

Emerging Need to Study Acoustic and Biomarkers (EEG) in Predicting Substance Use Relapse: A Brief Report

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Abstract : The current study aims to highlight specific voice parameters which could be seen more prominently in the cases of substance use relapse as compared to the non-relapse cases. The current study tries to present the possibilities of relapse in the cases of substance use based on voice samples. As literature suggests a strong correlation of neural markers in substance use, current study also considers EEG excerpt as a biomarker to postulate, strengthened and substantiate findings. The major aim of the study is to explore accuracy of Layered Voice Analysis (LVA) as an objective tool in predicting its clinical utility.

Key words : Acoustic markers, substance use relapse, layered voice analysis

Introduction

In 2019, Ministry of Social Justice and Empowerment of India released a survey report, where a household survey of total 200,111 participants across 36 states and UTs was conducted. In this survey 72,642 individuals (aged 18-75 years) of people were found with drug dependence. Drug influence was found to be most in the males of northern and eastern zones of India followed by southern and western zones (Ambekar et al, 2019). Despite several de-addiction and rehabilitation centers, a major challenge before the society is dealing with its relapse which is highly probable due to its addictive properties which is confirmed in several studies (Decker et al, 2017; Andresson et al, 2019; Moeller & Paulus, 2019). Keeping in view a huge rate of relapse in substance use, the current study plans to target exploration of Indian population.

In the past two decades, substance abuse has emerged as a strong phenomenon affecting all the segments of Indian society (Sahu&Sahu 2012). According to WHO report of 2019, 31 million persons are suffering from drug related disorders. Substance use has been identified as a serious problem targeting public health. The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, commonly known as DSM-5, which is published by American Psychological Association in May 2013, defines substance use as a group of disorders where it identifies ten separate categories of drugs having potential to result into

substance use disorders. These are- caffeine, tobacco, cannabis, hallucinogens, opioids, alcohol, inhalants, sedatives, stimulants and other unidentified substances. These substances have potential to produce adverse neurobiological, cognitive, psychological, behavioural, social and legal consequences and are highly associated with major mental health and social disturbances resulting in crime ranging from mild to heinous. The basis of targeting male sample in this proposed study is a higher prevalence rate of substance use in male population (European Monitoring Centre for Drugs and Drug Addiction, 2005; Thibaut, 2018).

The recent studies show strong evidence of substance use related rising crime in India. This includes pathological gambling (Sarkar, 2012), suicide (Reddy, 2019) physical abuse, child abuse, sexual assault (Sharma, 2018). These observations are found prevalent worldwide where substance use has been found associated with criminal conduct (Cheon et al, 2017; Bennet et al, 2008). Drug use and delinquent offending is also evidenced in the earlier studies (Johnson et al, 1991). Avasthi and Ghosh (2019) supports that drug use in India has significantly grown in the past two to three decades where natural substances have been replaced by non-natural or synthetic substances (Avasthi et al, 2019).

The proposed study plans to identify the acoustic markers in the patients of substance abuse which can predict the possibilities of relapse in such patients. India has a high rate of male population suffering from substance abuse and also their subsequent involvement in anti-social and criminal activities. Therefore this study suggests to assess the possibilities of relapse so that the government bodies can take necessary steps to control the re-occurrence of substance use and the related crime.

There are several research studies conducted on substance use and its association with various crimes and delinquency (Skjærvø et al, 2017; McKetin et al, 2020; Sutherland et al, 2015; Walters, 2018; Fearn et al, 2016; Craig et al, 2019). As mentioned earlier about the problem of relapse which has been much studied in terms of biomarkers and neuroimaging including EEG, ERP etc. (Moeller & Paulus, 2019; Hanlon et al, 2016; Houston et al, 2018; Tokko et al, 2019), an exploratory work is intended to find out other psychophysiological parameters which might be of great importance.

