Research Article

Examining Cannabis Flower and Concentrate Quantity Estimation Accuracy Differences With and Without Visual Cues

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Bradley T. Conner[1], Mohammad I. Habib[1] & Mark A. Prince[2]
[1]Department of Psychology, Colorado State University
[2]Department of Psychiatry and the Behavioral Health Sciences, Keck School of Medicine at the University of Southern California

ABSTRACT

Objective: Cannabis consumers tend to overestimate cannabis quantities. However, it is unknown whether visual cues, such as pictures or physical piles of cannabis products, help consumers more accurately estimate cannabis quantities. In this study, we evaluate whether picture cues and physical cannabis cues improve the accuracy of flower and concentrate quantity estimations compared to when no visual cues are provided. **Method:** Sixty participants in a private cannabis club were asked to prepare their preferred method of cannabis administration (i.e., joint, bowl, dab) with their typical amount of cannabis product. Research staff measured the weight of the prepared product and participants were not informed of this weight. Participants were then asked to estimate the weight of their prepared cannabis and were randomized to receive either pictures of different weights of cannabis (picture cues), physical piles of cannabis products (physical cues) or no visual cues to reference when estimating their prepared product weight. The sample was 66% White, 58% Non-Hispanic, 54% female, and the average age was 30.7 years (SD = 7.7). Accuracy of estimations was assessed using Wilcoxon Rank Sign tests, and groups differences were assessed using Kruskal-Wallis tests due to violations of normality. **Results:** Among flower products, the no cue and picture cues produced estimations that were statistically distinguishable from 1 (n = 172, W = 1.66, p < .05, r = -0.64; n = 147, W = 1.43, p < .05, r = -0.60, for the no cue and picture cue conditions, respectively); however, the physical cues produced estimates that were statistically indistinguishable from 1 (n = 174, W = 1.25, p = 0.13, r = -0.24). Among concentrate products, the no cue and physical cue conditions had estimations that were statistically indistinguishable from 1 (n = 48, W = 0.42, p < .19, r = -0.21; n = 124, W = 1.94, p = .25, r = -0.15 for the no cue and physical cues conditions, respectively), but the picture cues did not (n = 117, W = 3.77, p < .05, r = -0.75). **Conclusions:** These data suggest that physical cues may be helpful in improving accuracy of estimation of cannabis quantities; however, overall, visual cues may not be helpful in improving accuracy of estimation of cannabis quantities.

Key words: = marijuana; pictures; measurement; high-potency; THC

With the continued popularity of cannabis in the United States, the diversity of cannabis products continues to expand (Davenport, 2021; Hall & Lynskey, 2020; Spindle et al., 2019). Increasing diversity of cannabis products complicates the measurement of tetrahydrocannabinol (THC) exposure, the psychoactive compound in cannabis. This is

Corresponding Author: Bradley T. Conner, PhD, Colorado State University Fort Collins, 1876 Campus Mail. Fort Collins, Colorado, 80523. Email: brad.conner@colostate.edu

because different cannabis products have different amounts of THC (i.e., potency), and the method of administration alters blood absorption of THC (Wang-Schweig et al., 2024). Self-report measures of cannabis use are common methods employed to measure cannabis consumption (Bonar et al., 2017; Bonn-Miller et al., 2016; Borodovsky et al., 2022; Budney et al., 2022; Callaghan et al., 2019; Caulkins et al., 2020; Collins et al., 2014; Cuttler & Spradlin, 2017; Freeman et al., 2014; Goodman et al., 2019; Pedersen et al., 2021; Pol et al., 2013; Sikorski et al., 2021; Trull et al., 2022). However, the reliability and validity of self-report data can be affected by memory and social desirability (Carroll, 1995; Del Boca & Darkes, 2003; Johnson & Fendrich, 2005; Smart & Jarvis, 1981). This indicates that self-report data may need to be supplemented with other data, such as blood cannabinoid concentrations or urine toxicology screenings to ensure accurate estimation of THC exposure. Despite flaws, cannabis use self-report measures are affordable, easy to implement over a large array of contexts, and can help researchers understand cannabis consumption patterns over time. Thus, even with collection of blood or urine as options for assessing THC exposure, it is likely that researchers will continue to rely on self-reported cannabis use for the foreseeable future.

