The effect of methylphenidate and mixed amphetamine salts on cognitive reflection: A field study

RUNNING HEAD: Methylphenidate and cognitive reflection

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Abstract

Rationale Methylphenidate (MPH) and mixed D,L-amphetamine salts (MASs; Adderall) were previously found to have unreliable effects on judgement and decision processes.

Objective We predicted that MPH and MASs have a specific effect of reducing heuristic responses, which should lead to increased performance on the cognitive reflection test (CRT). The CRT is considered to be a testbed for heuristic versus deliberative response modes.

Methods We recruited a sample of 15,361 individuals using the Prolific Academic crowd-sourcing platform. From this initial pool, our final sample consisted of 294 participants (125 MPH users and 169 MASs users) who conformed to the study criteria and completed the experimental tasks. Tasks were performed on days where participants were either medicated or not, allowing to assess the effect of medication status.

Results There was a strong positive effect of taking MPH on CRT scores (Cohen's d = 0.40) which was not qualified by frequency of MPH usage, ADHD symptoms, and demographic factors. There was also a somewhat weaker effect for MASs (Cohen's d = 0.07). No effects of MPH and MASs were recorded for risk taking and numeracy.

Conclusions The results indicate that MPH enhances decision making in tasks where heuristic responses typically bias it.

Keywords methylphenidate, amphetamine, ADHD, decision making, heuristics

Methylphenidate is in one of the most commonly prescribed ADHD medications (Chai et al. 2012; Grimmsmann and Himmel 2021) and its neuro-cognitive effects were extensively studied in both adults and children with ADHD. These studies showed that MPH improves various aspects of executive function such as sustained attention, response inhibition, and working memory capacity (Aron et al. 2003; Turner et al. 2005; Pietrzak et al. 2006; Kurscheidt et al. 2008; Agay et al. 2010; Pievsky and McGrath 2018). Studies of healthy adults also evidenced a positive impact of MPH on these cognitive aspects (Vaidya et al. 1998; Aron et al. 2003; Turner et al. 2005; Agay et al. 2010, 2014).[1] However, in studies of reasoning, judgement, and decision making it was typically found that MPH had only a weak effect (see reviews in Linssen et al. 2014; Marraccini et al. 2016; Pievsky and McGrath 2018). For instance, it did not affect performance in the Iowa Gambling task (Bechara et al. 1994) a complex task used to evaluate multiple decision processes (Agay et al. 2010, 2012; Marraccini et al. 2016) and in similar tasks (Kroyzer et al. 2014). The goal of the current paper was to clarify the effect of MPH on judgement and decision processes as well as that of mixed D,L-amphetamine salts (MASs; e.g., Adderall). MASs are often used as a slower release version of MPH though there are subtle differences in how they affect brain processes (as elaborated below).

We propose a simple model for the potential effect of MPH and MASs on judgment and decision making based on the cognitive architecture postulated by dual system theory (Denes-Raj and Epstein 1994; Frederick 2005; Kahneman 2011). Though the theory is controversial (Keren and Schul 2009) it provides a reasonable descriptive

[1] Notice though that focused attention has its drawbacks: certain cognitive aspects such as task switching are potentially impaired by the usage of methylphenidate (Rajala et al. 2020).

account (Chater 2018). According to the theory, System 1 operates via associative and tacit reasoning, which can be performed rapidly (Keren and Schul 2009). By contrast, System 2 uses more deliberative and slower processes with greater working memory requirements. It has been posited that System 1 impairs decision making when the modal response involves the use of heuristics, namely fast and frugal cognitive shortcuts, and when these heuristics are inefficient (Frederick 2005; Travers et al. 2016). System 2 can also lead to poorer decisions in cases when heuristic responses are highly efficient (Dijksterhuis and Nordgren 2006; Ayal et al. 2015). We argue that given the tendency of MPH and MASs to improve the ability to invest attention, these substances increase System 2 processing and reduce heuristic responses. Therefore, in tasks where heuristic processes are a) prevalent, and b) result in poor judgement, MPH and MASs should improve decision performance.

