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Spending money to make change: Association of methamphetamine abstinence and voucher spending among contingency management pilot participants in South Africa

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Abstract

Aims: Methamphetamine Use Disorder is prevalent in South Africa. This analysis uses data from a contingency management (CM) pilot study in South Africa to replicate and expand on a U.S.-based study showing that CM voucher spending was associated with drug abstinence behavior.

Design: Participants with methamphetamine-use disorder were enrolled in an 8-week CM trial requiring thrice weekly visits and received cash vouchers in exchange for stimulant-negative urines at each visit.

Participants: Participants were 33 treatment-seeking individuals with methamphetamine use disorder including 22 men (66.7%) and 11 women (33.3%) with a mean age of 34 years (S.D.=7.7). Participants reported using methamphetamine for a mean of 11.7 years (S.D. = 4.9).

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Declarations of competing interest: The authors declare that there are no competing interests.

Setting: All study procedures took place in South Africa between August 2016 and May 2018.

Measurements: A time-lagged counting process Cox Proportional Hazards model for recurrent event survival analysis examined the relationship between frequency of and participant-categorized type of CM expenditures (hedonic, utilitarian, consumable or durable) and drug abstinence.

Findings: After controlling for severity of baseline methamphetamine use and accumulated CM earnings (proxied by cumulative negative urines), those spending CM earnings at a previous visit ("*spenders*") were more likely to produce stimulant-negative urine samples subsequently, compared to those who did not ("*savers*") [OR = 1.23, CI = 1.08-1.53, p = .002]. There were significantly more cumulative stimulant-negative results among *spenders* vs. *savers*, p<.001, although cumulative spending did not significantly predict abstinence once spending in the prior time period was controlled for, suggesting a *recency effect* tied to the underlying spending mechanism. When extending the original analyses to look at the effect of spending on current abstinence, controlling only for recent abstinence (rather than cumulative abstinence), spending was no longer a significant predictor. Spending type did not affect methamphetamine abstinence. Qualitative results suggest spending CM vouchers may support social reintegration over the course of the trial.

Conclusions: Abstinence outcomes are a function of CM spending in both the U.S. and South Africa. Findings of a significant relationship between contingency management spending and subsequent stimulant-negative urine samples across geographic locations provide guidance toward future work in optimizing CM efficacy.

1. Introduction

1.1 Methamphetamine use and treatment in South Africa

In the Republic of South Africa, there is an epidemic of 'tik' or methamphetamine use, which accounted for more than 37% of patient admissions to drug treatment centers in the Western Cape province (Dada et al., 2016), primarily in the city of Cape Town (Peltzer, Ramlagan, Johnson, & Phaswana-Mafuya, 2010). Methamphetamine (MA) use disorder is associated with multiple adverse health issues (Darke, Kaye , McKetin, & Duflou, 2008), including cardiovascular pathology (Kaye, McKetin, Duflou, & Darke 2007), poor mental health (e.g. depression, suicide) (Marshall & Werb, 2010; Akindipe, Wilson, & Stein 2014) and risky sexual behavior (Parry, Plüddemann, Myers, Wechsberg, & Flisher, 2011; Meade et al., 2012; Wechsberg et al., 2010). South Africa faces multiple intersecting health threats, including high HIV prevalence among MA users (Plüddemann, Plüddemann, Myers, & Parry, 2008), underscoring the need for development and scale-up of effective treatments for methamphetamine use disorder.

Cognitive Behavioral Therapy (CBT), including motivational interviewing, and problem-solving, is the primary treatment approach for MA use disorder in South Africa (Jones et al.,

2014; Sorsdahl et al., 2015a; Sorsdahl et al., 2015b). However, relapse rates remain high (Gouse et al., 2016). Another approach to treatment, that of contingency management (CM), uses monetary incentives, whereby individuals receive vouchers that increase in value in exchange for consecutive biomarkers documenting drug abstinence (Petry 2013; Petry, Alessi, Ledgerwood, 2012a; Petry, Alessi, Ledgerwood, 2012b). These vouchers can, in turn, be exchanged for prosocial goods or services (i.e. not tobacco, alcohol, or lottery tickets). In U.S. populations, CM has been shown to be equally effective and useful, alone or in combination with CBT and other usual treatments, among those seeking treatment for MA use disorder (Shoptaw et al., 2005; Rawson et al., 2006; Forster, DePhilippis, Forman, 2019). However, it is unclear whether the underlying behavior trends in CM voucher use and MA abstinence are generalizable to CM programs implemented in other cultures or geographic regions.

