Research paper

# Modelling predictors of UK undergraduates' attitudes towards smart drugs

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## ARTICLE INFO

## ABSTRACT

*Background:* Smart drug use is increasing but we have little insight into their use. We hypothesized that use is predicted by attitudes and various factors including incremental morality and entity intelligence beliefs would be associated with positive attitudes, whilst perception of unfairness would be associated with negative attitudes.

*Methods:* UK undergraduates completed an online survey to establish attitudes towards smart drugs, previous use and likely future use as well as measures of several factors hypothesized to predict attitudes.

*Results:* Attitudes were found to predict previous and likely future use. Attitudes were more positive in those who believed that smart drugs were harmless and those who felt they knew enough to use them safely. By contrast, perceived unfairness was associated with negative attitudes.

*Conclusions:* Interventions to reduce smart drug use should focus on attitudinal beliefs around potential harm and safety, as well as emphasizing the debate around unfairness.

## 1. Introduction

Smart drugs, also known as cognitive enhancers, are prescription drugs taken by individuals, either without a prescription or at a dose exceeding that which is prescribed, with the intention of improving cognitive functions such as concentration, vigilance or memory [1]. In some cases, the drugs may also result in changes to mood (i.e. emotional enhancement) but this is not typically the aim of taking smart drugs [2] Commonly used smart drugs include methylphenidate (Ritalin, Concerta), amphetamine (Adderall), and modafinil (Provigil) but other classes of drug are also discussed in this context, including acetylcholine esterase inhibitors and beta-blocker [3,4]. The main cognitive enhancers used were originally designed to treat a range of disorders including Attention Deficit Hyperactivity Disorder (ADHD) and narcolepsy [5], by targeting various deficits in cognitive functioning such as attentional biases, aberrant learning, and absence of top-down cognitive control [3]. However, they are increasingly being used by healthy individuals, though questions remain around their ability to enhance cognition within non-clinical populations [5–7]. One population for whom smart drug use is thought to be particularly prevalent is university students, who seek to enhance cognitive functioning to improve academic performance [5,8–10]. Smart drug prevalence estimates in students range from 5–35% in the US [10], 1–16% in Europe [11–13], and 0.02–9% in the UK [14,15].

In addition to debate around the effectiveness of smart drugs in healthy populations, the use of drugs to gain an academic advantage has sparked a bioethical debate, in which smart drugs have been framed as analogous to doping in sport. Focus groups with university students, their parents and health care professionals identified one of most contentious issues surrounding smart drug use was the potential injustices and inequalities that could arise from their use [16]. Specifically, they found that views on equality of opportunity, that is whether everyone has equal access to forms of enhancement and therefore the benefits they bring, are critical in understanding how people perceive smart drugs. By contrast, honesty and authenticity of performance, appear less important [16,17].

Safety concerns have also been raised [18]. Evidence relating to the health and safety impact of smart drugs is lacking because most studies investigating drug effects do so in the context of them being used as prescription medication in clinical populations, which may mean findings do not apply to healthy individuals using the drugs as smart drugs. Yet, the limited research available suggests that whilst modafinil has no serious side effects in the short term, the psychostimulants methylphenidate and amphetamine have been linked with short-term side-effects such as cerebrovascular complications, anxiety and decreased connectedness [7]. The long-term effects (>1 year) are largely unknown owing to a lack of longitudinal studies in healthy populations [19]. However, work in ADHD populations, including several

randomised control trials, indicates that the psychostimulants are associated with relatively mild side effects such as a dry mouth [20,21] and reduced appetite but also more serious effects of increased in heart rate and blood pressure [21–24]. Comparative studies have found, perhaps unsurprisingly, that users are less concerned about the safety of smart drugs than non-users [6,25], and perceptions of the severity of possible health risks have been inversely associated with willingness to use smart drugs [26–32].