To evaluate decision impairments brought about by heuristic processing, Frederick (2005) developed the Cognitive Reflection Test (CRT), a series of problems where people typically make fast but incorrect judgements (see e.g., Travers et al. 2016). For example, consider the following CRT question. “If it takes five machines five minutes to make five widgets, how long would it take 100 machines to make 100 widgets?” The question evokes an immediate associative judgment, which likely uses mental completion of the numbers list as a heuristic (5, 5, 5, 100, 100, ?). However, this judgement (of 100) is wrong (the correct answer is 5 minutes). Several studies found that instructions to deliberate improve CRT performance (Szollosi et al. 2017; Patel et al. 2019; Sjastad and Baumeister 2021). We predicted that MPH and MASs would have a similar effect.

While predicting a positive effect of MPH and MASs on CRT performance, we did not have unidirectional predictions regarding the effect of these substances on response time. On the one hand System 2 is considered to be associated with more prolonged and deliberative processing (Keren and Schul 2009) yet on the other hand individuals who score high in cognitive tests requiring comprehension and mental coding, typically have shorter completion times (e.g., Lindley et al. 1988).

We conducted a quasi-experimental field study to examine whether boosting attention by means of MPH and MASs improves CRT performance. The two substances have a similar pharmacological effect, with their primary consequence being an increase in central dopamine and norepinephrine activity (Faraone 2018), though there are some important nuances. Especially, MPH leads to vesicular monoamine transporter 2 (VMAT-2) inhibition, while MASs leads to its redistribution (Riddle et al. 2007). Furthermore, MPH leads to monoamine oxidase activity inhibition, while MASs do not (Robinson 1985; Faraone 2018). Functionally, a recent meta-analysis suggested that with respect to ADHD symptoms, MPH and MASs have similar effect sizes (Stuhec et al. 2019). However, a meta-analysis of healthy adults indicates that MPH significantly improved sustained attention and inhibitory control while MASs did not (Roberts et al. 2020). The reasons for this functional difference are not yet clear. Given that our sample was heterogenous with respect to ADHD symptoms, we expected MPH to have a more pronounced effect on CRT performance than MASs. Following Stuhec et al. (2019) we also tested whether this differential effect is moderated by the extent of ADHD symptoms.

The study was conducted using Prolific Academic, a crowdsourcing platform. An initial survey was administered in order to identify individuals using MPH or MASs on a weekly basis (with ADHD or not). The main session of the study was then performed with no intervention either on days where these individuals were under the influence of MPH and MASs (i.e., medicated) or not. In this main session participants performed the CRT (Frederick 2005) as well as two additional decision tasks. The first was a test of representativeness, a heuristic defined as estimating the likelihood of an event by comparing it to prototypical examples (Tversky and Kahneman 1983). The second was a risk-taking test. Risk taking, namely the preference of options with higher variance in the magnitude of outcomes (including long shots) is an aspect of decision making that was previously found to unaffected by MPH (e.g, Kroyzer et al. 2014; Marraccini et al. 2016). Participants also completed a numeracy test, which was used to examine the effect of medication status on numeric reasoning skills, independently of its effect on heuristics.

Method

Participants: The study was preapproved by the Technion Research Ethics Committee. We recruited a sample of 15,361 individuals using the Prolific Academic crowd-sourcing platform (https://prolific.ac) from the US, UK, Ireland, Australia, and Canada.[2] This initial pool of participants completed a consent form and a short survey enabling us to evaluate the study inclusion and exclusion criteria. Inclusion criteria were the reported weekly usage (i.e., one day a week or more) of MPH or MASs. Exclusion criteria were age below 18 (this was rechecked although Prolific does not allow minor participation)

[2] We aimed for 15,000 individuals and the stopping point was based on the resources available for the study.