1.2 Evidence of CM effectiveness outside the United States

While contingency management as a treatment approach to drug use has predominantly focused on US populations, there has been evidence of success of CM for drug abstinence among those seeking treatment for cocaine use in Spain (Garcia-Rodriguez et al., 2009) and crack-cocaine use in Brazil (Miguel et al., 2016). Among CM studies for heroin use in China, the success appears to be somewhat dependent on the magnitude of the incentives provided, with greater methadone treatment retention and heroin abstinence among those receiving higher lottery-based incentives (Hser et al., 2011).

To our knowledge, there have been no prior CM studies for drug treatment piloted in South Africa. However, voucher-based incentive approaches have been implemented in South Africa and other sub-Saharan African populations for HIV testing (Kim, Haile, & Lee, 2016; Sibanda et al., 2017; Kranzer et al., 2018), as well as antiretroviral therapy initiation and adherence (Yotebieng et al., 2016a; Yotebieng et al., 2016b; Linnemayr, Stecher, & Mukasa, 2017; McCoy et al. 2017; Czaicki, Dow, Njau, & McCoy, 2018). In a recent review of CM approaches for HIV care in low-income and middle-income countries, Galárraga and Sosa-Rubí (2019) found mixed results for both cash and non-monetary voucher incentives among African populations. Financial incentives showed overall increases in HIV testing and initiation of antiretroviral therapy (ART). Escalating cash incentives were found to be effective at sustaining retention in care among those with greater baseline financial need. However, financial incentives were not necessarily effective for HIV prevention behaviors or long-term adherence to antiretroviral treatment plans. In their review, the authors highlight the need to better understand the psychological responses to financial incentives, and, specifically, the potential behavioral economic pathways by which financial incentives succeed or, in some cases, fail.

1.3 Potential economic mechanism for US-based contingency management success

One important starting point for understanding the behavioral economic pathways by which contingency management is successful is to examine the role of how participants spend their vouchers on drug abstinence behavior. In a U.S. sample of men identifying as gay/bisexual and seeking treatment for MA use disorder, participants in a CM program who frequently spent their vouchers (termed "spenders") improved their probability of being MA abstinent

at their next clinic visit compared to those who did not spend their vouchers (termed "savers") (Ling-Murtaugh et al., 2013). The finding that drug abstinence outcomes are a function of frequency of CM spending is suggestive of an economic mechanism of *substitutability*, in which certain goods can qualitatively serve as substitutes for other goods (e.g. tea vs. coffee), even if they are not identical, as long as the substitute has a reinforcing response (Rachlin, Battalio, Kagel, & Green, 1981; Rachlin, Green, Kagel, & Battalio, 1976; Green & Freed, 1993). A substitute could be almost any item or experience for which the drug user would be willing to exchange drug use. Thus, in a CM context, the monetary vouchers could act as a substitute for MA use by producing a reinforcing (positive affective) response, either through the consumption of goods bought with CM vouchers, or even through the act of spending itself.

In this previous work, it was also hypothesized that if a substitutability mechanism were underlying CM success, the type of expenditure might additionally influence abstinence behavior, with spending on better drug substitutes being more strongly associated with drug abstinence. For example, because drugs provide a hedonic experience, it was hypothesized that *hedonic* purchases would be a better drug substitute than *utilitarian* purchases and, consequently, more likely to produce a negative urine sample at the next visit (Ling Murtaugh et al., 2013). The hedonic pleasure received from drug use is short-lived, diminishing over time and with chronic use (Koob & Le Moal, 2008; Koob & Volkow, 2010). Individuals have also been shown to have a greater discount rate for consumable items (such as food, beer, or cigarettes) than they do for money (Estle, Green, Myerson, & Holt, 2007; Odum & Baumann, 2007). Thus, one might expect that more short-lived *consumable* purchases would also serve as a closer substitute for the drug experience than more *durable* purchases, as long as the assumption is made that those durable purchases did not serve as routine reinforcers. The Ling-Murtaugh et al.(2013) study found that each single instance of spending was significantly predictive of a subsequent negative urine result, yet no single category of goods that CM vouchers were spent on significantly increased the likelihood of an abstinent outcome. This could be because participants in that study did not rate their own purchases, but could also be because the act of spending in itself offers a reward distinct from the purchase itself.

There is also evidence that motivation may play in a key role in whether or not a substitutability mechanism is operative in CM. Non-treatment-seeking MA users show a less consistent response to CM (Menza et al, 2010). Moreover, a study by Fletcher, Dierst-Davies, and Reback (2014) found that, controlling for total amount earned over the course of a CM intervention for MA use disorder among a sample of homeless, non-treatment seeking men who have sex with men, fewer days between instances of voucher spending were associated with higher levels of overall methamphetamine use in the course of the intervention. Thus, in non-treatment-seeking groups, frequent voucher spending may reflect a tendency toward immediate gratification. Overall, these studies of spending in CM trials suggest that substitutability may be one underlying mechanism, particularly for those motivated to seek treatment, but may not offer a full behavioral economic explanation of CM success. Thus, it is important to replicate and further explore the role of voucher spending and CM success among different treatment-seeking populations.