Given the possibility that these drugs are not effective in healthy individuals, concerns about fairness, and potential health risks, it is important to better understand determinants of smart drug use. Alongside work showing lesser safety concerns among users [6], studies have found that higher levels of study-related stress are associated with increased cognitive enhancement through both lifestyle drugs (e.g. caffeine) and some prescription drugs [3,15,33,34]; indeed, prevalence rates are doubled in highly competitive universities, where stress may be greater [35]. It has been argued that, as smart drug use becomes more prevalent, other students may feel greater pressure to use smart drugs, to remain competitive against smart drug users [19]. Empirical evidence, which has focused on two types of norms – i.e., perceptions of others' attitudes towards smart drug use (injunctive norms), and perceptions of others' smart drug use (descriptive norms) [36] – has, however, been mixed. While awareness of others using smart drugs (i.e. descriptive norms) has been found to increase use [15], perceived encouragement from others to use smart drugs (i.e. injunctive norms) has been found to have no impact on willingness to take smart drugs [28]. A study of 65 Canadians suggested that users viewed decisions to take cognitive enhancing substances as self-determined, rather than the result of coercion from others, though it remains possible that self-authored decisions are nonetheless informed by perceptions of the social environment [17].

One area that has received little attention in the literature is whether there is any association between smart drug use and implicit beliefs about personal attributes; i.e., beliefs held, often without awareness, about the very nature of one's own attributes. Dweck et al. [37] propose that people hold one of two implicit belief theories regarding the flexibility of personal attributes, and these theories impact on processing of social information and human actions. With regards to intelligence, for example, an individual may subscribe to an 'entity theory', viewing intelligence as fixed, or an 'incremental theory', viewing intelligence as modifiable. Implicit intelligence beliefs tend to be important in education in general, determining an individual's goals, responses to difficulty and educational attainment [37,38]. Entity intelligence theorists tend to pursue performance goals [39], placing emphasis on the winning outcome and focusing on tasks that verify their intellectual ability, whereas incremental intelligence theorists tend to pursue mastery goals focusing on learning new concepts and improving their competence [40]. While not yet investigated within the smart drug domain, research has shown that those who hold entity beliefs are more likely to cheat on exams after initial failure in order to maintain the appearance of high achievement [41]. It is therefore plausible that entity theorists may view smart drugs more positively than incremental theorists. Implicit theories have been identified for morality [37] – that is, beliefs in whether morality is fixed or can shift across settings – but, despite the bioethical debate around smart drugs, the role of implicit morality beliefs in shaping smart drug use has not been investigated. Given widely-held views that smart drugs are unfair [16,17], we speculate that those who hold positive attitudes towards smart drugs may be more likely to hold incremental morality beliefs, believing that, in some settings, engaging in 'unfair' behaviour is not indicative of a general lack of morality.

This study sought to model determinants of beliefs about smart drugs and related behavioural tendencies among UK-based undergraduate students. Using a cross-sectional survey design, we measured global attitude towards smart drugs, previous smart drug use and behavioural expectation i.e., the likelihood that the participant would use

smart drugs in the future [42]. A wealth of research demonstrates that attitudinal beliefs typically correspond with intentions and behaviour [43,44]. Thus, we hypothesized that:

1 Positive attitudes towards smart drugs would be associated with higher levels of actual past use, and greater expected future use.

Support for this hypothesis would justify modelling smart drug attitudes as an outcome of interest in subsequent analyses. Measures were thus taken of potential determinants of smart drug attitudes: study stress, awareness and availability of smart drugs, perceptions of safety and fairness, and implicit morality and intelligence beliefs. We hypothesized that:

2. Greater study stress, awareness of others' use, availability, beliefs that smart drugs are safe, and endorsement of incremental morality and entity intelligence theories, will be associated with more positive attitudes towards smart drugs.
3. Beliefs that taking smart drugs is unfair will be associated with more negative attitudes towards smart drugs.

## 2. Materials and methods

### 2.1. Sampling period

The study ran from November until March (i.e. for a four-month period). This period includes an examination period and typical end of term deadlines at the host institution and this academic year is typical of many UK universities.