and self-reported schizophrenia or other psychotic disorder. We included both individuals who reported having ADHD or not. A total of 443 participants met our recruitment criteria and were invited to participate in the second (and main) session of the study. Three hundred and eighty two participants started the second session. Forty eight participants did not complete the session, nine did not report their MPH or MASs consumption rate, and 31 declared that they are using both MPH and MASs and were therefore excluded. Our final sample consisted of 294 participants, 125 MPH users (age: M = 31.98, SD = 10.32; 48% male) and 169 MASs users (age: M = 31.28, SD = 8.78; 43% male). In the MPH users group 54% reported having ADHD and 67% anxiety/panic disorder. In the MASs group 52% reported having ADHD and 61% anxiety/panic disorder. Participants were compensated by $0.17 for taking part in the first brief session and an additional $2 for completing the second session.

Study design: Allocation of participants into study groups was based on self-reported usage of three medications: Ritalin, Concerta, and Adderall. Those reporting taking Ritalin and Concerta were allocated to the MPH group, and those taking Adderall were allocated to the MASs group. We did not include additional medications in order to increase homogeneity. Medication status was identified based on participants' reported usage of MPH or MASs a few hours prior to the time of Session 2. A threshold of four hours was used for standard Ritalin (Markowitz et al. 2003), eight hours for the long lasting version of Ritalin (Lopez et al. 2003; Markowitz et al. 2003), and 12 hours for Concerta (Lopez et al. 2003; Markowitz et al. 2003) and Adderall (Tulloch et al. 2002).

Experimental tasks: Session 1 of the study included a brief survey of demographics, self reported diagnosis, and drug usage (see complete survey in the supplementary section). In session 2, which took place about four days later (Mean=4.3, SD=1.1), we first administered the expanded numeracy scale (Lipkus et al. 2001), a 7-item questionnaire assessing a person's numeric skills. This was followed by the Cognitive Reflection Test (CRT; Frederick 2005), which involves three judgement tasks in which rapid judgements are typically flawed (Sjastad and Baumeister 2021). As shown in the Appendix, some names and quantities were slightly modified from the original version so that answers will not pop up in a Google search using the questions as keywords (retrieved on April 10, 2021). Response time was measured from the time the test was presented until participants pressed the completion button. Because the CRT has only three items, it often lacks high reliability values (Cronbach Alpha ranges between 0.60 and 0.74; Liberali et al. 2012; Weller et al. 2013; Campitelli and Gerrans 2014). In our study reliability was 0.65 (appropriate for exploratory purposes; Nunnally 1978). The CRT was followed by a test we developed for assessing the usage of the representativeness heuristic (Tversky and Kahneman 1983). Specifically, we used Tversky and Kahenman's "Linda problem" (Tversky and Kahneman 1983) and two items based on based on Bar-Hillel and Neter (1993), as detailed in the supplementary section. However, Cronbach Alpha for this test was low (0.40) and therefore we do not report the group differences. We also administered two items to examine participants' risk taking tendencies, using the scenario of a hypothetical investment (e.g., Menkhoff and Sakha 2017; See Appendix). Cronbach Alpha was adequate for exploratory purposes (0.64).

Additionally, we examined the compatibility of the study groups in ADHD symptoms. This was done using the well validated Adult ADHD Self-Report Scale (ASRS, V.1.1. Part A) (Kessler et al. 2005) and Conners' Adult ADHD Rating Scale (CAARS) (Conners et al. 1999). The last items asked about medication: what drugs (Ritalin, Concerta, or Adderall) were taken earlier that day and when they were taken (see supplementary section). Finally, a follow-up survey conducted one month following the main experiment queried about dosages taken during the previous month (see supplementary section).

Analysis: To evaluate the compatibility of the study groups, differences between groups' gender, ethnicity, and self reported diagnosis were tested using logistic regression, with drug type (MPH and MAS) and medication status (medicated, unmedicated) as predictors. Differences in (ranked) education and age, as well as frequency of medication, dosage,[3] and ASRS and CAARS scores were examined using analysis of variance (ANOVA).