1.4 Study hypotheses

Here, we examine whether those associations between CM voucher spending and negative urine samples observed among treatment-seekers for MA use disorder in the U.S. (Ling-Murtaugh et al., 2013) are replicated among treatment-seekers residing in South Africa, serving as a cross-cultural test of substitutability of CM vouchers for drug use.

Specifically, we hypothesize that:

> H1: If voucher redemptions are acting as a substitute for methamphetamine use, participants who redeem their CM earnings at a visit (*spenders)* will be more likely to have a negative urine result at their next visit compared to participants who do not redeem (*savers*), even when controlling for cumulative successful earning days (prior abstinence) and cumulative expenditures (prior spending).

Based on previous implementation of voucher-based financial incentives in non-Western populations and specifically in Sub-Saharan African populations, we anticipate that there will be high levels of adherence to drug abstinence. However, we do not have any specific hypotheses related to cultural norms among our South African population that would influence spending behavior. We do extend the previous design by asking treatment-seekers to rate their own purchases and provide open-ended qualitative reflections on their spending and saving behavior.

As such, we also predict that:

> H1b: If the goods purchased via voucher spending are acting as a substitute for methamphetamine, participants who spend their CM earnings on purchases they rate as more *hedonic* will be more likely to produce a negative urine sample at their next visit compared to participants who spend their CM earnings on purchases they rate as more *utilitarian*, when controlling for cumulative successful earning days (prior abstinence) and cumulative expenditures (prior spending).

> H1c: If the goods purchased via voucher spending are acting as a substitute for methamphetamine, participants who spend their CM earnings for purchases they rate as more *consumable* will be more likely to give a negative urine sample at their next visit compared to participants who spend their CM earnings for purchases that they rate as more *durable*, when controlling for cumulative successful earning days (prior abstinence) and cumulative expenditures (prior spending).

We also extend the original research in two ways. First, we include participants' own ratings of their purchases and qualitatively examine their interpretation of their spending and saving behavior to gain insights into the psychological role that spending may play in CM success. Second, we examine whether the spending effect still holds when controlling for just a recent successful earning day (a negative urine in the 1-2 days prior) rather than cumulative successful earning days (cumulative negative urines) over the course of the treatment to date. This additional analysis is intended to offer some insight into how important a single instance of spending behavior is for current abstinence, after controlling for a participant's status in just the previous time period, but not considering a participant's overall prior success, i.e. cumulative successful earning days, in the treatment program. The purpose of

this analysis is to attempt to disentangle the simultaneous effects of spending and drug use on subsequent drug use for just a single time period.

2.   Materials and Methods

2.1   Participants

Study participants were 33 treatment-seeking men and women enrolled in a larger pilot study to examine the neurobiological correlates corresponding to successful CM treatment for methamphetamine use disorder in South Africa (Okafor et al., 2019). Participants were recruited either through referrals from drug rehabilitation centers or from flyers posted in shopping centers, community centers and homeless shelters. In order to be included in the study, participants were English-speaking 18-45 year-olds who (1) provided voluntary informed consent; (2) met DSM-5 criteria for MA use disorder; and (3) provided at least one urine sample positive for MA during a 2-week screening period prior to the commencement of the study. Participants were excluded from enrolling in the study if they had (1) failed to attend at least 4 visits during the 2-week screening period or to complete measures during that period, and (2) a physical or mental illness that would interfere with safe study participation.

2.2   Design

Consented participants enrolled in an 8-week trial and were required to attend clinic and provide a urine sample three times each week. All study procedures took place between August 2016 and May 2018. All aspects of the study were overseen by the Institutional Review Boards of the University of Cape Town, South Africa and the University of California, Los Angeles.

The initial urine sample negative for metabolites of MA was worth ZAR25 (ZAR10 = $.75US) in compensation. Consecutive negative samples increased in compensation value by ZAR12.50. For every three consecutive negative samples, a ZAR100 bonus (~USD $7.53) was provided. Total possible earnings accumulated by providing each scheduled urine sample negative for MA metabolites was ZAR4850 (~ USD $365.21). When samples provided were positive for MA or amphetamine or if a sample was not provided, there was no compensation.