Layered voice analysis instrument is a scientific tool which has been proved to be effective in forensic investigations which aids to find out possibilities of deception by voice samples of suspects. This tool has also been used in clinical studies; however substantial literature base is still awaited. Vocal acoustic properties are still unexplored in such cases while predicting relapse. However, the literature concerning the voice acoustic properties in other psychiatric disorders such as depression (Espinola et al, 2020; Hashim et al, 2017; Cummins et al, 2015), bipolar disorder (Gideon et al, 2016), schizophrenia (Compton et al, 2018; Chakraborty et al, 2018) and other mental health disorders (Cogen et al, 2019; Daly et al, 2015) is widely available. Therefore keeping in mind a strong comorbidity of substance use

with mental disorders and antisocial patterns (Walker, 2017; Lehman & Dixon, 2016; Mir et al, 2015; Peters, 2015; Auerbach et al, 2016), the current study proposes to assess vocal acoustic markers in predicting relapse in substance use, using EEG as an additional aid to corroborate the findings.

On the other hand EEG studies are also available pertaining to substance use. EEG has been used as a diagnostic and screening tool in substance use where it has assured of related abnormalities (Mumtaz et al, 2018; Mumtaz et al., 2017). In a recent neuroimaging study on predicting relapse in substance use where a weakened functional connectivity of corticolimbic and corticostriatal brain regions were found of significant importance along with reduced gray and white matter volume and connectivity in prefrontal regions (Moeller & Paulus, 2018). In this study, addiction has been studied in terms of initiation to the prediction of relapse. Results indicated that response inhibition and its underlying neural correlates predict both substance use outcomes in terms of onset and abstinence. Roles of frontal cortex were explored such as, inferior frontal gyrus, dorsal anterior cingulate cortex, and dorsolateral prefrontal cortex.

Furthermore it was found that under activation of these brain regions during response inhibition predicted not only the onset of substance use, but also better abstinence among addicted individuals. However, the significant role of subcortical areas is still unclear because of inconsistent results and also that these regions are less classically reported in studies of healthy response inhibition. A conclusion was drawn that response inhibition is not only significant in current substance addiction, but rather a core neurocognitive dimension that predicts key substance use outcomes. They also concluded that early intervention in inhibitory deficits could have a great significance and relevance in clinical and public health. The prediction regarding relapse has been explored in various aspects such as social bonding and social interest, where internal and external vulnerability factors have been explored (Giordano et al, 2014). Duration in relapse is also explored (Naderi, 2008). Apart from this, role of socio cultural factors have also been explored where family, perceived social support and expressed emotions were also found to have role (Atadokht et al, 2015). Lack of proper communication with the family members (single individuals) and lack of understanding and maltreatment of husband, wife, and children (married individuals) was found as an important factor in addiction relapse (Din Mohammadiv et al., 2007).

fMRI studies have also suggested significant findings. In a study on personality measures and striatal and insular activity during reward-processing in terms of relapse, it was explored that neuroimaging can be developed in combination with other measures as an instrument to predict relapse (Gowin et al, 2015). High risk situations for relapse for self-referred addicts has also been explored where unpleasant emotions and physical discomfort was found to be the most important reason for relapse and whereas, pleasure emotions were

found to be the least important reason (Shafiei et al, 2014). 369

In India studies have been conducted encompassing the factors responsible for relapse in substance use (Mattoo et al, 2009; Sau et al, 2013; Sharma, 2012), interventions in relapse (Rentala et al, 2020), long term outcome (Singh et al, 2008), effects of injection cessation (Mehta, 2012), coping behaviours in relapse (Maulik et al, 2002) etc. The relapse vulnerability is explained by Sinha (2011) where it was explored in terms of biological and clinical connotations.

Although, an extensive research is still awaited regarding clinical use of LVA, there are few studies which have been conducted in various countries concerning the use of LVA in clinical and organizational domains. In a study authors analyzed managerial affective states by using conference call audios in which a vocal emotion analysis was done. They generated new evidence that their linguistic content provides useful information (Mayew& Venkatachalam 2011). Another study on adult ADHD was conducted by Bloch et al. (2015) on prosody production which relates with both, emotional and cognitive state of the speaker and to the task being performed where they found significant changes in ADHD females. Construction of a communication system based on emotional synchronization was also explored where effectiveness was verified by experiments in human-robot communication (Usui at al., 2008).