Our main analysis examined group differences in CRT scores, risk taking, and numeracy using ANOVA, with drug type and medication status as between-subject factors. A secondary analysis was conducted to examine the interaction with ADHD by adding ADHD as independent factor in the ANOVA. Additionally, being medicated on a given day is naturally affected by the base rate (i.e., average frequency) of usage and not only by a random factor. Hence, we conducted regression analyses controlling for the frequency of medication (1 to 7 times a week) as well as ADHD symptoms. In a second

[3] Since recommended dosages of Ritalin and Concerta vary slightly, in the analysis of dosage we compared the effect of medication type (Ritalin, Concerta, Adderall) rather than drug type (MPH vs. MASs).

regression model we also added demographic factors for robustness. We also evaluated whether results were qualified by individual's CAARS scores by adding the interaction of medication status by CAARS scores to the regression model.

Results

Baseline group characteristics: Table 1 presents the characteristics of individuals who were medicated or not while performing the experimental tasks. Those medicated at the time of the study were slightly less educated (ranked education: $F(1,289) = 6.64$, $p = .01$). Specifically, though the percentage of individuals with Bachelor's degree in the four groups was not different (around 50% in all), the rate of those with a higher degree was higher for unmedicated MPH users ($\chi^2(1) = 4.96$, $p = .03$) though not for unmedicated MASs users ($\chi^2(1) = 0.57$, $p = .45$). Gender proportions in the four groups were similar (53% female) with no differences due to either medication type or status ($\chi^2(3) = 3.91$, $p = .27$). Most participants self-reported as Caucasian (68%), with no difference in this respect between groups ($\chi^2(3) = 6.81$, $p = .08$). There were also no differences between groups in age ($F(3, 290) = 1.62$, $p = .19$).

As expected, the frequency of medication was different in the four groups ($F(3, 290) = 19.16$, $p < .001$), with the medicated group taking MPH and MASs about 5.2 days a week on average and the unmediated group only 3.4 days a week on average. As indicated above, the frequency of medication is one of the factors we controlled for in our main analyses. Also, there was a difference in the rate of those reporting being diagnosed with ADHD ($\chi^2(3) = 53.02$, $p < .001$), with more individuals diagnosed with ADHD in the medicated group, though with the limitation of self report. Thus, it was important to

examine both the effect of ADHD and its interaction with medication status. On the other hand, there were no differences in ASRS and CAARS scores ($F(3, 290) = 0.85$, $p = .47$; $F(3, 290) = 1.15$, $p = .33$, respectively) which denote the severity of ADHD.[4] The mean dosages taken were 23.42 mg (SE = 2.50) for Ritalin, 36.87 mg for Concerta (SE = 3.74), and 20.71 mg for Addreall (SE = 1.25). Mean dosages did not differ between medicated and unmedicated participants ($F(1,148) = 1.20$, $p = .28$).

Effect of medication on cognitive reflection: The mean CRT performance levels in the four study groups are presented in Figure 1. As can be seen, being medicated with MPH substantially improved CRT scores by about 48% compared to being unmedicated (1.40 vs. 0.95 on average). By contrast, using MASs was associated with a lower improvement of only about 7% (1.11 vs. 1.04 on average). Because the baseline assumption of homogeneity of variance was rejected (for MPH, $F(123) = 5.30$, $p = .02$) we used Aligned Rank Transform (ART) ANOVA, a non-parametric analysis (Wobbrock et al. 2011) to statistically test the difference between groups. The results showed a significant main effect of medication status on CRT scores, $F(1,290) = 5.45$, $p = 0.02$, Cohen's $d = 0.20$. Additionally, though the effect size was higher for MPH (Cohen's $d = 0.40$ vs. 0.07 for MASs), the interaction between drug type and medication status did not reach significance, $F(1,290) = 2.61$, $p = .11$. Also, there was no significant effect of drug type, $F(1,290) = 0.97$, $p = .33$.[5]

[4] It might be that participants who reported symptoms in these tests did so based on their behavior while being medicated.

[5] We also re-ran this analysis without five individuals who had high response times (three standard deviations above the average of 99.1 seconds). The results replicated the main effect of medication status ($F(1,285) = 6.84$, $p = .009$).