### 2.2. Participants and procedure

Eligible participants – i.e., full-time undergraduates at a UK university, aged 18 years or over – completed an online survey. The study was advertised via email circulars to students at the host institution, King's College London, a research-intensive Russell Group university in the UK. It was additionally advertised on social media (Facebook, LinkedIn, Twitter), student websites (e.g. www.studentroom.co.uk), and on posters displayed at multiple London universities. Study adverts featured a URL or QR code linking to the study information and a consent form. Consenting participants were granted access to the online questionnaire, which took approximately 30 min to complete. Those who completed the questionnaire were offered entry into a £100 Amazon.co.uk voucher prize draw. All procedures were approved by the King's College London Psychiatry, Nursing & Midwifery Research Ethics Subcommittee (HR15/162824).

Of 612 participants who started the questionnaire, 191 failed to complete and one did not meet the age criterion, yielding a final sample of 420 participants (298 female [71%], 122 male [29%])). Age ranged from 18 to 58 years (mean = 21.58 years, SD = 3.83) with most participants (92.2%) being aged between 18 and 25 years of age and, therefore, of typical university student age. Most participants have previously only completed school level qualifications as would be expected for those studying an undergraduate degree (94.5%) however, a small proportion had previously completed postgraduate qualifications (certificate, diploma or masters, 4.5%) or a professional qualification (1%) suggesting a minority may be returning to higher education. An a priori power analysis suggested that a minimum sample size of n = 103 was required to achieve power at 0.80 using a multiple regression with 7 predictor variables and a small overall predicted effect size (f = 0.15).

### 2.3. Measures

All measures were self-reported. Unless otherwise specified, multi-item measures were combined into a global scale mean score. Reliability coefficients (Cronbach's alpha) are reported for all multi-

item scales designed to tap the same latent construct.

*Global attitudes towards smart drugs* were measured via a single item: 'Please indicate your attitude to using smart drugs' (1 = extremely negative, 5 = extremely positive).

*Previous smart drug use.* Participants indicated whether, since the beginning of their university studies, they had ever taken any of the following drugs with the intent to provide cognitive enhancement (yes/no): methylphenidate, amphetamine, modafinil, beta-blockers or rivastigmine. These drugs were all chosen based on frequent citation in the literature on smart drug use [45–47] and recent work showing similar use of the different types of drugs in student populations [4]. Those reporting use (i.e. 'yes') were asked to indicate which of the drugs listed they had used, and the frequency with which they took them (seldom/sometimes/regularly/often). Finally, those reporting use were asked to rank the importance of four potential reasons for taking smart drugs: to look 'smart'; to achieve a study goal; to support learning, or 'other' (1 = most important, 4 = least important). Those reporting that they had not used smart drugs were not asked further questions about this decision. In addition, no question about other drug use (prescription or otherwise) were asked of any participants.

*Behavioural expectation.* Given the cross-sectional design, future use of smart drugs could not be assessed. Therefore, we asked students to estimate the likelihood that they would consider taking a smart drug in the next 12 months (1 = extremely unlikely, 5 = extremely likely).

*Study stress* was measured using a ten-item Perceived Stress Scale [48], previously modified to relate to studying [3] (e.g. 'In the last month, how often have you felt nervous and stressed about your studies?'; 1 = never, 5 = very often; $\alpha = 0.89$).

Following Schelle et al. [3], *awareness and accessibility* of smart drugs was measured using six items, each measuring different aspects of awareness and accessibility (e.g. "I am aware of students using smart drugs regularly"; 1 = strongly disagree, 5 = strongly agree). *Safety views* were measured by two separate items [3], one measuring perceived safety and another knowledge of safety ("I think it is harmless to use smart drugs", "I know enough about 'smart drugs' to safely use them"; 1 = strongly disagree, 5 = strongly agree). *Perceived fairness* was measured using a single item: "I think that smart drugs provide an unfair advantage for students compared to those that do not take them" (1 = strongly disagree, 5 = strongly agree; [3]).

