

An Examination of the Validity of the Standardized Field Sobriety Test (SFST) in Detecting Drug Impairment

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Abstract

Background and Aims

The purpose of this study was to assess the validity of the three components of the SFST — Horizontal Gaze Nystagmus (HGN), One Leg Stand (OLS), and Walk and Turn (WAT) — in identifying drug impairment.

Methods

Data from 2,142 completed Drug Evaluation and Classification cases involving central nervous system (CNS) stimulants, CNS depressants, narcotic analgesics (NA), cannabis or no drugs were analyzed using multinomial logistic regression.

Results

All four drug categories showed signs of impaired performance on the SFST. On the HGN test, users of CNS depressants were significantly more likely to experience lack of smooth pursuit and distinct nystagmus at maximum deviation compared to those who did not use drugs. On the OLS test, users of all four drug classes were significantly more likely to sway while balancing and use their arms to maintain balance, but were less likely to hop, as compared to drug-free cases. Users of CNS depressants, CNS stimulants and NA were also significantly more likely to put their raised foot down during the test. On the WAT test, users of CNS depressants, CNS stimulants and NA were less likely to keep their balance while listening to the test instructions compared to those who had not used drugs. Users of CNS depressants were less likely to touch heel-to-toe while walking, whereas individuals who had used NA were less likely to take the correct number of steps.

Discussion and Conclusions

These findings provide support for the use of the SFST as a screening tool for law enforcement to identify impairment in persons who have used CNS stimulants, CNS depressants, cannabis or NA. This work will have direct and immediate relevance to the training of police officers and will facilitate the enforcement of drug-impaired driving laws.

Background

The SFST has been widely implemented across Canada, the United States, and parts of Australia. Individual components of the battery have also been incorporated into the field impairment testing procedures used in many other countries, including the Drug Evaluation and Classification (DEC) program to detect impairment due to drugs (International Association of Chiefs of Police, 1999). Although the SFST is sensitive to alcohol impairment, few studies have assessed the test's ability to accurately detect drug-related impairment. The validity of using the SFST as part of the DEC program has to a large extent been inferred from studies of the overall accuracy of the DEC program to identify persons impaired by drugs other than alcohol. The

problem with this approach is that the DEC program employs a much wider range of tests and measurements than the three tests of the SFST to identify drug impairment.

A group of researchers (Downey et al., 2012; Papafotiou et al., 2005a,b; Silber et al., 2005) in Australia have conducted a series of studies to determine the sensitivity of the SFST in detecting impairment due to substances other than alcohol. For instance, Silber et al. (2005) examined the effect of low doses of amphetamines on SFST performance at 120 and 170 minutes after ingesting the drug. None of the three amphetamines showed any evidence of impairment on the SFST.

Downey and colleagues (2012) explored the effects of MDMA and methamphetamine on SFST performance 4 and 25 hours following drug ingestion. Although methamphetamine was not found to impair performance on the SFST, the results showed that MDMA significantly impaired overall performance of the SFST in comparison to the placebo condition, with 22% of the participants being deemed impaired on two or more components of the SFST 4 hours post-drug consumption.

Papafotiou and colleagues (2005a,b) conducted two studies that assessed whether performance on the SFST provided a sensitive measure of impaired driving behaviour following the administration of either a low (1.74%) or high dose (2.93%) of THC. In the first study (Papafotiou, 2005a), participants performed a driving simulation task and the three components of the SFST. Results showed that driving performance was significantly impaired 80 minutes after the consumption of THC, while performance on the SFST correctly identified up to 76% of participants as being either impaired or not impaired. Papafotiou et al.'s (2005b) second study involved a more thorough examination of the three components of the SFST after administration of the same high or low dose of cannabis as used previously. The researchers also recorded head movement or jerks (HMJ) as a potential indicator of cannabis impairment. Findings revealed a positive relationship between the dose of THC administered and the number of participants classified as impaired. The inclusion of HMJ increased the number of subjects deemed to be impaired. Interestingly, lack of smooth pursuit (the first stage of HGN) was significantly related to cannabis use 55 and 105 minutes following administration of the drug, but not 5 minutes after cannabis smoking. This result is inconsistent with the DEC protocol as the only drug categories known to produce HGN are depressants, inhalants and dissociative anaesthetics. The authors noted that blood samples in their study were only tested for THC and as such, it is possible that the lack of smooth pursuit displayed by the participants may have occurred as the result of their consumption of drugs other than cannabis. Papafotiou and colleagues (2005b) also reported that subjects' performance on the WAT test was significantly related to THC condition, with two signs of this test being observed at all times: no balance and using arms to balance. Three signs of the WAT test were found to be unrelated to the level of THC during all administrations of this test, including misses heel to toe, improper turn, and incorrect number of steps. The authors also suggested that the OLS test provided the best indicator of impairment associated with the administration of THC.

Finally, Bosker and colleagues (2012) assessed the effects of smoking cannabis with and without alcohol on SFST performance in a study of heavy cannabis users. The results from this investigation showed that cannabis use (dose of 400 µg/kg body weight THC) was significantly

related to impairment on the OLS test, whereas impairment on the HGN test only approached statistical significance. When cannabis was combined with alcohol (BACs of 50 and 70 mg/dL), participants' performance on the HGN was significantly impaired. Performance on the WAT test was not found to be impaired by cannabis either alone or in combination with alcohol.

Aims

The objective of this study was to examine data from the components of the SFST that are recorded during DEC evaluations to assess the validity of the three components of the SFST — Horizontal Gaze Nystagmus (HGN), One Leg Stand (OLS), and Walk and Turn (WAT) — in identifying impairment among suspected drug-impaired drivers.