We also ran the ANOVAs with ADHD diagnosis as an additional between-subject factor. Due to the fact that the Aligned Rank Transform (ART) ANOVA (Wobbrock et al. 2011) is limited to two independent variables, we conducted separate analyses for MPH and MASs. The (ART) ANOVA results for MPH users showed a significant positive effect of medication status as previously, $F(1,121) = 7.82$, $p = .006$) and no effect of ADHD, $F(1, 121) = 0.44$, $p = .51$, as well as no medication status by ADHD interaction, $F(1,121) = 0.21$, $p = .65$. For MASs users the ANOVA showed no significant effect of medication status, $F(1,165) = 0.39$, $p = .53$, and no main or interaction effect of ADHD ($F(1,165) = 2.97$, $p = .09$; $F(1, 165) = 1.45$, $p = .22$, respectively).

To examine additional possible confounding effects we conducted a series of regressions controlling for various factors. The results are summarized in Tables 2 and 3. As can be seen, for MPH the effect of medication status was maintained while controlling these factors. Interestingly, while the medicated group tended to have a somewhat higher frequency of medication, this frequency had a close to zero effect on CRT scores. For MASs, by contrast, the effect of medication status was not statistically significant when controlling for the various factors. An additional significant factor in the regression model was gender, with men having significantly higher CRT scores both in MPH and MASs users (1.34 vs. 0.83 for women on average; see Tables 2, 3). We also examined whether the effect of MASs and MPH would be more pronounced for individuals with higher CAARS scores (denoting ADHD symptoms). However, the regression term for the interaction of CAARS by medication status introduced considerable multicollinearity (VIF > 5) and was not significant. Therefore, this analysis is not further detailed.

Finally, we examined the effect of medication status on response time in the CRT. Interestingly, the effect trended in the direction of shorter responses for medicated participants (with a mean RT of 111.2 seconds for nonmedicated participants vs. 86.3 for medicated participants). This difference did not reach significance, $F(1, 290) = 2.84$, $p = .09$. We consequently tested whether increased response time is associated with higher CRT scores. To evaluate this we calculated the correlation between CRT completion time and performance. The results showed a weak correlation of 0.14 ($p = .02$).
Thus, individuals who responded slower had better scores but MPH and MASs had no significant effect on this pattern (see also Supplementary Figure S1).

Effect of medication on other cognitive tests: As shown in Figure 1, differently from the CRT, medication status did not substantially affect numeracy scores. Those medicated with MPH had only slightly higher scores (by 6%; 6.20 vs. 5.84 on average) while MASs led to virtually no improvement (2% difference; 6.12 vs. 6.01 on average). Because homogeneity of variance differed across conditions, we again used (ART) ANOVA, which indicated no significant effect for medication status ($F(1,290) = 1.98$, $p = .16$, Cohen's $d = 0.20$), or any other significant effect. Thus, while MPH did have a slight positive effect on numeracy (as it did for CRT performance) it was not significant.

Also, as indicated in Figure 1, the effect of medication on risk taking was small. Slightly more choices from the high-risk high-reward option were made when medicated with MPH (by 18%; 0.45 vs. 0.38) but slightly fewer choices were made when medicated with MASs (by 17%; 0.41 vs. 0.49). The effect of medication status was not significant, $F(1, 290) = 0.02$, $p = 88$, Cohen's $d = 0.03$; and neither was the interaction between

medication status and medication type, $F(1, 290) = 2.39$, $p = .12$. The results thus replicate the null effect of MPH on risk taking reviewed above.

Discussion

Our findings showed that those medicated with MPH and MASs while performing the experimental tasks had higher cognitive reflection scores. The interaction of medication status by drug type was not significant yet the effect was more pronounced for MPH compared to MASs (Cohen's $d = 0.40$ vs. 0.07). Moreover, when controlling for the frequency of medication, ADHD symptoms, and demographic factors the effect remained significant only for MPH. This is consistent with the recent literature showing a more pronounced effect of MPH than MASs for undiagnosed individuals (Roberts et al. 2020). Importantly, there was no effect of MPH on risk taking and numeracy scores. The current finding thus shed light on the necessary conditions for an effect of MPH on decision performance: It occurs in settings where associative responses guide decisions wrongly and cognitive reflection overcomes this effect.