To understand THC exposure from self-report data, research participants need to report their frequency of use, the quantity they consumed during use episodes, and the potency of their products (Prince et al., 2018). Measuring cannabis consumption with only frequency is insufficient, as only evaluating frequency obscures the different consumption patterns that may be present. For instance, consuming cannabis one day can be used to describe either a single hit of low potency flower at night before sleep or continuously consuming multiple grams of high potency cannabis throughout the day. Between frequency, quantity, and potency, measuring the quantity of cannabis consumed is likely the hardest for consumers to estimate. Often, in self-report surveys, participants are asked to estimate a precise number of grams consumed in a cannabis use session up to 30 days ago when they may not have known they were going to need to recall the amount they consumed at the time of use. This challenge is exacerbated by the fact that many cannabis products are either not labeled or the labels do not clearly indicate a common serving size in either grams of product or milligrams of THC (Davenport, 2021). The importance of accurately estimating cannabis quantity whether in self-report, observational, or controlled cannabis research is central to the validity of the assessment of cannabis use and is necessary to better understand relations between cannabis use, predictors of cannabis use, and consequences of cannabis use.

To evaluate cannabis consumers' accuracy in estimating their typical cannabis quantities, we previously conducted a field observational research study in which participants prepared a bowl, rolled a joint, or loaded a dab tool with their usual amount of cannabis and then they estimated how many grams of product they prepared (Prince et al., 2018). We also measured the actual amount of cannabis they prepared and compared the actual amount to the participant's estimate. The primary findings indicated that, regardless of demographic characteristics, individuals overestimated cannabis quantity in all preparations (e.g., flower in joints, flower in bowls, loading dabs). However, the overestimation was systematic but not uniform. On average, participants overestimated smaller quantities to a greater degree than larger quantities. This was most pronounced across preparations, with participants being particularly inaccurate at estimating small quantities of concentrated cannabis products when compared to relatively larger quantities of cannabis flower. This indicates that self-reported estimations of cannabis quantity are likely unreliable and inaccurate, potentially obscuring relations between cannabis use, predictors, and outcomes. Though we note that the overestimation bias was systematic by quantity, with more estimation for smaller quantities (Prince et al., 2018). While this research was enlightening, there were a number of questions left unanswered, including, "Would providing visual cues of specific cannabis quantities significantly improve self-reported cannabis quantity estimations?"

In our previous study (Prince et al., 2018) we did not give participants any visual cues to help them estimate their cannabis. In survey studies, visual cues are common to provide consumers when estimating alcohol and cannabis consumption. For alcohol consumption, researchers used visual aids successfully to train participants to estimate and pour standard drinks (Metz et al., 2017). Similarly, it is common when researchers are asking participants to estimate cannabis quantity that they provide visual cues, such as pictures of cannabis weights and joints of different sizes (e.g., Bonar et al., 2017; Borodovsky et al., 2022; Collins et al., 2014; Cuttler & Spradlin, 2017; Goodman et al., 2019; Pedersen et al., 2021; Pol et al., 2013). For self-report studies, many of the surveys include photos of cannabis products next to reference items (e.g., dollar bill, lighter, etc.), which are used to scale the cannabis photos.

Researchers include visual cues with the goal of improving cannabis quantity estimation; however, research has not yet established whether these visual cues actually improve cannabis quantity estimation. One study evaluated the use of visual cues in estimating cannabis consumption with a prompt card (Pol et al., 2013). In their study, the prompt card contained images of different weights of cannabis that participants then used to estimate the weight of their cannabis products. Ultimately, the study found that participants tended to underestimate the weight of their cannabis products when using the prompt card.