*Implicit intelligence beliefs* were measured using the eight-item Theory of Intelligence Scale (e.g. 'your intelligence is something about you that you can't change very much' [1 = strongly disagree, 6 = strongly agree]; $\alpha = 0.94$) [37]. *Implicit morality beliefs*, i.e. whether a participant believed their moral character to be fixed or flexible, were measured using the three-item Implicit Theory of Morality Scale (e.g. 'your moral character is something basic about you and you can't change much' [1 = strongly disagree, 6 = strongly agree]; $\alpha = 0.90$) [37].

### 2.4. Data analysis

#### 2.4.1. Data preparation

Fairness (1 item), safety (2 items), and awareness and availability (6 items) measures are not part of a standardised scale. Scores on these items could feasibly co-vary, and so the nine items were subjected to an exploratory factor analysis, to identify whether these items could be reduced to a smaller number of latent factors, thus reducing overlap between items. Two factors were identified (i.e. eigenvalues > 1), on each of which component items showed loadings over 0.40. The first factor (eigenvalue = 3.75, 41.66% variance explained), which consisted of five items ('I am aware of students using smart drugs regularly', 'I am aware of students using 'smart drugs' at particularly intense study times (e.g. deadlines and exams)', 'I have spoken about 'smart drugs' with other students', 'I have been offered 'smart drugs' by another student', ''Smart drugs' are readily accessible on this campus.'), was labelled 'Awareness and Availability'. The second factor

(eigenvalue = 1.65, 18.36% variance explained) consisted of two items ('I think it is harmless to use 'smart drugs'', ''Smart drugs' should be freely accessible') and was labelled 'Perceived Harmlessness'. The two factors correlated at r = .221. These two factors, and two items which did not load on either factor, which were labelled 'Perceived Safety Knowledge' ('I know enough about 'smart drugs' to safely use them') and 'Unfairness' ('I think that 'smart drugs' provide an unfair advantage for students compared to those that do not take them'), were entered into analysis as discrete variables.

#### 2.4.2. Hypothesis testing

The relationship between attitudes and use (previous, and forecast future use; i.e. Hypothesis 1) was assessed using two univariate regression models, modelling previous use, and behavioural expectation respectively, in both of which attitude was entered as the sole predictor variable. Hypotheses 2 and 3 were tested using correlation and regression analyses. First, Pearson's correlations between each hypothesised predictor variable and attitude towards smart drugs identified significant correlates (p < .05), which were subsequently entered into a multiple regression model. To achieve the most parsimonious predictive model, backwards stepwise elimination was used, whereby redundant hypothesised predictors are systematically removed from the model, until further refinement is not possible without losses in predictive utility. All regression model assumptions were met [49]: no multicollinearity or singularity was observed among predictors at any stage within the backwards model, with all tolerance values were below 0.2 or 0.1, and all variance inflation factor scores approximating 1, and none above 10.

## 3. Results

### 3.1. Sample characteristics

Of 420 participants, 17.1% (N = 72; 43 male, 29 female) reported having used smart drugs previously. There was no difference between previous users (mean = 22.37 years, SD = 3.73) and non-users (mean = 21.43 years, SD = 3.73) in terms of age (t(412) = 1.92, p = .055). There was, however, a difference in gender profile between users and non-users ($\chi^2$(1) = 5.32, p = .032) with males more likely to take smart drugs. Of users, 58.3% (N = 42) reported only having used modafinil, 11.1% (N = 8) using only amphetamine, 9.7% (N = 7) using only beta-blockers, and 8.3% (N = 6) using only methylphenidate. Nine (13% of users) reported trying more than one smart drug. We analysed choice of drug in three categories (modafinil, psychostimulants and beta-blockers) to see if there were any differences by age using a One-Way ANOVA. This revealed significant differences (F(2, 60) = 11.84, p < .001). Post-hoc Tukey tests revealed that those taking beta-blockers (mean = 28.89 years, SD = 11.05) were significantly older than those taking psychostimulants (mean = 21.44, SD = 1.53, p < .001) or modafinil (mean = 21.50 years SD = 1.57, p < .001). The majority of the 72 users reported 'seldom' use (56.9%, N = 41), whilst 22.2% (N = 16) reportedly used them 'sometimes' and 16.7% (N = 12) reported regular use. Three did not specify. There was no significant correlation between age and frequency of use (r = 0.087, p = .471). Due to the small sample sizes for some drugs and frequency of uses, it was not possible to conduct an analysis by gender for either of these. The most commonly endorsed reason for using smart drugs was 'Other', with 47% (N = 34) of participants ranking this as most important and citing a range of reasons including to enhance focus and concentration, combat tiredness, and reduce stress. 'To support learning' was the second highest scoring reason, followed by 'to look smart'. The least commonly-endorsed reason was 'to achieve a study goal'. Eight users reported using them for multiple purposes, including but not limited to smart drug use. The most common additional reason for use, i.e. on top of using smart drugs for cognitive enhancement, was for recreational use.

