.66$, $\eta^2 < 0.001$) affected responses to their peers' CE use.

Level of Competition

Participants rated how acceptable it was for M. Miller and themselves to use CE while imagining scenarios where the environment varied in how competitive it was (more or less competition for jobs and promotions). There was a main effect of competition when people rated the acceptability of M. Miller's CE use; the more competitive the environment, the less acceptable people thought it was for M. Miller to use CE ($F(2,5030) = 10.06$, $p < 0.001$, $\eta^2 = 0.004$). An interaction between competition and metaphor was also observed ($F(2,5030) = 5.34$, $p = 0.005$, $\eta^2 = 0.002$). Tests of simple effects revealed that acceptability ratings were significantly higher for the Key metaphor relative to the Pandora's box metaphor when the environment was not competitive ($p = 0.004$) or somewhat competitive ($p = 0.02$), but no metaphor difference when the environment was very competitive ($p = 0.13$) (Figure 4). An additional interaction was found between competition and role ($F(2,5030) = 4.24$, $p = 0.02$, $\eta^2 = 0.002$). Tests of simple effects

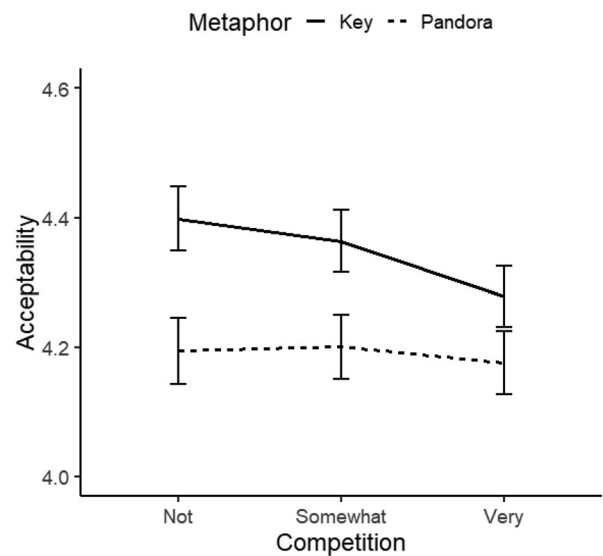


Figure 4. Metaphor interacted with the level of competition when participants rated the acceptability of M. Miller's CE use.

showed that acceptability ratings were higher in the employee condition relative to the student condition when the environment was not competitive ($p = 0.003$) or somewhat competitive ($p = 0.01$), but no role difference when the environment was very competitive ($p = 0.053$) (Figure 5).

When imagining that their own environment was more competitive, participants found their own use of CE less acceptable ($F(2,2154) = 10.19$, $p < 0.001$, $\eta^2 = 0.01$). When rating the acceptability of their own CE use, neither metaphor ($F(1,1077) = 1.63$, $p = 0.2$, $\eta^2 = 0.002$) or the respondent's own role ($F(1,1077) = 1.06$, $p = 0.3$, $\eta^2 = 0.001$) affected responses to varying levels of competition.

Authority Figures' Encouragement of CE Use

Participants rated how acceptable it was for M. Miller and themselves to use CE while imagining that varying numbers of authority figures (teachers vs. supervisors) in M. Miller's and their own lives actively encouraged the use of CE. When rating the acceptability of CE use for M. Miller, there was a significant main effect of authorities' encouragement of CE ($F(2,5030) = 381.28$, $p < 0.001$, $\eta^2 = 0.13$); the more authorities encouraged CE use, the more acceptable M. Miller's CE use was to participants. A three way interaction between authorities encouragement, metaphor and role was also observed ($F(2,5030) = 3.84$, $p = 0.021$, $\eta^2 = 0.002$). Tests of simple effects were conducted to explain the nature of this interaction. Ratings were significantly higher under the Key metaphor relative to the Pandora's box metaphor, but only

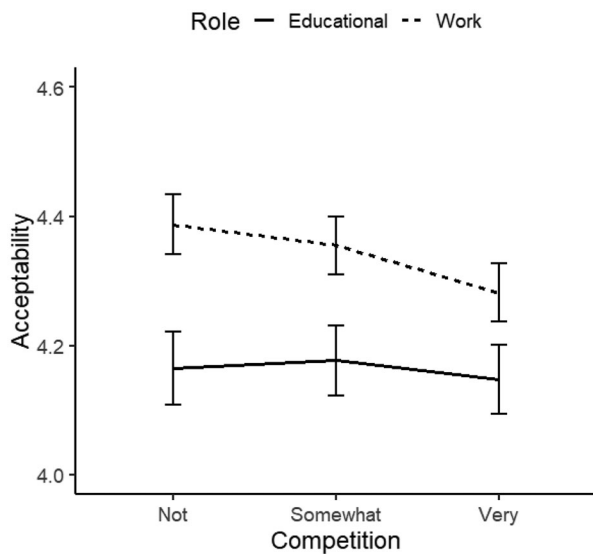


Figure 5. The character's role/setting (educational or work) interacted with the level of competition when participants rated the acceptability of M. Miller's CE use.

in employee conditions, and only when half ($p = 0.004$) or most ($p = 0.003$) authorities encouraged CE use (Figure 6).