The current examination is a field study and therefore there were some differences between participants who were medicated and those who were not. However, controlling for relevant factors such as the frequency of medication, self reported ADHD, and demographics did not change the significance of the effect of MPH. A related issue is that one may argue that the current design is orthodox because individuals opt to use nootropics such as MPH and MASs on days where their cognitive performance is perceived as low, which should weaken any cognitive effect of these substances (e.g., Arria et al. 2017). However, the results indicate that despite the potentially orthodox

design, there was a substantial effect of MPH on CRT performance. Furthermore, our study did not use placebo which may affect the results (Looby et al. 2021). However, notice that a placebo effect would have led to a positive effect in all tasks and in both drug types, whereas we obtained a positive effect only in the cognitive reflection test; and the effect was somewhat stronger for MPH compared to MASs.

Another interesting observation was that about 53% of those reporting weekly administration of MPH and MASs did so without being diagnosed with ADHD, at least according to their self report. This percent is somewhat similar to the rate of Nature readers who reported taking MPH to enhance cognitive functions rather than for medical purposes (Maher 2008). While our study cannot verify whether (or not) these individuals had undiagnosed clinical or sub-clinical ADHD, we did find that self reported ADHD diagnosis did not moderate the effect of MPH, which suggests a potentially broad positive impact of MPH on cognitive reflection for diagnosed and undiagnosed individuals. Similar non-selective effects were recorded in studies of memory and attention (e.g., Agay et al. 2010, 2012; Pievsky and McGrath 2018).

Thus, to sum up, the results suggest that when interpreting the effect of nootropics such as MPH and MASs on judgement and decision processes, the moderating effect of task type should be considered. As far as we know, most relevant studies of reasoning, judgment, and decision making focused on tasks where there are no misleading intuitive responses. The effect size of taking MPH and MASs in these studies was found to be close to zero (Pievsky and McGrath 2018; Roberts et al. 2020). However, the reason for this null effect might be that in the studied tasks extensive deliberation does not improve

one's judgements.[6] In the cognitive reflect test, on the other hand, instruction to deliberate typically enhance performance (Szollosi et al. 2017; Patel et al. 2019; Sjastad and Baumeister 2021), and in this test we found that MPH and to a lesser extent MASs improved participants' judgments.

An interesting question (and perhaps puzzle) for follow-up research is to what extent the effect of MPH is driven by changes in response time. It has been suggested that the effect of relevant cognitive capacity on CRT performance is not simply and linearly mediated by completion time (Bago and De Neys 2019). In our study there was a weak positive correlation between completion times and CRT performance, but interestingly, response time did not increase when individuals were medicated. This suggests that the effect of MPH and MASs was on the quality of attentional allocation (e.g., prioritization of the experimental task). Further research should shed light into this.

Appendix:

Cognitive reflection test:

1. In part of the ocean, there is a field of plankton. In a certain time of the year, the field doubles in size every hour. If it takes 38 hours for the patch to cover 1 square kilometer, how long would it take for the patch to cover half a square kilometer? ___ hours

2. If it takes 5 machines 5 min to make 5 lottery tickets, how long would it take 100 machines to make 100 lottery tickets? ____ min

[6] This notion may also explain the negative effect of MPH on performance in reversal learning tasks which are highly intuitive (e.g., van der Schaaf et al. 2013). As noted at the outset, in some tasks extensive deliberation may even interrupt decision performance.