### 3.2. The relationship between attitudes, previous use and behavioural expectation

Participants with more positive attitudes towards smart drugs were more likely to have taken them previously (r = .47, p < .001), and attitude predicted 22.4% of variance in previous smart drug use, (Model F (1, 418) = 120.62, p < .001). Similarly, those with positive attitudes believed they were more likely to use them in future (r = .69, p < .001), with attitude predicting 48.1% of variance in behavioural expectation (Model F (1, 148) = 387.33, p < .001; β = .69, p < .001). Hypothesis 1 was thus supported, and the role of positive attitude in predicting previous or likely future use justified the emphasis of our subsequent analyses on attitudes as an outcome of interest.

### 3.3. Factors predicting attitudes to smart drugs

As might be expected from the analysis of previous users and non-users there was no significant relationship between age and attitude to smart drugs (r = −.029, p < .547). There was, however, a gender difference with males were more likely to exhibit more positive attitudes (mean = 2.82, SD = 1.16) than females (mean = 2.32, SD = 0.95; t(418) = 4.62, p < .001).

'Awareness and Availability' (r = .30, p < .001) and 'Perceived Harmlessness' (r = .71, p < .001) both correlated with attitudes, such that those who were more aware of smart drugs and thought them readily available or who perceived them as harmless were more likely to hold positive attitudes towards the drugs (see Table 1). 'Perceived Safety Knowledge' was also positively associated with attitudes, with those who more strongly felt that they knew enough about smart drugs to use them safely showing more positive attitudes (r = .52, p < .001). Finally, attitude was negatively associated with 'Unfairness' (r = −.40, p < .001), with those more strongly believing that smart drugs offered an unfair advantage holding more negative attitudes towards them. There was no correlation between stress and attitude to smart drugs (r = .028, p = .29). Neither intelligence (r = −.003, p = .50) nor morality beliefs (r = .023, p = .33) were associated with smart drug attitudes. Hypothesis 2 thus received mixed support, and Hypothesis 3 was supported.

At the first step, a model comprising Awareness and Availability, Perceived Harmlessness, Perceived Safety Knowledge, and Unfairness explained 59.2% of variance in attitude towards smart drugs (R² = .592, Model F (4, 417) = 149.77, p < .001) Removing Awareness and Availability at the second step did not improve the predictive power of the model but created a more parsimonious model, which explained 58.9% of variance in attitudes R² = .589, F change = 3.301, p = .07; Model F (3, 417) = 197.496, p < .001). Within this model, Perceived Harmlessness (B = 0.62, p < .001) and Perceived Safety Knowledge (B = 0.17, p < .001) were positive predictors, while Unfairness had a negative effect on smart drug attitudes (B = −.18, p < .001). Given the association between gender and attitudes this analysis was repeated with gender included. However, the final model was unaffected and therefore the analysis not reported here (Table 2).