In this current study we aimed to build on our previous study and van der Pol et al.'s study by determining how accurately frequent cannabis consumers estimate their typical flower and concentrate quantities when presented with either 1) pictures of different weights of ground flower, concentrate products, and pictures of pre-rolled joints (picture cues); 2) physical piles of ground cannabis, joints, and concentrate (physical cues); or 3) no visual cues. We hypothesized that estimations of cannabis quantity would be significantly more accurate in the cued conditions, with those in the physical cue condition providing more accurate estimations compared to those in the picture cue condition, and both would be significantly more accurate compared to the condition with no visual cues.

METHODS

Participants

Sixty-two participants were randomly assigned to 1 of 3 conditions (i.e., picture cues n = 19, physical cues n = 23, no cues n = 20). Sample sizes are uneven across groups due to the random assignment to conditions procedure we employed. The average age of participants was 30.7 years (*SD* = 7.7, Range: 21.9 - 60.7). The mean age of first cannabis use was 15.7 (*SD* = 3.26, Range: 8 - 28). The majority of participants were White (66%), Non-Hispanic (58%), and female (54%). Eighty-eight percent of the sample reported some level of intoxication at the time of the study. On a 0 to 10 point scale (0 = "not at all high", 10 = "very high"), the mean level of subjective intoxication was 4.16 (*SD* = 2.51). Note that 66% of the sample who reported a non-zero amount of intoxication indicated 5 or less on the scale. Potential participants who appeared to the research team to be too intoxicated to consent were not approached to be participants.

Procedures

Data were collected from social events that permitted cannabis use held in a private cannabis club in a large city in Colorado. One event was a member-only social event. Members were given time and space to socialize and consume cannabis as they wished. Throughout the evening, individuals were asked if they would like to participate in the research study and informed that they would be compensated for their participation. If they indicated that they wanted to participate, they were randomly assigned to one of the conditions (i.e., picture cues, physical cues, or no cues). The second event was a member-only Bingo night held at the same location. Upon entry to the social club, potential participants indicated interest in participation, were assigned a number, and, throughout the night, research staff called out numbers and randomly assigned participants to conditions. For both events, nearly all attendees (i.e., > 95%) indicated they were interested in participating.

The study procedures were held constant across both events. After indicating interest in participation, research staff screened participants for inclusion criteria, which consisted of being over the age of 21, not pregnant assessed by self-report, and self-reported cannabis use at least 2 times per week in the past year. Those that were eligible then completed the informed consent process.

After consenting, participants chose to either roll a joint or pack a bowl, and if they indicated that they had previously used dabs, they were asked to load a dab tool. Participants only completed their preferred method of preparing flower. They could elect to use their own cannabis product, which they brought with them, or cannabis that was provided to them by the cannabis club. However, they used standardized rolling papers, bowls, and dab tools provided by research staff. First, research staff tared the scale with the tool that the participant was going to use for their preparation by placing the empty bowl, dab tool, or rolling paper on the scale and resetting the scale to 0 with the item on the scale. This ensured that weight displayed was for the cannabis quantity used only. For each preparation (i.e., joint, bowl, dab), participants were then asked to roll or load a quantity that was typical for them to use. They were then asked to place the preparation on a scale, and indicate their estimate of the weight, in grams for flower preparations and in milligrams for the concentrate preparation. Participants could not see the actual weight, as research staff placed a screen over the display so that only research staff could see the value. The research staff recorded participant estimation along with the actual weight of the preparation. Participants were not told the actual weight of the preparation. In the cued conditions, participants were instructed that they could use the cue to help with their estimation.