When rating the acceptability of their own behavior, there was again a significant main effect of authorities' encouragement of CE use ($F(2,2152) = 105.227$, $p < 0.001$, $\eta^2 = 0.09$). There was also a main effect of the respondents' own role: student respondents again found their own CE use more acceptable than employee respondents, at all levels of authorities' encouragement ($F(1,1075) = 4.03$, $p = 0.045$, $\eta^2 = 0.004$). No other main effects or interactions were significant.

Self vs. Other, Belief vs. Behavior

We examined how the personal relevance of the questions affected people's ratings. Rating one's own potential CE use was considered more personal than rating the acceptability of others' use. Similarly, deciding whether your own use of CE is acceptable (a belief) is different from deciding whether you would consider using CE (a behavior). We operationalized personalness on a continuum as follows: (Least personal) "Is it acceptable for people to take CE?" (after reading about M. Miller) < "Is it acceptable for people to take CE?" (after reading about themselves) < "Is it acceptable for you to take CE?" < "Would you consider taking CE?" (Most personal). A repeated measures ANOVA revealed a significant effect of personalness ($F(3,3240) = 66.72$, $p < 0.001$, $\eta^2 = 0.06$), and all four levels were significantly different from

each other (all p values < 0.008, Bonferroni corrected). Participants rated the acceptability of other's use at 4.57 (SD = 1.58) after reading about M. Miller and at 4.36 (SD = 1.80) after reading about their own situation. The acceptability of self-use was rated at 3.96 (SD = 1.99) while ratings of whether or not participants would actually consider using CE averaged at 3.73 (SD = 2.07).

Relationships with Demographic Variables

We derived a total acceptability score for survey 1 and survey 2 by summing the acceptability ratings given in each survey. These total scores were used to examine how demographic variables influenced acceptability ratings. Age, education, gender, and the competitiveness of the respondent's environment emerged as significant predictors of CE acceptability (Supplemental Results 1).

DISCUSSION

We confirmed the hypothesis that opinions about CE use are malleable. While metaphors did not influence acceptability judgments about the use of CE by others, they did appear to affect whether participants would consider using CE themselves. Participants exposed to the Key metaphor were more likely to consider using CE than participants exposed to the Pandora's box metaphor. While both metaphors suggested that CE allows users to employ mental faculties that they already have, the different meanings associated with them may have aligned with different valuations of CE use. For example, the Pandora's box metaphor may have raised concerns about the negative consequences of CE use, such as individual side effects or societal unintended consequences. However, this metaphor effect was unreliable and we cannot make any firm conclusions about the effect of metaphors on shaping opinions in this study. The metaphor effect was not observed when included in an omnibus ANOVA with other factors and would not survive multiple comparison correction. The effect size ($d = .13$) was also smaller than that observed in Conrad et al. (2019) ($d = .23$). The pattern of results also contrasts with results from Conrad et al. (2019), in which the metaphor framing affected opinions about others' use of CE but not self-use. Metaphor choices may thus have nuanced effects on different aspects of opinions about CE, and may have a stronger, weaker, or no effect when they highlight different features of the target. The fuel/steroids metaphors frame CE as an