3. I bought a set of shoes and sport socks for 110 pesos in total. The shoes were 100 pesos more than the socks. How much did the shoes cost? ____ pesos

Hypothetical investment test

1. Imagine that you are an investor in an option market and your goal is to make as much money for a client over the next 3 months. You can choose to invest in one out of two stocks. In each stock you predict the outcome is as follows :

Stock 1. Every day, there is a 1 in 2 chance (50%) for a 1% profit from the invested amount, and otherwise no profit and no loss in the same given day.

Stock 2. Every day, there is a 1 in 2 chance (50%) for a 3% profit from the invested amount, and otherwise a loss of 1% in the same given day.

The draw on each day is independent of the previous day. In this particular market you cannot change your choice during the 3 months. Which stock would you invest in? ____

2. Now a third stock has been added to the market:

Stock 3. Every day, there is a 0.5% profit from the invested amount.

Which of the three stocks (1, 2, or 3) would you now prefer? _____

Declarations

Conflict of interest The authors declare no competing interests.

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Figure 1: Differences between the four study groups in cognitive reflection (CRT scores; top panel), numeracy (middle panel), and risk taking (bottom panel). For comparison, scores are presented as proportions. Error terms denote standard errors.

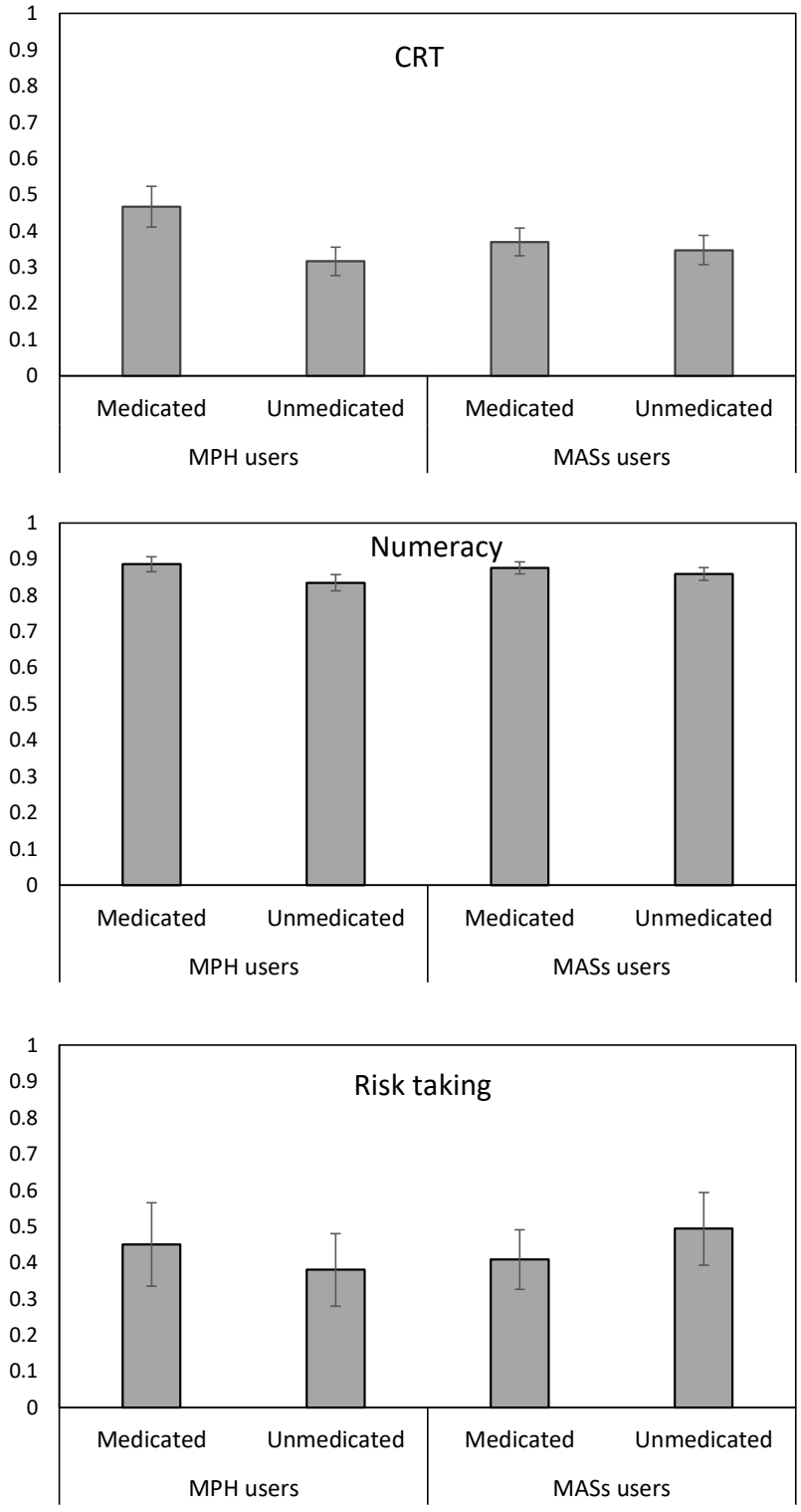

Table 1: Participants' characteristics in the four study groups. Standard deviations appear in parentheses.

Characteristic	MPH users		MASs users	
	Medicated (n = 50)	**Unmedicated** (n = 75)	**Medicated** (n = 93)	**Unmedicated** (n = 76)