The immediate subsequent negative sample, following a positive or missing sample, returned to ZAR25 in value. To maintain motivation, a "rapid reset" rule was used, such that participants could return to their prior place in the escalating schedule after three consecutive MA-negative urine samples following a MA-positive or missing sample. All compensation was provided in the form of vouchers, which were equivalent to pre-paid credit cards delivered to their cell phone with a unique voucher code, and could be spent at multiple commonly-frequented stores, but could not be exchanged for cash, or used to purchase gift cards, cigarettes, or alcohol. Participants were asked to bring their receipts from voucher-expenditures to their next clinic appointment.

At the completion of the study, participants were asked to return for a debriefing interview. During the interview, they reviewed each spending event and categorized individual items

from each of their purchases made with a CM voucher. Specifically, participants reviewed and categorized the items they had spent their CM vouchers on into the following non-exclusive groups on a 5-point Likert scale: *hedonic* if their use was deemed pleasurable or entertaining (i.e. "How much do you enjoy [this item]?" on a scale of *1* = Not at all enjoyable to *5* = Extremely enjoyable); *utilitarian* if the item was deemed practical or necessary (i.e. "How useful is [this item]?" on a scale of *1* = Not at all practical to *5* = Extremely practical) and *consumable* if participants reported that they were used completely or became useless in a short period of time and *durable* if their period of usefulness was longer term (i.e. "Is [this item] something you use up all at once or something you use multiple times?" on a scale from *1* = One use, *2* = 2 - 5 uses, *3* = 5 - 15 uses, *4* = 15+ uses, *5* = Does not wear out).

Interviewees were also asked several semi-structured questions, followed by prompts, e.g. "What do you mean by that?" or "Tell me more." The purpose of these semi-structured questions was to elicit insights into how participants viewed their voucher payments, including the trajectory of their spending and saving. Questions included (1) "When you first enrolled in this program and learned about the payment vouchers, did you have something specific in mind that you wanted to buy with the money you would receive?" (2) "When you first thought about the payment vouchers, did you think about how much total money you would receive or did you think about how much money you would receive each week (or each visit)? " (3) How did your purchasing decisions change over the course of the study?"

2.3 Measures

2.3.1 Demographic measures—At baseline, all participants provided the following demographic information via questionnaire: (1) age, (2) income, (3) years of schooling, (4) form of employment and (5) race/ethnicity.

2.3.2 Drug use measures—The Structured Clinical Interview for DSM-5 (SCID) interview was conducted to confirm MA use disorder. Drug screening was conducted through urine sample collection at the baseline visit and at each of the 3-weekly clinic visits. Urine samples were analyzed immediately on-site with immunoassay-based dip cards (CLIAwaived, Inc., San Diego, CA, USA) for methamphetamine or amphetamine.

2.3.3 Spending Measures—Participants received a CM voucher payment conditional on visit attendance and a stimulant-negative urine sample. The nature of the CM voucher payments (a unique electronic voucher code) allowed for participants to document their exact purchases and total amount spent per purchase. However, the paper receipts from these vouchers had to be physically brought to the clinic for the study coordinators to log them. The spending measures used to predict a stimulant-negative urine sample at the subsequent visit are the total ZAR expenditures as a continuous variable and whether spending using a CM voucher had occurred in the prior time period. As a descriptive categorization of spending behavior, participants were sorted into *spenders* or *savers* based on a median split on frequency of spending behavior.

2.4 Statistical analysis

Demographics and spending behavior were characterized with descriptive statistics including means, medians and percentages. A time-lagged counting process Cox Proportional Hazards model with standard errors calculated using a grouped jackknife procedure was used to examine the effects on negative urine results up to but exclusive of the current time point of both participants' acquired wealth, as measured by *cumulative successful earning days (*cumulative negative urines), and *total expenditures* (total R spent to date).

Each spending event was assigned an average score for each of the categories of purchase type ("utilitarian," "hedonic," "consumable," "durable"), e.g. if a participant purchased two items in one spending event, one rated as a 1 and one rated as a 5 on the hedonic Likert scale, the entire purchase event would be assigned an average hedonic value of 3. The same approach was taken with the consumable and durable purchases, where the average score across items was taken. Consistent with Ling-Murtaugh et al. (2013), the qualitative categorization of being a *spender* or *saver* was not used as a model variable. Instead spending behavior was captured by two variables: 1) cumulative amount spent prior to the current time period, and 2) whether a CM voucher spending event occurred in the previous time period.

All analyses were completed using the xts, survival, arm, and dplyr packages in R. If data was missing, the missing observation was omitted for that time period but the participant was not otherwise excluded. For missing data from persistent timelagged variables (e.g. cumulative spending), we use the most recent available observation in the models.