Implicating the use of LVA in assessing global stress level, it was established that the propriety voice generated global stress parameter might serve as an indicator of a stress level in a setting with controlled background noise. Another study determining the personality traits with the use of LVA concluded a significant correlation between emotional factors and personality traits (Manchireddy et al, 2010). Also, in the domain of very common psychiatric disorders such as anxiety and depression LVA is found useful. In a study on evaluation of symptoms of depression and anxiety, correlations were observed among various parameters, psychological and physiological indexes. LVA was found to be a reliable technology in the assessment of depression and anxiety. Use of LVA in detection of cognitive dissonance was investigated in Duke University and they concluded that vocal cues are successful at identifying misreporting in a laboratory setting. Voice analysis is able to detect emotions stemming from this dissonance and successfully classify individuals as misreports or truth-tellers 71% of the time (Hobson et al, 2010).

Role of LVA in analyzing cognitive dissonance was further established by Elkins in 2011 who further with his associates partially confirmed LVA role in security screening (Elkins et al, 2012).. In a study by Conradie in University of South Africa on pedophilia, it was concluded that LVA technology is a sophisticated linguistic tool to access what goes on in the mind of the pedophile and it does have the capacity to unravel his mind. The information it can unearth about the paedophile (thinking levels, emotional levels, risk factors, sexual arousal) is invaluable for the investigator, the court, the therapist and the correctional officer. Study

was conducted on interaction between signaler and recipient and identifies the circumstances under which people feel more or less embarrassed in response to a compliment on a product. By measuring participants' emotional reaction with the LVA technology, authors believed that they were able to capture less biased emotional measures than self-reports (Han et al, 2010).

Conclusion

This study suggests use of novel parameters of assessing and predicting relapse in substance abuse population such as Layered voice analysis instrument and EEG markers. Substance use related crime rate is very much prevalent in India. The government of India has devised many programs to eradicate the current conditions but a need for improvement and more research is needed in this area. Looking at the current circumstances where the drug use is highly associated with criminal and antisocial conduct in the Indian society, a need to know the effectiveness of current programs is felt which can be assessed by knowing the probability of relapse in substance use cases.

References

1. Ambekar A, Agrawal A, Rao R, Mishra AK, Khandelwal SK, Chadda RK on behalf of the group of investigators for the National Survey on Extent and Pattern of Substance Use in India (2019). *Magnitude of Substance Use in India*. New Delhi: Ministry of Social Justice and Empowerment, Government of India.
2. Andersson, H. W., Wenaas, M., & Nordfjærn, T. (2019). Relapse after inpatient substance use treatment: a prospective cohort study among users of illicit substances. *Addictive behaviors*, 90, 222-228.
3. Atadokht, A., Hajloo, N., Karimi, M., & Narimani, M. (2015). The role of family expressed emotion and perceived social support in predicting addiction relapse. *International journal of high risk behaviors & addiction*, 4(1).
4. Auerbach, R. P., Alonso, J., Axinn, W. G., Cuijpers, P., Ebert, D. D., Green, J. G., ... & Nock, M. K. (2016). Mental disorders among college students in the World Health Organization world mental health surveys. *Psychological medicine*, 46(14), 2955-2970.
5. Avasthi A, Basu D, Subodh BN, Gupta PK, Goyal BL, Sidhu BS, et al. Epidemiology of dependence on illicit substances, with a special focus on opioid dependence, in the state of Punjab, India: Results from two different yet complementary survey methods. *Asian J Psychiatr*. 2019;39:70-9.
6. Avasthi, A., & Ghosh, A. (2019). Drug misuse in India: Where do we stand & where to go from here? *The Indian journal of medical research*, 149(6), 689.