After completion of the task, participants completed a survey assessing demographics, cannabis use history, current subjective intoxication, and information about the preparation (e.g., how similar is this to a joint you would typically roll, would you share this with others). If participants used their own product, they could take the product with them and consume it; if the cannabis was provided to them, they dumped the cannabis out of the joint, bowl, pipe, or dab preparation back into the container they retrieved it from. At no point did study staff handle cannabis products. Participants were compensated with a $10 amazon digital gift card for their participation in the study.

Materials

Materials used in this study consisted of dab tools, bowls, rolling papers, cannabis, and the survey instrument. Research staff or participants provided the dab tools, bowls, or rolling papers. Participants or the private cannabis club provided the cannabis products. As this was an observational study, research staff were not permitted to handle cannabis at any time during the study. The survey instrument was presented to participants on computers brought by the research staff using the Qualtrics online survey tool. The lead author went to a retail dispensary in Colorado and purchased the cannabis products used in the physical cannabis cue condition, which consisted of flower, pre-rolled joints of different sizes, and concentrated cannabis. Each were precisely weighed using the same scale. These products were used as visual cues (pictures of the products are available upon request from the corresponding author). We also used the picture of the products as the visual cue in the picture condition (available upon request). All pictures were taken in the same light from the same angle at the same time. Research staff placed bottle caps and a pre-rolled cigarette in the photos as visual references to assist participants. Nothing was done to prevent settling or compaction of the piles of cannabis.

Measures

Demographics, descriptives, history of cannabis use, and other pertinent information were included in the online survey that participants completed as part of this study. We also asked participants to use a visual analog scale to indicate how intoxicated they were at the time of their participation in the study from 0 – "not intoxicated at all" to 10 – "as high as I have ever been."

Analysis Plan

There were several methodological challenges with the data from this study. First, as presented in our previous work (cf. Prince et al., 2018), misestimation is proportional to the absolute quantity of the product being estimated. For example, participants consistently report greater discrepancy between actual and estimated cannabis quantity for concentrated cannabis products compared to cannabis flower. To account for this, we chose to calculate ratios (i.e., estimated weight/actual weight) as the index of misestimation. For the ratio variables, a value of 1 would indicate that the participant estimated the exact actual weight of the product. For values greater than 1, the estimated weight was more than the actual weight and for values less than 1, the estimated weight was less than the actual weight.

Analyses began with descriptive statistics, data visualization, and checks for violations of assumptions (e.g., normality - Kolmogorov–Smirnov tests, outliers – values greater than 3*SD*). Next, we compared estimations across cue conditions and across flower and concentrate estimations to a ratio of 1 using one-sample Wilcoxon Sign Rank tests. Wilcoxon Sign Rank tests provided a test of whether the group median differed from 1 (i.e., accurate estimation). We calculated effect size *r* to supplement the null hypothesis significance tests. Next, we compared groups using Kruskal Wallis tests, which provide an overall test of differences between conditions and then follow-up pairwise tests. These tests indicate whether groups differ from each other, with the caveat that one group could be greater than 1 and the other could be less than 1, which makes interpretation complicated. Additional analyses that control for subjective intoxication were conducted and can be provided upon request from the corresponding author, however, they are not presented here because the pattern of results do not differ. Thus, we used data visualizations to ensure we made appropriate inferences from the tests. All analyses were run in the statistical software R (R Core Team, 2024). Descriptive statistics were calculated using the *tidyverse* (Wickham et al., 2019) and *psych* packages (Revelle, 2023). Data visualizations were created using *ggplot2* (Wickham, 2014) and *ggside* packages (Landis, 2024). All non-parametric tests were conducted using built in *base* R functions (R Core Team, 2024).

RESULTS

Univariate descriptive statistics for the ratio estimation accuracy, grouped by cannabis product type (flower, concentrated cannabis) and condition (physical cues, picture cues, and no cue), are presented in Table 1. Recall that a ratio value of 1 equates to an accurate estimation of the quantity of the product. Across conditions, participants' estimations ranged from substantial underestimation (0.02) to substantial overestimation (16.0). There was a wider range of misestimations for concentrated cannabis (Range: 0.02 – 16.0) estimations compared to flower estimations (Range: 0.12 – 5.88).