2.5 Qualitative analysis

All debriefing interviews were digitally recorded and transcribed verbatim. Responses were independently coded by two investigators (TK and KLM). Both investigators fully coded 10 interviews, discussing and revising a codebook. TK coded the remaining interviews, referencing the codebook. Qualitative analyses were conducted using Dedoose, a qualitative data coding software.

3.   Results

3.1   Sample demographics

This analysis included 22 men (66.7 %) and 11 women (33.3%) with a mean age of 34 years (S.D.=7.7) and a mean number of 11 (S.D. = 2.7) years of schooling. Self-reported MA use in the month prior to enrollment was a median of 21 days and participants used MA for a mean of 11.7 years (S.D. = 4.9). The majority of participants (68%) had a median monthly household income of less than R25 000 ($1882), with 15% (n = 5) having no monthly household income. Most were employed in semi-skilled labor (e.g. hospital aide, painter, bartender, bus driver, cook, garage guard, waiter, machine operator). From the 33 participants in the analysis, 768 of a possible 792 urine samples were provided (97% submission rate) and, of these, 625 (80%) were methamphetamine-negative.

3.2   Spending and saving behaviors

The average amount earned across the course of the study was R 3380 (S.D. = 1899)/ $254 ($143), which translated to 69% of the total possible earnings. The median cumulative amount spent over the course of the study was R2593 ($195). A median split divided participants into *spenders* (n = 16), who made an average of 18 purchases (S.D. = 2.7); significantly more than *savers* (n = 17), who made an average of 7 purchases (S.D. = 5.4), $t(31) = 10$, $p = 2 \times 10^{-7}$. The average number of cumulative stimulant-negative events among *spenders* - 24 (S.D. = .34) - was significantly greater than the average number of stimulant-negative events among *savers* – 15(S.D. = 7.5), $p = 6 \times 10^{-4}$.

3.3.   Substitutability

As illustrated in Table 1 (Model 1), for each additional stimulant-negative test in the previous time periods, a participant had a 2.09 [1.69, 2.59] times higher likelihood of having a negative urine sample in the subsequent study visit ($Z = 6.73$, $p < .001$).

Inclusive spending to date was quantified using the time-varying factor labeled 'cumulative expenditures.' A participant with greater cumulative expenditures did not have significantly greater odds of a current negative urine (Table 1, Model 2). However, an instance of spending at the prior visit significantly increased the odds of a negative urine result at the next visit, even after controlling for cumulative instances of successful earnings days/ abstinent behavior (Table 1, Model 3), suggesting an additional protective effect of recent spending on drug abstinence. When controlling for abstinence at just the prior visit, not considering cumulative abstinence, and controlling for spending history (cumulative expenditures), spending in the prior time period no longer significantly decreased the odds of a negative urine result at the subsequent visit (Table 1., Model 4).

3.4   Purchase Type

The median hedonic and utilitarian rating participants assigned to their purchases was 4.14 for each, respectively, and, contrary to expectation, utilitarian and hedonic ratings were highly correlated (*r* >.95). There was no main effect of the type of spending in the previous period associated with a subsequent negative urine. If participants had spent in the previous time period, the more "consumable" that expenditure was (vs. "durable"), the less likely they were to provide a negative urine sample in the next time period, but the result was not statistically significant, $B = -.01$, $SE = 0.01$, $Z = -0.96$, $p = 0.34$. If participants had spent in the previous time period, the more "utilitarian" that expenditure was, the less likely they were to provide a negative urine sample in the next time period, but, again, the result was not statistically significant, $B = -.009$, $SE = 0.008$, $Z = -1.19$, $p = 0.23$. Similar results were found for "hedonic" expenditures, whereby the more "hedonic" an expenditure was, the less likely they were to provide a negative urine sample in the next time period, $B = -.01$, $SE = 0.007$, $Z = -1.28$, $p = 0.20$.

3.5   Structured CM interview responses

All participants who were successfully contacted after the completion of the study returned for a debrief interview. There were no differences between those who were contacted successfully and those who were lost to follow-up on demographics, baseline years of drug

use, or success in the pilot. The proportion of subjects completing a debrief interview (n=17), did not differ by whether they were *spenders* or *savers* with 63% of *spenders* and 70% of *savers* returning for an interview, *t(31) = 1.22*, p = .233.