**Table 2**
Final multiple regression model: predictors of attitude towards smart drugs.

| Final Model | SE | B | β |
|---|---|---|---|
| Perceived Harmlessness | .039 | .615 | .560** |
| Perceived Safety Knowledge | .028 | .166 | .211** |
| Unfairness | .029 | −0.184 | −0.212** |
| R² | .589 | | |
| Model F | 197.50 | | |

** p < .001.

### 4. Discussion

Positive attitudes towards smart drugs were found to predict rates of previous use, and forecasted future use in line with the theory of planned behaviour [43]. Following on from this we found that participants who believed smart drugs to be harmless, and those who felt they knew enough to use them safely, tended to have more positive attitudes, while those who felt that smart drug use was unfair had more negative attitudes. These findings suggest that smart drug use might be reduced through raising awareness of the absence of evidence regarding their safety and emphasising ethical arguments around the fairness of using smart drugs to potentially enhance cognitive performance.

Beliefs that smart drugs pose little risk to safety, and greater confidence in such beliefs, were linked to positive attitudes towards using smart drugs. Views about the harmlessness of smart drugs were associated with views towards their accessibility, which we interpret to indicate that those who perceive smart drugs to pose little harm consequently believe that they should be readily available. Previous studies have suggested that users consider the safety of smart drugs by comparison with street drugs, and the fact that they are regularly prescribed by doctors for various conditions, can be used as a means of downplaying potential health risks [50]. A lower perceived risk of harm could be a reason for a more positive attitude towards using smart drugs. It is unclear whether those who believe they have adequate knowledge of smart drugs to use them safely are simply unaware of possible safety risks, or recognise the potentially negative side effects but believe them to be outweighed by cognitive enhancement benefits [51]. Alternatively, people with more positive attitudes may consequently downplay safety concerns [11]. The same bidirectional relationship may underpin the relationship we observed between unfairness and smart drug attitudes. Non-users have been argued to be more ethically minded than users [15], such that perceptions of unfairness may lead to negative attitudes, though conversely, people seeking to rationalise their negative attitudes may subsequently portray smart drugs as unfair. The true causal direction of the relationships between beliefs and global attitudes among our sample cannot be fully established due to our cross-sectional design. A measure of awareness and availability of smart drugs, as derived from factor analysis, correlated with attitude towards smart drugs, which corresponds with previous findings that awareness and availability of smart drugs influences the decision of whether to take them [15]. Yet, this did not predict smart drug attitudes when controlling for perceptions of harmlessness,

**Table. 1**
Correlates between attitudes towards and use of smart drugs and intelligence and morality beliefs *p < .05 **p < .001.

| | Scale Range | Mean | SD | N | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Attitude | 1–5 | 2.46 | 1.04 | 420 | – | | | | | | | |
| 2. Study Stress | 1–5 | 2.87 | .71 | 420 | .03 | – | | | | | | |
| 3. Intelligence Beliefs | 1–6 | 3.68 | .98 | 420 | −0.00 | −0.01 | – | | | | | |
| 4. Morality Beliefs | 1–6 | 3.87 | 1.19 | 419 | .02 | .04 | −0.06 | – | | | | |
| 5. Awareness and Availability | 1–5 | 2.73 | 1.04 | 418 | .30** | .00 | .02 | −0.02 | – | | | |
| 6. Perceived Harmlessness | 1–5 | 2.16 | .95 | 419 | .71** | .09* | −0.03 | −0.01 | .22** | – | | |
| 7. Perceived Safety Knowledge | 1–5 | 2.25 | 1.33 | 420 | .52** | −0.03 | −0.13* | −0.05 | .45** | .46** | – | |
| 8. Unfairness | 1–5 | 3.31 | 1.20 | 419 | −0.40** | .02 | −0.06 | .10* | −0.14* | −0.24** | −0.24** | – |

safety knowledge, and unfairness. Moderately strong positive correlations were observed between awareness and availability, and harmlessness and safety knowledge perceptions, suggesting that people who were aware of smart drug use and believed that they should be available also tended to view them as harmless, and were confident that their views were based on adequate knowledge of their safety. Awareness and availability beliefs may therefore represent a proxy for perceived harmlessness and safety knowledge, such that, when the three variables are mutually controlled, awareness and availability did not emerge as an independent predictor. Interventions to reduce smart drug use may therefore be more effective if targeting perceptions of harm, and challenging users' knowledge regarding safety, than targeting the availability beliefs that may follow from these perceptions.