Table 1. *Univariate Descriptive Statistics for the Ratio Estimation Accuracy by Cannabis Type and Condition*

	mean	*SD*	*median*	*min*	*max*	*skew*	*kurtosis*
Flower No Cue	1.84	1.26	1.43	0.12	5.88	1.61	2.69
Flower Picture Cue	1.46	0.63	1.42	0.48	2.67	0.32	-0.89
Flower Physical Cue	1.46	1.10	1.16	0.14	4.67	1.64	2.15
Concentrate No Cue	1.43	3.06	0.38	0.02	12.50	2.80	7.19
Concentrate Picture Cue	4.43	4.18	2.74	0.67	16.00	1.48	1.37
Concentrate Physical Cue	2.40	2.72	1.02	0.19	9.09	1.30	0.45

It was unclear from the skewness and kurtosis values alone whether the ratio estimation distributions violated normality assumptions; therefore, we used Kolmogorov–Smirnov tests to test for these violations. In each condition there were outliers or extreme estimation errors present. Results are presented in Table 2. Kolomogorov-Smirnov tests revealed that all ratio estimation variables were significantly non-normal. Paired with the presence of outliers, we chose to analyze data using non-parametric tests.

Table 2. *Kolmogorov–Smirnov Tests for the Ratio Estimation Accuracy by Cannabis Type and Condition*

	Statistic	*p-value*
Flower No Cue	0.75	<.01
Flower Picture Cue	0.69	<.01
Flower Physical Cue	0.67	<.01
Concentrate No Cue	0.51	<.01
Concentrate Picture Cue	0.76	<.01
Concentrate Physical Cue	0.57	<.01

We compared the average estimation accuracy among each cue group for each product type to 1 (i.e., accurate estimation) using Wilcoxon Signed-Rank tests. Results, presented in Table 3, revealed significant differences between the average estimation accuracy of flower weights among the no cue and picture cues that were statistically distinguishable from 1 (n = 172, W = 1.66, p < .05; n = 147, W = 1.43, p < 0.05, for the no cue and picture cue condition, respectively). The effect size estimations for those comparisons were large (r = -0.64 and r = -0.60 for the no cue and picture cues condition, respectively). The average estimation accuracy among the physical cues condition did not statistically differ from accurate, and the effect size estimate for that comparison was small (n = 174, W = 1.25, p = .13, r = -0.24). For concentrated cannabis, average accuracy estimations for the no cue and the physical cue conditions were not significantly different than the accurate estimate, with small effect sizes (n = 48, W = 0.42, p < .19, r = -0.21; n = 124, Z = 1.94, p = .25, r = -0.15 for the no cue and physical cues conditions, respectively). For the picture cues condition, the average accuracy estimate of product weights was significantly different from 1, with a large effect size (n = 117, W = 3.77, p < .05, r = -0.75).

Table 3. *Kruskal Wallis Omnibus and Pairwise Comparisons Across Type and Condition*

	χ^2	*p-value*	ε^2
Flower Omnibus	2.54	.28	0.01
No Cue vs Picture Cue	0.38	.54	-0.02
No Cue vs Physical Cue	2.40	.12	0.03
Picture Cue vs. Physical Cue	0.91	.34	-0.02
Concentrate Omnibus	16.33	<.01	0.24
No Cue vs Picture Cue	13.24	<.01	0.33
No Cue vs Physical Cue	6.92	.01	0.14
Picture Cue vs. Physical Cue	4.78	.03	0.09