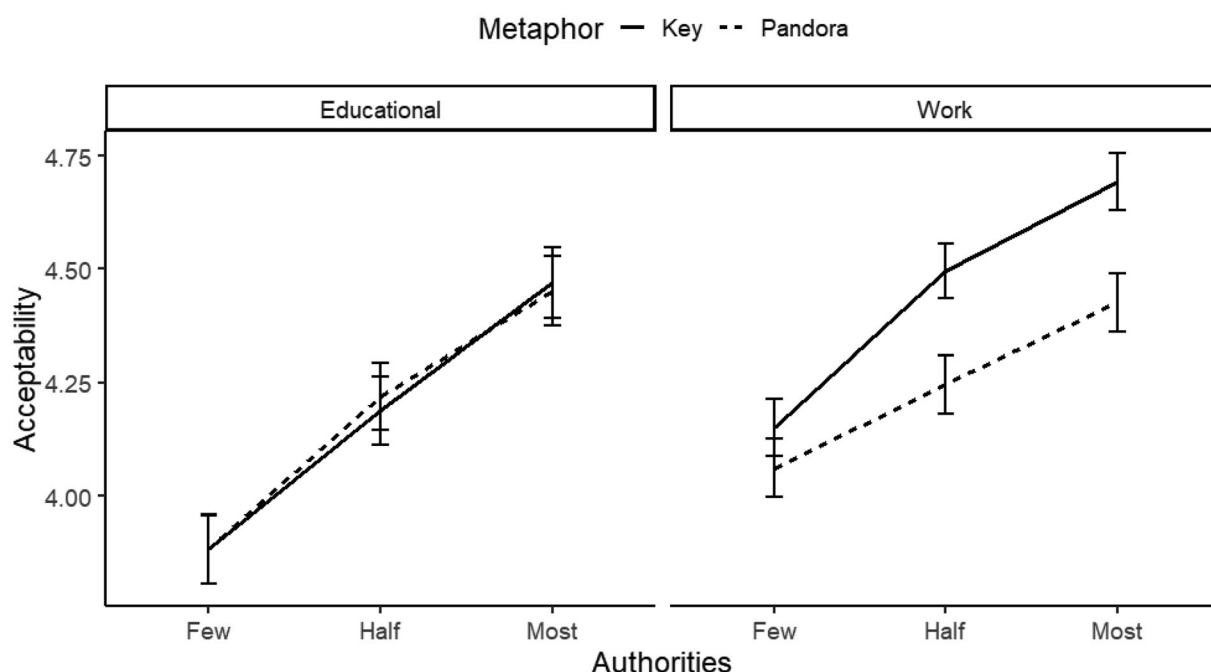


Figure 6. There was a three-way interaction between the character's role/setting (educational or work), the framing metaphor (key or Pandora's box), and the number of authority figures who encourages CE use.

external energy source, while the key/Pandora's box metaphors frame CE as granting access to internal hidden capabilities. Tubig and Simmerman (2019) suggest that care should be taken when choosing metaphors to highlight the various ethical dimensions of CE. Perhaps this focus on external versus internal framing has an impact on peoples' attitudes about others versus themselves. The distinction between internal and external framings relates to another ethical dimension of CE use: dehumanization. Castelo et al. (2019) suggest that people who enhance their mental abilities beyond normal levels may be dehumanized, while people who use enhancement to restore lost abilities are not. If external framings of CE invoke the idea of embellishing one's abilities beyond their "true" level, the negative associations with dehumanization may also be activated, while this may not be the case for internal framings which imply restoring or enabling access to one's true abilities. We do note, however, that participants' comprehension of the metaphors was not explicitly measured. We assumed that most people would understand the concept of a Pandora's box, as Greek mythology is commonly taught in middle and high school across the United States. However, the concept is certainly less familiar than a key, and some participants may not have understood the meaning. This could also account why we did not observe a robust difference between metaphor conditions.

Activity type (blue vs. white collar) did not affect acceptability ratings for CE use by M. Miller.

Additionally, whether participants' own activities were physically and/or mentally demanding did not affect the general acceptability ratings corresponding to the second vignette. This observation is notable in light of prior research demonstrating that participants found CE use less acceptable for athletes than employees (Conrad et al. 2019). Whereas the difference in level of physical activity could have explained this finding from prior research, findings from the present study suggest that this explanation is not likely the case. When rating the acceptability of CE use, perhaps participants were sensitive to fairness, and found the competition of athletic activity more salient than its physicality. This view is consistent with that of Goodman (2010), who opines that CE use "should be especially tolerated when the activities at stake are non-zero-sum and when the importance of process is outweighed by the importance of outcome." It is possible that participants evaluated the acceptability of CE use by considering whether or not an activity is zero-sum (as reflected in how competitive it is), not whether that activity physically and/or mentally demanding.

Unlike metaphor and activity type, role/setting (student/educational vs. employee/professional) affected acceptability ratings for CE use. Participants found CE use more acceptable for employees than students. This finding is consistent with prior research by Conrad et al. (2019), who proposed 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’.” Activities in an educational setting typically amount to a zero-sum game, whereas in a professional setting, it is possible for everyone to benefit on the whole. In contrast to the general finding that people are more accepting of CE use by employees than students, we found that participants who were themselves students were more likely to consider using CE than those who were employees. Perceived acceptability is not synonymous with the actual use of CE, and there may be other factors that determine whether a student or an employee would actually use CE (e.g. age). Students may be more likely to encounter the use of CE on campus by their peers, and this increased exposure may contribute to their feeling more open about CE use and less concerned about potential harms.