Surprisingly, given previous studies reporting a positive relationship between stress and smart drug use [3,28,33,34], study-related stress did not correlate with smart drug attitudes. There are several possible explanations for this. Firstly, the discrepancy may arise because previous studies have modelled actual use whereas we have modelled attitude. Whilst attitudes are hypothesized to predict behaviour and we have demonstrated they do so in this context, they are not the only factor to do so [43]. Therefore, it is plausible that stress does predict use but that this is not mediated by attitude. Secondly, the difference may arise because different smart drugs have different relationships with stress. In the current study, our previous use data showed that the majority of those in our cohort who did use smart drugs, chose to use modafinil. It may, therefore, be the drug that our cohort is most aware of irrespective of personal use, and therefore the most influential when determining their views of smart drugs. Previous work has shown that the strongest relationship between stress and cognitive enhancement is found with lifestyle drugs, such as caffeine, or specific prescription drugs, most commonly methylphenidate and beta-blockers are considered [3,33,34]. In the present study we did not consider lifestyle drugs and, although methylphenidate and beta-blockers were used, they were not the most prevalent indicating students from this cohort may more commonly consider modafinil when reflecting on smart drugs. Whilst psychostimulants have been shown to have some stress-relieving effects in healthy people [52], modafinil has been shown to trigger stress responses [53]. Therefore, it may be important to establish the relationship between stress and specific smart drugs, rather than assume the same relationship exists for them all. Another possible explanation of the lack of relationship between stress and attitude to smart drugs is the overall level of stress. One previous study, found that the only stress-related item they measured which significantly predicted drug use was whether students felt the demands of their study were overwhelming [54]. It is therefore possible, that any level of stress up until this point of feeling overwhelmed is not sufficient to impact on attitude to smart drugs. This explanation would seem unlikely to explain our lack of relationship because our measure of stress showed a range of 1–4.8 on a scale of 0–5, indicating that at least in some cases, individual rated themselves as very stressed.

We found no evidence that intelligence beliefs were associated with attitudes towards smart drugs. Previous research has shown that people who believe that intelligence is a fixed entity i.e. not something they can change are more likely to cheat in situations that are thought to have the potential to reveal intelligence, such as exams, as they feel that this is the only way to overcome the constraints imposed by their intelligence [41]. Thus, we hypothesized that these individuals may also hold more positive attitudes towards smart drugs, which frequently spark debate around honesty and are deemed by some as analogous to doping in sports i.e. cheating. The lack of a relationship between intelligence beliefs and smart drug attitudes may have occurred for several reasons. Firstly, our data may not have had sufficient range to show any effects. This is unlikely because the scores were normally distributed around a mean of 3.68 on a scale of 1–6 with all scores represented, indicating this is unlikely to be the case. Secondly, the lack of relationship may indicate that students do not give much