7. Bennett, T., Holloway, K., & Farrington, D. (2008). The statistical association between drug misuse and crime: A meta-analysis. *Aggression and Violent Behavior*, 13, 107-118.
8. Bloch, Y., Aviram, S. Neeman, R., Braw, Y., Nitzan, U., Maoz, H. & Mimouni-Bloch, A. (2015). Methylphenidate mediated change in prosody is specific to the performance of a cognitive task in female adult ADHD patients. *The World Journal of Biological Psychiatry*, 2015; Early Online: 1-5.
9. Chakraborty, D., Xu, S., Yang, Z., Chua, Y. H. V., Tahir, Y., Dauwels, J., ... & Keong, J. L. C. (2018, October). Prediction of negative symptoms of schizophrenia from objective linguistic, acoustic and non-verbal conversational cues. In *2018 International Conference on Cyberworlds (CW)* (pp. 280-283). IEEE.
10. Cheon, H., Decker, S. H., & Katz, C. M. (2018). Medical marijuana and crime: Substance use and criminal behaviors in a sample of arrestees. *Journal of Drug Issues*, 48(2), 182-204.
11. Cohen, A. S., Fedechko, T. L., Schwartz, E. K., Le, T. P., Foltz, P. W., Bernstein, J., ... & Elvevåg, B. (2019). Ambulatory vocal acoustics, temporal dynamics, and serious mental illness. *Journal of abnormal psychology*, 128(2), 97.
12. Compton, M. T., Lunden, A., Cleary, S. D., Pauselli, L., Alolayan, Y., Halpern, B., ... & Bernardini, F. (2018). The aprosody of schizophrenia: Computationally derived acoustic phonetic underpinnings of monotone speech. *Schizophrenia research*, 197, 392-399.
13. Craig, J. M., Intravia, J., Wolff, K. T., & Baglivio, M. T. (2019). What can help? Examining levels of substance (non) use as a protective factor in the effect of ACEs on crime. *Youth violence and juvenile justice*, 17(1), 42-61.
14. Cummins, N., Sethu, V., Epps, J., Schnieder, S., & Krajewski, J. (2015). Analysis of acoustic space variability in speech affected by depression. *Speech Communication*, 75, 27-49.
15. Daly, I., Williams, D., Hallowell, J., Hwang, F., Kirke, A., Malik, A., ... & Nasuto, S. J. (2015). Music-induced emotions can be predicted from a combination of brain activity and acoustic features. *Brain and cognition*, 101, 1-11.
16. Decker, K. P., Peglow, S. L., Samples, C. R., & Cunningham, T. D. (2017). Long-term outcomes after residential substance use treatment: Relapse, morbidity, and mortality. *Military medicine*, 182(1-2), e1589-e1595.
17. Din Mohammadi MR, Amini K, YazdanKhah MR. Survey of social and environmental factors related to the relapse of addiction in volunteer addicted individuals in welfare organization of Zanjan. *J Zanjan Univ Med Sci*. 2007;15(59):85-94.
18. Elkins, A. C. (2011). Vocalic markers of deception and cognitive dissonance for

- automated emotion detection systems.
19. Elkins, A. C., Burgoon, J., & Nunamaker, J. (2012). Vocal analysis software for security screening: Validity and deception detection potential. *Homeland Security Affairs*, 8, 17.
 20. Espinola, C. W., Gomes, J. C., Pereira, J. M. S., & dos Santos, W. P. (2020). Detection of Major Depressive Disorder Using Vocal Acoustic Analysis and Machine Learning. *medRxiv*.
 21. European Monitoring Centre for Drugs and Drug Addiction (2005). www.emcdda.europa.eu
 22. Fearn, N. E., Vaughn, M. G., Nelson, E. J., Salas-Wright, C. P., DeLisi, M., & Qian, Z. (2016). Trends and correlates of substance use disorders among probationers and parolees in the United States 2002–2014. *Drug and alcohol dependence*, 167, 128–139.
 23. Gideon, John, Emily Mower Provost, and Melvin McInnis. "Mood state prediction from speech of varying acoustic quality for individuals with bipolar disorder." *2016 IEEE international conference on acoustics, speech and signal processing (ICASSP)*. IEEE, 2016.
 24. Giordano, A. L., Clarke, P. B., & Furter, R. T. (2014). Predicting substance abuse relapse: The role of social interest and social bonding. *Journal of Addictions & Offender Counseling*, 35(2), 114–127
 25. Gowin, J. L., Ball, T. M., Wittmann, M., Tapert, S. F., & Paulus, M. P. (2015). Individualized relapse prediction: Personality measures and striatal and insular activity during reward-processing robustly predict relapse. *Drug and alcohol dependence*, 152, 93–101.
 26. Han, Y., & Nunes, J. (2010). Read the Signal But Don't Mention It: How Conspicuous Consumption Embarrasses the Signaler. *ACR North American Advances*.
 27. Hanlon, C. A., Dowdle, L. T., & Jones, J. L. (2016). Biomarkers for success: using neuroimaging to predict relapse and develop brain stimulation treatments for cocaine-dependent individuals. In *International review of neurobiology* (Vol. 129, pp. 125–156). Academic Press.
 28. Hashim, N. W., Wilkes, M., Salomon, R., Meggs, J., & France, D. J. (2017). Evaluation of voice acoustics as predictors of clinical depression scores. *Journal of Voice*, 31(2), 256–e1.
 29. Hobson, J. L., Mayew, W. J., & Venkatachalam, M. (2012). Analyzing speech to detect financial misreporting. *Journal of Accounting Research*, 50(2), 349–392.
 30. Manchireddy, B., Sadaf, S., Kamalesh, J. (2010). Layered Voice Analysis Based Determination of Personality Traits. *Australasian Medical Journal*, 3, 8, 521–522.