We also found that participants rated CE use more acceptable if more peers used CE, the environment was less competitive, and authority figures encouraged CE use. In the first survey, participants rated CE use more acceptable the more peers M. Miller character had; in the second survey, the participants also rated CE use more acceptable the more peers they themselves had. This suggests that concerns about peer pressure to use CE are not unfounded. Even if CE use is not prevalent today, people’s views on its acceptability, and therefore their decision to use or not use CE, may vary by the prevalence of CE use. People may feel pressure to use CE—not to gain an advantage over others—but simply to keep up with their peers (see the “Red Queen” principle described in Chatterjee 2006). Alternatively, rather than peer pressure per se, an increased prevalence of CE use among one’s peers may lead more people to find CE use acceptable as societal norms begin to change.

We also found that that participants rated CE use more acceptable the less competitive the setting for both surveys. Moreover, we found a significant interaction between metaphor and competition. The metaphors influenced opinions when the environment was not competitive or somewhat competitive, but the influence of metaphor vanished when the environment was very competitive, suggesting that competition then became the more pressing factor. Given that possible disparities resulting from CE access have yet to cause public uproar, concerns about such disparities may seem speculative. Nonetheless, the concern about distributive injustice reflects broader concerns regarding resource allocation, especially when people have limited resources to achieve upward mobility for

themselves in education and employment. Because the public may view opportunities like job placements or promotions as being limited, they may find CE use less acceptable as the number of such opportunities decreases. Participants’ views are therefore consistent with Goodman’s (2010) claims: the more competitive an activity is, the more it is like a zero-sum game, where someone must lose in order for someone to win.

In both surveys, participants rated CE use more acceptable the more authority figures encouraged its use. As with peer pressure, our findings are consistent with concerns about the influence of authority figures (Appel 2008; Cakic 2009; Chatterjee 2006; Coercion 2004; Dubljević et al. 2014; Forlini et al. 2015; Forlini and Racine 2009; Greely et al. 2013; Hotze et al. 2011; Maier et al. 2015; Maslen et al. 2015; Mohamed 2014; Schelle et al. 2014; Schoomaker 2007; Schuijff and Brom 2013). There is a fine line between encouragement and expectation of CE use, and our results suggest that subordinates may be particularly sensitive to the views of their superiors. Specifically, there was a three-way interaction between metaphor, role, and authority figures, demonstrating the multiplicative effects of each of these factors: CE was the most acceptable when it was framed with the Key metaphor, the target was an employee, and most authority figures encouraged CE use. These findings have implications for people in positions of authority, whose views may influence the behavior of their subordinates, whether intentionally or not.

Overall, the participants in this study were sensitive to changes in the amount of peer pressure, competition and influence from authority figures. Disadvantaged groups in society such as populations experiencing racial inequality or those who are economically disadvantaged may be particularly vulnerable to these negative consequences of CE use. For example, employees may feel unable to say no to pressure to enhance if their job may be at risk. Future research on CE use must therefore try to gather attitudes and experiences from diverse populations and disadvantaged groups. The present study represents an improvement over previous studies as the sample was collected on Amazon’s Mechanical Turk, where participants are more diverse, report relatively low income, and are closer to the US population as a whole than typical undergraduate subject pools (Paolacci et al. 2010). However, there was still a disproportionate number of white respondents to our survey (approximately 75%).

Finally, we found that across all three scenarios (i.e. peers' use of CE, competition, encouragement by authority figures), people found CE use more acceptable in the first vignette (concerning M. Miller) than the second one (concerning the participants themselves). Consistent with the study by Conrad et al. (2019), this finding suggests that respondents may be more cautious about their own behavior while believing that others should have the freedom to make their own choices about CE use. This finding is also in line with previous surveys where participants expressed the importance of respecting others' decisions to use CE (Bell et al. 2013; Forlini and Racine 2009; Greely et al. 2013). If policymakers are to consider the public's perception of CE use when drafting regulations for it, they should remain cognizant of this difference.

CONCLUSION

We found that metaphor (Pandora's box that releases brain performance vs. key that unlocks brain potential) had a limited effect on the perceived acceptability of CE which was unreliable and smaller than previously reported, activity type (blue vs. white collar) did not generally affect acceptability ratings, and role/setting (student/educational vs. employee/professional) had the most robust effect on acceptability judgments. For policymakers and influencers, this observation suggests that a 'one-size-fits-all' approach to regulating CE use may be inconsistent with public opinion. If the public finds CE use a duty in some settings, but morally repugnant in others, it may make sense for people in any given setting to define the conditions of CE use on their own. Additionally, we found that the acceptability ratings were informed by concerns raised in the neuroethics literature: peer pressure, distributive injustice, and influence by authority figures. This finding suggests that all members of society—whether students or teachers, employees or employers, or constituents or politicians—should be cognizant of how their beliefs and actions may affect those around them. Given the apparent lack of consensus on the ethics of CE use, every member of society has some power to shape the discourse.

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DATA AVAILABILITY STATEMENT

The raw data from this study are freely available at the Open Science Framework: <https://osf.io/qvp39/>.

DISCLOSURES STATEMENT

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