Education (%)*				
High School	40.8	20.0	33.6	34.2
Bachelor's Degree	44.9	48.0	47.3	51.6
Master's Degree or higher	14.2	32.0	14.1	18.4
Gender (% male)	44.0	53.4	40.0	52.1
Ethnicity (% Caucasian)	78.0	65.3	72.0	57.9
ADHD (% self-reported)*	80.0	40.0	81.7	40.8
Age	31.12 (9.23)	32.56 (11.01)	32.55 (8.45)	29.72 (8.99)
Frequency of medication*	5.17 (1.88)	3.51 (2.11)	5.28 (1.88)	3.30 (2.39)
ASRS	19.28 (5.16)	19.08 (4.97)	19.17 (5.34)	18.11 (4.60)
CAARS	38.88 (15.95)	35.8 (15.98)	38.7 (18.07)	34.7 (15.79)

Notes: * = $p < .05$ (difference between study groups)

ASRS = Adult ADHD Self-Report Scale; CAARS = Conners' adult ADHD Rating Scale.

Table 2: Regression analyses for the effect of MPH on Cognitive Reflection Test (CRT) scores.

MPH	**Beta**	**T score**	**Sig**	**Beta**	**T score**	**Sig**
		Model 1			Model 2	
Medicated	.21	2.11	.03*	.20	2.08	.04*
Frequency of med.	-.00	-.01	.99	.04	.37	.72
CAARS	-.05	-.35	.72	-.09	-.61	.54
ASRS	.05	.35	.72	.08	.58	.57
Bachelor's Degree	-	-	-	-.18	-1.62	.11
Master's Degree	-	-	-	-.08	-.66	.51
Gender	-	-	-	.27	2.9	.004*
Ethnicity	-	-	-	.12	1.27	.21
Age	-	-	-	.03	.35	.73
Model fit		$r^2 = 0.04$			$r^2 = 0.14$	

Notes: * = $p < .05$

Table 3: Regression analyses for the effect of MASs on Cognitive Reflection Test (CRT) scores.

MASs	**Beta**	**T score**	**Sig**	**Beta**	**T score**	**Sig**
		Model 1			Model 2	
Medicated	-.02	-.29	.77	.05	.53	.60
Frequency of med.	.13	1.52	.13	.12	1.17	.24
CAARS	.05	.41	.68	.12	.92	.36
ASRS	-.06	-.43	.67	-.09	-.62	.54
Bachelor's Degree	-	-	-	.06	.61	.55
Master's Degree	-	-	-	.10	1.14	.26
Gender	-	-	-	.28	3.60	<.001*
Ethnicity	-	-	-	.02	.24	.81
Age	-	-	-	.01	.13	.90
Model fit		$r^2 = 0.02$			$r^2 = 0.11$	

Notes: * = $p < .05$