31. Houston, R. J., & Schlienz, N. J. (2018). Event-related potentials as biomarkers of behavior change mechanisms in substance use disorder treatment. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging*, 3(1), 30-40.
32. Johnson, B. D., Wish, E. D., Schmeidler, J., & Huizinga, D. (1991). Concentration of delinquent offending: Serious drug involvement and high delinquency rates. *The Journal of Drug Issues*, 21, 205-229.
33. Lehman, A. F., & Dixon, L. (Eds.). (2016). *Double jeopardy: Chronic mental illness and substance use disorders*. Routledge.
34. Mattoo, S. K., Chakrabarti, S., & Anjaiah, M. (2009). Psychosocial factors associated with relapse in men with alcohol or opioid dependence. *Indian J Med Res*, 130(6), 702-8.
35. Maulik, P. K., Tripathi, B. M., & Pal, H. R. (2002). Coping behaviors and relapse precipitants in opioid dependence: a study from North India. *Journal of substance abuse treatment*, 22(3), 135-140.
36. Mayew, W.J. & Venkatachalam, M. (2011). The Power of Voice: Managerial Affective States and Future Firm Performance. *Journal of Finance*, Forthcoming, Available at SSRN: ssrn.com
37. McKetin, R., Boden, J. M., Foulds, J., Najman, J. M., Ali, R., Degenhardt, L., ... & Weatherburn, D. (2020). The contribution of methamphetamine use to crime: Evidence from Australian longitudinal data. *Drug and Alcohol Dependence*, 108262.
38. Mehta, S. H., Sudarshi, D., Srikrishnan, A. K., Celentano, D. D., Vasudevan, C. K., Anand, S., & Solomon, S. S. (2012). Factors associated with injection cessation, relapse and initiation in a community-based cohort of injection drug users in Chennai, India. *Addiction*, 107(2), 349-358.
39. Mir, J., Kastner, S., Priebe, S., Konrad, N., Ströhle, A., & Mundt, A. P. (2015). Treating substance abuse is not enough: comorbidities in consecutively admitted female prisoners. *Addictive Behaviors*, 46, 25-30.
40. Moeller, S. J., & Paulus, M. P. (2018). Toward biomarkers of the addicted human brain: using neuroimaging to predict relapse and sustained abstinence in substance use disorder. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, 80, 143-154.
41. Moeller, S. J., & Paulus, M. P. (2018). Toward biomarkers of the addicted human brain: using neuroimaging to predict relapse and sustained abstinence in substance use disorder. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, 80, 143-154.
42. Mumtaz, W., Vuong, P. L., Malik, A. S., & Abd Rashid, R. B. (2018). A review on EEG-based methods for screening and diagnosing alcohol use disorder. *Cognitive neurodynamics*, 12(2), 141-156.