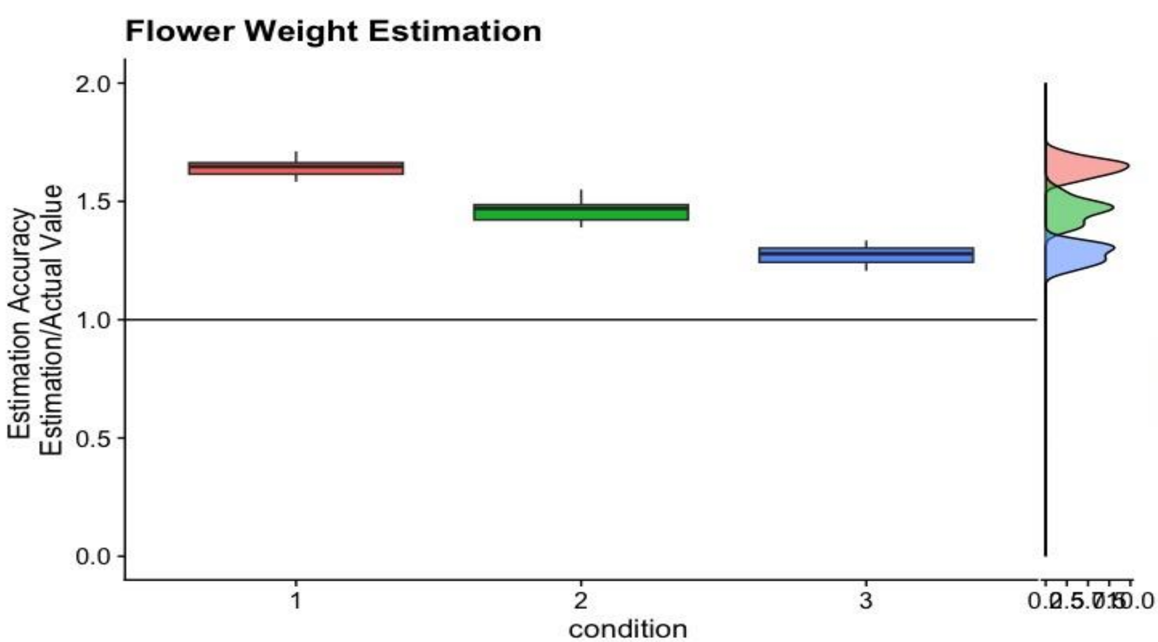
Note. ε^2 is an effect size measure for the Kruskal Wallis test statistic and is interpreted as amount of variance explained, with values 0.01 to < 0.06 being small effects, 0.06 to < 0.14 being medium effects, and 0.14 or above being large effects.

To compare conditions to one another, we conducted omnibus tests to assess whether there were differences across groups, then conducted follow-up Kruskal-Wallis tests for pairwise comparisons. Results, presented in Table 4 indicate that, for flower, there was not a significant omnibus test (x^2 = 2.54, p = 0.28, df = 2), and there were no significant pairwise differences across different cue types (see Figure 1). In contrast, for concentrated cannabis, the omnibus test (x^2 = 16.3, p < .01, df = 2) and all pairwise tests were significant. As seen in Figure 2, no cues yielded lower accuracy estimation ratios for the product weight (underestimated concentrate weight more) than picture cues (x^2 = 6.92, p < .05, df = 2) and physical cues. Picture cues yielded greater accuracy estimation ratios for the product weight (overestimated concentrate weight more) than physical cues (x^2 = 4.78, p < .05, df = 2).

Table 4. *One Sample Wilcoxon Signed-Rank Tests Comparing the Ratio Estimation Accuracy by Cannabis Type and Condition to 1.*