The majority of interviewees (12/17) explicitly reported positive feelings about the role CM vouchers in encouraging drug abstinence. Several themes emerged relating to potential pathways by which spending vouchers may have supported drug abstinence. Of the 17, 3 reported using CM voucher spending as a means to purchase a substitute for drugs. For example, one participant reported an early purchase of over-the-counter sleep medication in lieu of 'tik,' saying, "*I was trying to come clean, I was battling sleep and I know over the counter it's a quick easy thing to honestly do…[you take] two and you feel like chilled and relaxed. So, I was just looking for that chill*" while another stated that, "[*buying treats] is one of the biggest things that helped me - the fact that I had something to put in my mouth other than the wrong things.*" Almost all (15/17) talked about conceptualizing the voucher as a reward for staying clean, for which they were proud. As one participant shared, "*Having this - the vouchers- it was a different feeling, man…It was me like just patting myself – here's a reward now; you actually did well, actually in this week, and every week after that.*"

Almost all interviewees (16/17) reported having a goal they were saving for and 13 of them achieved this goal by week 8. However, participants with a spending goal still frequently spent their vouchers on non-goal-related items and many (11/17) reported that spending their vouchers allowed them to meet an immediate need (e.g. "*I didn't actually think of the tv very much* [goal purchase], *it was more I wanted to get the children things like their necessities*"). Participants (9/17) did report that the nature of how they spent and conceptualized voucher spending changed over the course of the 8 weeks. Initial purchases were often described as treats e.g. "[I started out buying] *the most things I craved for - ham, bacon, cheese and the custard, and the chocolate and chips*" and vouchers were viewed as rewards for staying clean, "*no one else had offered to give me something for [my] recovery, the period that I had to stay clean for, it was nice to be rewarded for it.*" Over time, several (7/17) reported that spending their vouchers was being used as a way to signal their success to others, e.g., "*I was boasting [to my family] - that's why they were so adamant on me taking them to [the grocery store] to see how much vouchers I had…I was proud when I received my vouchers. [The money] came from me; yes, [spending it] made me feel good.*" Spending the vouchers allowed them to signal that success both by providing for their families, e.g. "*Contributing to the home…that actually kept me [from using MA]…the feeling of a normal process and the feeling of gratitude when my mom says thank you,*" or by giving back to the community, e.g., "*I can say to my buddy, listen I'll come and we'll braai* [barbeque]. *I don't have money but I have (a voucher) so I can…buy the wood and I can buy the sausage. Let us braai.*" Many participants (11/17) also reported that spending the CM vouchers allowed them to strengthen their relationships, e.g. by taking their families grocery shopping with them, helping to contribute to the needs of lives of their partners, in-laws, children, and neighbors. The majority of participants (15/17) reported spending their vouchers on others, as well as on themselves (11/17), illustrating that immediate personal gratification may not have been a strong motivation in this population.

4.   Discussion

We show a partial cross-cultural replication of a relationship between spending behavior and drug abstinence among participants in a contingency management pilot trial for MA use disorder. In prior work, we found that spending, rather than saving, CM vouchers affected methamphetamine abstinence in a U.S. population of gay/bisexual male treatment-seekers (Ling-Murtaugh et al., 2013). Here, in a different population and geocultural region, we also found that spending CM vouchers in the previous period increased the probability of methamphetamine abstinence in the next period. We term this trend a *recency effect,* as the last expenditure made with CM vouchers was a more important contributor to methamphetamine abstinence than overall CM voucher spending behavior. In the U.S. study, participants with greater *cumulative* expenditures also had significantly greater odds of a methamphetamine abstinence at the following clinic visit. This finding was not replicated in the South African population. In both studies, the type of expenditure (hedonic, utilitarian, consumable, or durable) was not significantly associated with CM success.

In the South African population, we extended the previous U.S.-based analyses, by examining how recent spending interacts with only recent abstinent behavior, as opposed to overall abstinent behavior to date. The practical implication of doing this additional analysis is to account for the possible high correlation between addiction status and spending in any time period when predicting subsequent drug use. We show that spending in the prior time period is no longer significant when taking into consideration abstinence behavior in the time period just prior, but not considering overall abstinent behavior. This finding suggests that recent prior abstinent behavior (e.g. abstinence on a Monday) is the strongest predictor of current abstinent behavior (i.e. abstinence on a Wednesday). We also extend the U.S. work by asking participants to rate and discuss spending events in a qualitative debriefing interview. Our findings are suggestive that, among the South African study population, spending CM vouchers may operate to some degree through a substitutability mechanism, but may also help promote societal reintegration and feelings of self-worth. Overall, the current study presents additional evidence that spending CM vouchers in the recent prior time period, and not the specific type of the expenditure made, is predictive of drug abstinence in demographically and geoculturally-diverse populations. However, in the South African participant population, the effect of recent spending is only significant in the context of overall CM success (as measured through cumulative negative urines to date), but not recent success. The qualitative data suggests a nuanced and evolving role of how participants' spend their CM vouchers in the context of their larger abstinence journey that cannot be adequately captured by examining spending events in isolation.