43. Mumtaz, W., Vuong, P. L., Xia, L., Malik, A. S., & Abd Rashid, R. B. (2017). An EEG-based machine learning method to screen alcohol use disorder. *Cognitive neurodynamics*, 11(2), 161-171.
44. Naderi SH, Bina Zadeh M, Sefatian S. 1 ed. Tehran: Medical Council Organization; 2008.
45. Peters, R. H., Wexler, H. K., &Lurigio, A. J. (2015). Co-occurring substance use and mental disorders in the criminal justice system: A new frontier of clinical practice and research.
46. Reddy, V. E. N. K. A. T. A. S. H. I. V. A. (2019). Mental health issues and challenges in India: A review. *International Journal of Social Sciences Management and Entrepreneurship (IJSSME)*, 3(2).
47. Rentala, S., Ng, S. M., Chan, C. L., Bevoor, P., Nayak, R. B., & Desai, M. (2020). Effect of holistic relapse prevention intervention among individuals with alcohol dependence: a prospective study at a mental health care setting in India. *Journal of Ethnicity in Substance Abuse*, 1-21.
48. Sahu, K. K., &Sahu, S. (2012). Substance abuse causes and consequences. *Bangabasi Academic Journal*, 9, 52-61.
49. Salganik, I., De Vries, A., Intrater, S. &Sheizaf, O. (2006). LVA Computerized Global Stress Readings as a Function of Task Induced Stress. Working paper, Nemesysco Ltd. Retrived from citeseerx.ist.psu.edu
50. Sarkar, S., Singh Balhara, Y. P., Parmar, A., &Rajhans, P. (2018). A study of pathological gambling and its correlates among patients seeking treatment for substance use disorders in North India. *Journal of Substance Use*, 23(2), 193-198.
51. Sau, M., Mukherjee, A., Manna, N., &Sanyal, S. (2013). Sociodemographic and substance use correlates of repeated relapse among patients presenting for relapse treatment at an addiction treatment center in Kolkata, India. *African Health Sciences*, 13(3), 791-799.
52. Seitz, N. N., Lochbühler, K., Atzendorf, J., Rauschert, C., Pfeiffer-Gerschel, T., & Kraus, L. (2019). Trends in substance use and related disorders: Analysis of the epidemiological survey of substance abuse 1995 to 2018. *DeutschesÄrzteblatt International*, 116(35-36), 585.
53. Shafiei, E., Hoseini, A. F., Bibak, A., &Azmal, M. (2014). High risk situations predicting relapse in self-referred addicts to bushehr province substance abuse treatment centers. *International journal of high risk behaviors & addiction*, 3(2).
54. Sharma, A. K., Upadhyaya, S. K., Bansal, P., Nijhawan, M., & Sharma, D. K. (2012). A study of factors affecting relapse in substance abuse. *Education*, 2(17.033), 17-033.
55. Sharma, r. K. (2018). Child abuse in india: problems, concerns, policies & legal provisions. *International Journal of Technical Research and Applications*,6,2, 15-20.

56. Singh, S. M., Mattoo, S. K., Dutt, A., Chakrabarti, K., Nebhinani, N., Kumar, S., & Basu, D. (2008). Long-term outcome of in-patients with substance use disorders: A study from North India. *Indian journal of psychiatry*, 50(4), 269.
57. Skjærvø, I., Skurtveit, S., Clausen, T., & Bukten, A. (2017). Substance use pattern, self-control and social network are associated with crime in a substance-using population. *Drug and alcohol review*, 36(2), 245-252.
58. Sutherland, R., Sindicich, N., Barrett, E., Whittaker, E., Peacock, A., Hickey, S., & Burns, L. (2015). Motivations, substance use and other correlates amongst property and violent offenders who regularly inject drugs. *Addictive behaviors*, 45, 207-213.
59. Thibaut, F. (2018). Gender Differences in Addiction: Clinical Implications. *Psychiatric Times*, *Psychiatric Times Vol 35, Issue 11*. Retrieved from: www.psychiatrictimes.com.
60. Tokko, T., Eensoo, D., Vaht, M., Lesch, K. P., Reif, A., & Harro, J. (2019). Relapse of drunk driving and association with traffic accidents, alcohol-related problems and biomarkers of impulsivity. *Acta neuropsychiatrica*, 31(2), 84-92.
61. Usui, T., Kume, K., Yamano, M. & Hashimoto, M. (2008). A Robotic KANSEI Communication System Based on Emotional Synchronization. *IEEE/RSJ International Conference on Intelligent Robots and Systems Acropolis Convention Center Nice, France, Sept, 22-26, 2008*
62. Walker, E. R., & Druss, B. G. (2017). Cumulative burden of comorbid mental disorders, substance use disorders, chronic medical conditions, and poverty on health among adults in the USA. *Psychology, health & medicine*, 22(6), 727-735.
63. Walters, G. D. (2018). Does drug use inhibit crime deceleration or does crime inhibit drug use deceleration? A test of the reciprocal risk postulate of the worst of both worlds hypothesis. *Substance use & misuse*, 53(10), 1681-1687.