consideration to whether smart drugs are cheating. This is in line with previous research showing that honesty, and by inference cheating, is not necessarily a central consideration in smart drug use [16,17]. Thirdly, the failure to find any effect could arise from the fact that those with fixed intelligence beliefs may view using smart drugs is futile, given their perceived limited intelligences. Finally, the lack of any relationship between implicit intelligence beliefs and smart drugs could also suggest that intelligence beliefs about personal attributes do not impact on opinions about exogenous factors i.e. whether you believe you can improve your intelligence or not does not impact on whether you believe a drug could bring about the same effect. This has interesting implications for education interventions. In addition to there being no impact of intelligence beliefs on attitudes, we also found no relationship between morality beliefs and smart drugs. Given the bioethical debate sparked by smart drugs, we had hypothesized that morality beliefs would impact on attitudes towards these drugs. The lack of effect seen here, may also arise because the self-nature of the beliefs does not directly relate to exogenous factors. However, it is also possible that whilst smart drugs are known to create ethical debate, this does not necessarily equate to morality. Indeed, whilst ethics and morality are undoubtedly linked, they are arguably separate constructs and one can exist and be measured in the absence of the other [55]. Indeed, it has been suggested there are four key distinctions between ethics and morality [56]. Firstly, ethics can be viewed as convictions about what is a good or bad life to lead, whilst morality represents the principles about how we should treat others. Secondly, ethics is concerned with convictions about character e.g. how we should act, what we should like and what we should care about. By contrast morality is about actual voluntary actions, normally in the context of a specific event. Thirdly, ethics can be measured on a continuum whereas morality is treated as a dichotomous variable, normally either right or wrong. Finally, ethics is self-regarding, providing personal ideals about the self, whilst morality is other-regarding giving universal rules as to how we should act towards others. Whilst previous research into smart drugs has focussed on ethical considerations [12,16,17,32], the current study focussed on morality only and there is some limited evidence to suggest this may be less important. For example, it has been found use of smart drugs is self-determined and not influenced by others [17], indicating that people are self-focused when they think about the benefits and disadvantages of smart drug use, and therefore, this is self-rather than other-referential. Whilst the distinction between ethics and morality may explain the lack of findings here, it is also possible that we did not find any significant relationships because of a lack of spread in our morality measures. However, our data show that measures of morality were normally distributed around a mean of 3.87 with the full range of values represented, indicating this is unlikely. Future research should consider directly examining measures of ethics and morality in the same cohort. Finally, for the implicit theories for both intelligence and morality, it is possible that they do still impact on behaviour but not on attitudes, as discussed above in relation to stress.

Limitations of our study must be acknowledged. Firstly, whilst sufficiently large to power our statistical analyses, the representativeness of our sample may be questioned. The study was open to all UK full time undergraduate students, although it would seem likely that the majority participating were at the host institution. However, we did not collect additional data on discipline or university and therefore cannot be sure how representative our sample is for the UK university population as a whole or the population at the host university. This means that factors such as competitiveness cannot be extracted from the data. Additionally, within our sample, 17% reported having previously used smart drugs, a prevalence rate higher than documented in other UK studies [14,15]. A significantly higher percentage of males had used smart drugs (35%) than had females (10%), which corresponds with some previous research [15]. However, our sample was predominantly female (71%), and the under-representation of males (29%) potentially questions the robustness of the prevalence rate we observed among

male participants. We did not find any impact of age on our key outcome measures, although this may be because despite a wide range, the majority fell within 18–25 years meaning the sample was not very diverse. It is possible that a more diverse sample, for example, collected by including postgraduate students, may see subtle effects of age. Larger-scale surveys, conducted with support from senior management at multiple institutions, might seek to replicate our findings among a more representative sample. Secondly, our study sought to predict attitudes rather than behaviour itself. Whilst attitudes are important in determining behaviour, they do not provide the full picture and therefore, factors such as stress and intelligence beliefs may better correspond to other predictors of behaviour. Finally, we did not attempt to identify causality in our design. The study was cross-sectional, and we cannot be sure of the direction of any relationships as discussed above. Nonetheless, our findings suggest that efforts to curb smart drug use might fruitfully focus on emphasising evidence of the potential health risks associated with smart drug use among non-clinical populations [7,18], absence of evidence regarding longer-term impact [19], or the ethical or moral arguments that proscribe smart drug use.

## 5. Conclusion

Our study has shown that students who tend to have more positive attitudes towards using smart drugs when they consider smart drugs harmless, believe they should be freely accessible, and believe they know enough about smart drugs to use them safely also hold more positive attitudes, and do not view their use as unfair. Stress, and implicit beliefs around the nature of intelligence and morality, had no impact on attitudes. We encourage intervention developers who wish to reduce the use of smart drugs, to focus their issues of the safety and fairness of smart drugs.

## Declarations of interest

None.

## Ethical statement

All procedures were approved by the King's College London Psychiatry, Nursing & Midwifery Research Ethics Subcommittee (HR15/162824). All work was carried out in accordance with the Declaration of Helsinki.

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