One limitation to this study is our small sample. For example, a high correlation between cumulative cleans and cumulative expenditures in our small sample makes it difficult to examine the relationship between them. This can lead to falsely null results, which may explain why we were not able to replicate the U.S. finding that greater cumulative expenditures had significantly greater odds of a negative urine. A similar problem exists with having a high correlation between spending in the prior time period and having a negative urine sample in the prior time period. The simplest way to reduce the effect of the correlation between spending and clean urine results in the same time period would be to

randomly assign whether participants who are spending their CM vouchers actually receive the item they purchase. The ethical and affective considerations of this approach, however, present further challenges.

Even with a small sample size, we were able, with minimal attrition bias, to model the treatment effects on drug abstinence. This is because we had an extremely low rate of missing data on our dependent variable. The relatively high degree of adherence to treatment in this study (97% of possible urine samples were provided) compared to other CM studies (e.g., 63% in our US study population) is consistent with other high-value conditional incentive programs in low- to-moderate income countries and likely attributable to the fact that the overall potential earnings from this CM pilot are equivalent to approximately 10% of the monthly household income in Cape Town.

Given the limitation of our sample size, the conclusions that can be drawn from the model results depend, in part, on assumptions about the addiction process. If the state of addiction is best modeled as a cumulative process over time (as shown in Models 1-3 and assumed in the Ling-Murtaugh et al., 2013 paper), then there is a significant effect of spending in the recent time period on subsequent abstinent behavior. If, however, the addiction state is best modeled only by the most recent negative urine event, there appears to be no effect of spending in the prior time period. Cumulative negative urine counts are generally used in the field to categorize participants in CM treatment as "responsive" or not. Therefore, we interpret our results as supportive of a role of recent CM voucher spending behavior on abstinence among participants in this CM trial.

Another limitation is missing spending data. A risk to missing spending data, especially in a small sample, is that the missing data is directionally opposite to the observed data, i.e. all missing data would capture spending among those who had relapsed. However, in this sample, missing spending data in the time period was actually more likely among those who were drug abstinent at the next visit. It is notable that an analysis presented in the Supplemental materials (Table A.1) show that our results still hold true under a worst-case scenario, which imputes missing data (missing spending data captures "spending" and missing urine data captures "drug use"). The exception is that we also find a significant effect of spending on subsequent abstinence behavior when controlling for abstinence at just the prior visit (Table A.1, Model 4), i.e. in the supplemental analysis, the "recency" effect of spending holds for both assumptions about how to best model the addiction process.

The most pertinent limitation in our data is with respect to spending categorization analysis. Participants' judgments of the hedonic/utilitarian, durable/consumable value were made post-hoc at the debriefing interview. Not only might a post-hoc analysis risk inaccurate reflections on the part of the participant, but almost half of our study participants were lost to follow-up, which could result in selection bias. The overall rating of each spending event was calculated through an average rating across the combination of multiple items, limiting our ability to distinguish the reinforcing value of individual items at particular time points, as well as in real time.

We suspect that the financial constraints faced by our participants were responsible for the extremely high correlation between spending type categorizations. Many of the expenditures were on necessities (e.g. meat) but the vouchers allowed our participants to buy a higher quality of product than they usually would, conflating the utilitarian and hedonic values assigned to those expenditures. Many spending events were enacted on behalf of other people, making it more challenging for the participant to categorize them. It is likewise possible that the Likert-scale was not well-understood. As such, it is still unclear whether our null effect of spending type results are inconsistent with a pure substitutability effect or were just not strong enough to detect in this sample. While this study improved on the previous methodology by asking participants themselves to evaluate their spending events, a more precise design would capture participant's ratings for individual items during the spending event itself, as well as to later evaluate any remnant reinforcement of more durable goods bought in prior spending events.

The prediction of a positive effect of spending on drug abstinence arises from a theory of substitutability. While a pure substitutability theory (purchasing a pleasurable consumable item substitutes for purchasing a pleasurable consumable drug) is not borne out here, we suggest that spending, whether through the anticipation of the pleasure of the good that is acquired or some intrinsic joy in the act of spending, has an effect on subsequent abstinence through positive reinforcement. The repeated reward through multiple earning and spending events reinforces abstinent behavior. It is possible that a dispositional tendency to proactive behavior allows for both spending and abstinence. It is also possible that a third variable is responsible for enabling both CM voucher spending and the ability to maintain abstinence from time period to time period. Those with greater support infrastructure in place may be better able to access stores, may have more tangible spending goals, and may also be using that infrastructure to further their abstinence. Documenting this type of extended support network and access to resources such as transportation and grocery stores was not within the scope of the data collected for this study.