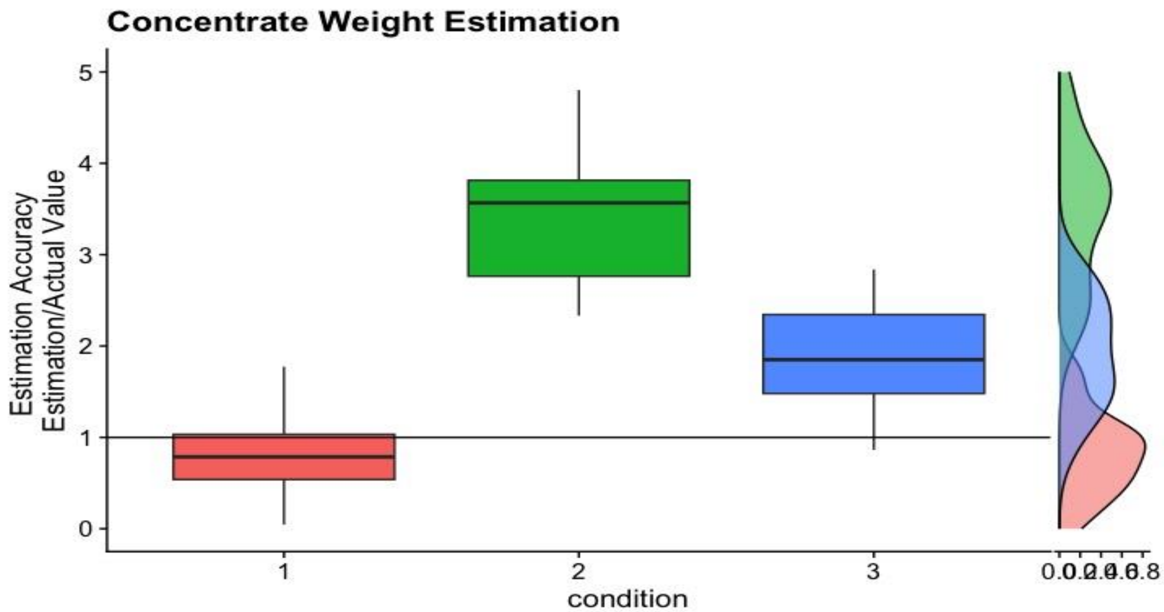
	estimate	statistic	p-value	Effect Size	Interpretation
Flower No Cue	1.66	172	.00	-0.64	large
Flower Picture Cue	1.43	147	.01	-0.60	large
Flower Physical Cue	1.25	174	.13	-0.24	small
Concentrate No Cue	0.42	48	.19	-0.21	small
Concentrate Picture Cue	3.77	117	.00	-0.75	large
Concentrate Physical Cue	1.94	124	.25	-0.15	small

Figure 1. *Boxplots And Density Plots of Flower Weight Estimation Accuracy by Condition*



Note. N = 62. Condition 1 = no cues; Condition 2 = picture cues; Condition 3 = physical cues.

Figure 2. *Boxplots and Density Plots of Concentrate Weight Estimation Accuracy by Condition*



Note. N = 62. Condition 1 = no cues; Condition 2 = picture cues; Condition 3 = physical cues.

DISCUSSION

The goal of the present study was to determine whether providing visual cues improved accuracy of cannabis quantity estimations in number of grams. The study was designed to build on previous work (Prince et al., 2018) that showed individuals who use cannabis at a high frequency are not accurate in their estimations of cannabis quantity while preparing joints, bowls, and dabs. Results from the present study showed that people who consume cannabis at a high frequency can accurately estimate concentrate and flower quantities accurately when provided with physical cues. For concentrate products, both physical cues and no cues help improve the accuracy of quantity estimations. However, in the flower condition, participants tended to overestimate the amount of cannabis they used, with the highest misestimation associated with no cues, followed by picture cues, both statistically significant misestimations, with the physical cues estimations not significantly different from the actual quantity. This pattern was different for concentrates, where participants in the no cue condition underestimated the quantity of cannabis concentrate they used to load the dab tool and overestimated the quantity the used in the picture cue and physical cue conditions.

Many research studies (for review, see Manthey et al., 2023) that rely on self-reported cannabis use, including cannabis use quantity, provide visual cues, such as pictures of varying weights of cannabis or pictures of rolled joints at various quantities (e.g., 0.25 gram, 0.50 gram, and 1 gram joints); however, no published research has established that these visual cues lead to improved prediction of actual quantities, despite the assumption that these pictures help. While we recognize the effort to improve the accuracy of assessing self-reported quantity (note that all authors of this manuscript routinely have used these pictures in our own work), we were concerned that the underlying assumption that the pictures improve estimation could introduce unknown bias resulting in inaccurate findings. We were also interested in testing whether pictures improve prediction accuracy across types of cannabis in a consistent manner. We felt that this work was an especially important step to follow work showing that individuals who engage in regular to heavy cannabis use are unable to accurately estimate cannabis quantity in joint, bowls, and dabs they have prepared (Prince et al., 2018).

It is possible that the picture cues did not improve the accuracy of estimations compared to no cues because it may have been difficult for the participants to compare the amount of cannabis in a picture to the actual amount of cannabis that they prepared. This could be due in part because the picture of cannabis products lacks depth (i.e., it is a two-dimensional image). Additionally, to make an accurate estimation based on a picture requires the participant to first compare the picture of the cannabis weight to a reference image (e.g., lighter, quarter, etc.) and then compare their prepared amount to the same reference (which they are likely familiar with but may not have on hand), introducing an additional source of error in the estimations. Next, it is possible that the pictures of the cannabis weights do not easily adapt to the heterogeneity in how much product can be loaded in a device (i.e., bowl size). Physical cues may improve accuracy since it is easier to compare a physical pile of cannabis to the prepared amount of cannabis. Additionally, physical cues are three-dimensional, which may help overcome the estimation error resulting from using a two-dimensional comparison picture. Lastly, the physical piles do not require a reference image for scale, so the comparison is done between the physical pile and loaded cannabis and not between reference images, reducing error when compared to the picture cues.

While physical cues are promising in helping improve cannabis quantity estimations, it is not feasible to use physical cues in self-report research conducted remotely or in states where cannabis is not legal. Even in states where cannabis is legal, such as Colorado, due to federal laws, it remains illegal to bring cannabis onto campus, thus into the lab. As such, when possible, it may help to use scales to measure consumption in number of grams. It may also be possible to measure quantity in number of hits, but it is unknown whether people who consume cannabis can accurately self-report the number of hits they consume.

These findings should be taken into consideration of the limitations associated with this study. This was a small sample. Findings should be replicated in larger samples. Participants were able to consume cannabis during the data collection event. This may have altered estimation accuracy; however, in supplemental analyses not presented here, ratings of subjective intoxication were controlled in all analyses and results did not differ from the pattern we saw when we did not control for subjective intoxication. We allowed consumption during data collection, as we thought this would simulate typical conditions when participants may be asked to estimate the typical quantities of cannabis they use. Future research could replicate these findings not allowing for cannabis consumption during data collection. The compensation amount, $10, may have influenced who volunteered to participate in the study, so findings may not generalize to all people who consume cannabis. Finally, we did not control for or assess all conditions. For instance, we did not test whether substances other than physical cannabis that resemble physical cannabis would provide the same benefit when estimating cannabis quantity. Future research could replicate this research using other substances to provide the physical cues, such as hemp or green leafy spices. If this research showed similar patterns, then it may be the case that, for research conducted in the lab, using physical cues may still be feasible in the current legal landscape.

Our findings indicate a need to continue to search for methodology that improves cannabis quantity estimation in research studies. It may be important to use methods, such as providing scales to participants to weigh cannabis products when using self-report and online data collection, to obtain accurate cannabis quantity. In-person studies could use physical cues to improve accuracy if it is legal for them to use actual cannabis in labs or if research shows that other substances can replace cannabis for the physical cues. Overall, however, our findings suggest that researchers should not assume that picture cues improve participants' estimations of cannabis quantity and may in fact worsen estimations compared to providing no cues or providing physical cues.

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