Our preliminary qualitative results do suggest some more nuanced mechanisms of reinforcement to the ones we hypothesized. Of the 17 participants who completed a debriefing interview, many reported using the purchases made by CM payment spending to treat themselves, their families, and friends, as a celebration of remaining drug-abstinent prior, as well as a social signal to others in their immediate family and larger community that they were succeeding in their aims. Thus, the empowerment of being able to spend, rather than the spending itself, could be initially serving as a reinforcer for an anticipated drug-negative urine sample and strengthen resolve to be drug-abstinent at the next day's visit. Many participants also reported a feeling of pride at being able to earn vouchers, which allowed them to financially contribute to the households they live in. This may have served as another form of positive reinforcement, distinct from the nature of the purchases on which they spent their vouchers, that strengthened interpersonal relationships. The resulting reintegration into their community from these improved social connections may, in turn, have played an important role in continued abstinence, with reinforcement eventually being replaced by social support.

Participants consistently reported that the nature of how they spent and conceptualized spending changed over the course of the 8 weeks, indicating that the relationship between spending and staying abstinent is dynamic as participants progress in the trial. While the "high" of a positive affective experience could theoretically be viewed as a drug substitute, the two experiences are qualitatively very different. MA use is associated with social stigma and social isolation in South Africa. Our qualitative findings suggest that voucher spending was often a social affair. This is consistent with other qualitative work in the region, in which financial incentives for ART adherence were viewed as having important emotional benefits, whereby patients felt appreciated and cared for (Greene, Pack, Stanton et al, 2017).

We should highlight the preliminary nature of the qualitative interviews. Only 17 of the 33 participants completed a debriefing interview, limiting the generalizability of the qualitative work to the larger sample. While there were no measurable differences between those who participated in the interview and those lost to follow-up, it is possible that those who were not reachable were less reintegrated into society after completing the CM pilot. However, this number of debriefing interviews is consistent with those required to capture the breadth of mental models associated with health-related decision making (e.g. see Krishnamurti, Eggers, & Fischhoff, 2008) and, as such, offers a starting point for further exploring psychological mechanisms attached to spending behavior in CM.

A final limitation of this study was our inability to measure each participant's larger economic portfolio. It is possible that participants used study earnings for spending on items that did not act as substitutes and used other income to buy substitutes instead. It is also possible that abstinence itself is driving the spending behavior, either by freeing up resources or time that would otherwise be spent on purchasing 'tik.' The psychological mechanisms by which spending affects drug abstinence may also alter over the course of the study, which is intimated in our qualitative data, but not possible to explore in greater detail with only a single debriefing interview.

5. Conclusions

Spending behavior is associated with subsequent negative urine provision in a contingency management pilot in a South African population of treatment-seekers for methamphetamine use disorder. Results from this study largely replicate those from a population of treatment-seekers in the U.S., in which redeeming, rather than receiving, contingency management vouchers supported methamphetamine abstinence. Initial qualitative data insights suggest that the act of spending vouchers may offer more than a drug substitute in this South African study population; ultimately encouraging drug abstinence through encouraging social reintegration. Overall, our findings do lend further support to the idea that the act of voucher redemption is tied to successful contingency management interventions among those seeking treatment in diverse cultural groups.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

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Highlights

- Drug abstinence outcomes are a function of contingency management voucher spending

- *Spenders* were more likely to produce stimulant-negative urines compared to *savers*

- Contingency management spending is associated with drug abstinence in South Africa

- Qualitative findings suggest ways spending may reinforce drug use abstinence

Table 1.

Summary of Time-lagged Counting Process Cox Proportional Hazards Models for Predicting Methamphetamine Abstinence at Any Given Study Visit

Variable	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 4 OR (95% CI)
Cumulative successful earning days "wealth" (negative urines)	2.09 * (1.69, 2.59)	2.09 * (1.70, 2.60)	1.66 * (1.33, 2.12)	
Cumulative expenditures (total R spent to date)		1.00 (.993, 1.00)	0.99 (0.98, 1.00)	1.00 (.992, 1.00)
Spending in prior time period (t-1), i.e. "spender"			1.23 * (1.08, 1.53)	1.02 (0.94, 1.11)
Recent successful earning day (negative urine in prior time period, t-1)				6.02 * (4.32, 8.38)
N_observations	736	703	498	498
N_events	599	567	443	443
N_Missing †	23	56	261	261

*
p<.05

†
spending data was responsible for a large proportion of the missingness