Methods

Data from 2,142 DEC evaluations conducted across Canada involving a single drug category that were conducted during 1995-2009 were used in this study. Four classes of drugs were represented in this set of evaluations, including CNS stimulants ($n = 852$), CNS depressants ($n = 135$), NA ($n = 312$), and cannabis ($n = 703$). There were also 140 “no-drug” cases whereby the opinion of the evaluator was that the suspect was not under the influence of any drug and no drug was found as a result of toxicological analysis of the bodily fluid sample provided. Both of these criteria had to be met in order to be classified as a no-drug case.

Standardized Field Sobriety Test

Data from the DEC evaluations on the three tests that comprise the SFST battery were analyzed for their potential association with the four drug categories. These three tests are briefly summarized below.

Horizontal Gaze Nystagmus Test

HGN is an involuntary jerking of the eye that occurs naturally as the eyes gaze to the side. HGN is exacerbated by certain classes of drugs. During the HGN test, the eyes of an individual are observed as the individual follows a slowly moving object, such as a pen, horizontally with his or her eyes as it is moved from side to side. The officer separately observes the left and right eye for three signs: lack of smooth pursuit (present, absent); distinct nystagmus at maximum deviation (present, absent); and nystagmus onset before 45° (present, absent).

One Leg Stand Test

In this test, the individual is instructed to stand with one foot approximately 15 cm off the ground and count aloud from 1,000 (1,000, 1,001, 1,002, etc.) for 30 seconds. There are four signs from the OLS test that are scored: swaying while balancing on one leg; using arms to maintain balance; hopping during test; and putting the raised foot down.

Walk and Turn Test

In the WAT test, the participant is directed to take nine steps, heel-to-toe, along a straight line. After taking the nine steps, the participant must turn on one foot and return in the same manner in the opposite direction. There are eight signs of impairment that can be observed during this test: could not keep balance while listening to the test instructions; started the test before the instructions were completed; stopped walking during the test; did not touch heel-to-toe while

walking; stepped off the line; used arms to maintain balance; took the incorrect number of steps; and turned improperly (i.e., not as demonstrated).

Data analysis

A series of multinomial logistic regression analyses were performed to assess the prediction of drug category from the various signs observed during the SFST battery. Separate analyses were conducted for each of the three components of the SFST. Classification rates for the outcome categories were also calculated as part of the analyses as they provide an estimate of the success of the model in correctly predicting the outcome category for cases for which the outcome is known.

Results

Prediction of Drug Category from Performance on Horizontal Gaze Nystagmus Test

A multinomial logistic regression analysis was performed to assess the prediction of drug category from performance on the HGN test. Results indicated that the set of three signs from the HGN test significantly distinguished the four drug categories of CNS stimulants, CNS depressants, NA and cannabis from the no-drug cases, $\chi^2(12, N = 2,142) = 442.65, p < .0001$. The classification rate for these drug categories was 42.2%; that is, less than half of all cases were correctly classified based on the inclusion of these three signs from the HGN test. The classification rate was 94.6% for CNS stimulants, 70.1% for CNS depressants, 0% for NA, and 1% for cannabis. As a follow-up to the overall multinomial logistic regression analysis, a series of binary logistic regression analyses were conducted to determine the specific signs from the HGN test that distinguished each of the four drug categories from the no-drug cases. Results indicated that users of CNS depressants were significantly more likely to experience lack of smooth pursuit and distinct nystagmus at maximum deviation compared to individuals who were not positive for drug use.

Prediction of Drug Category from Performance on One Leg Stand Test

A multinomial logistic regression analysis predicting drug category from performance on the OLS test showed that all four signs from this psychophysical test significantly distinguished the four DEC drug categories from the no-drug cases, $\chi^2(16, N = 2,142) = 305.79, p < .0001$. Based on this set of four signs, 43.6% of all cases were correctly classified, with classification being the highest for CNS stimulants (59.9%), followed by cannabis (55.4%), and NA (10.6%). No CNS depressant cases were correctly classified based on these signs from the OLS test. In examining the specific signs from the OLS test that distinguished the four drug categories from the no-drug cases, the results from the binary logistic regression analyses revealed that users of all four drug categories were significantly more likely to sway while balancing on one leg or use their arms to maintain balance during the OLS test, compared to individuals who had not used drugs. Users of CNS depressants, CNS stimulants and NA were also significantly more likely to put their raised foot down during the test. In contrast, the drug users across all four drug categories were less likely to hop during the OLS Test to maintain their balance compared to those who had not used drugs.

Prediction of Drug Category from Performance on the Walk and Turn Test

In predicting drug category from performance on the WAT test, the results revealed that the set of seven signs from this test significantly distinguished the four drug categories from the no-drug

cases, $\chi^2 (28, N = 2142) = 273.89, p < .0001$. An overall classification rate of 42.8% was calculated based on these seven signs. Classification was found to be highest for CNS stimulants (72.2%), followed by cannabis (39.7%), CNS depressants (9%) and NA (3.5%). In assessing the specific signs from the WAT test that distinguished the four drug categories from the no-drug cases, findings revealed that users of CNS depressants, CNS stimulants and NA were significantly less likely to keep their balance while listening to the test instructions compared to individuals who were not impaired by drugs. In addition, users of CNS depressants were less likely to touch heel-to-toe while walking, whereas individuals who had used NA were less likely to take the correct number of steps during the WAT test.

Discussion and conclusions

The present study has demonstrated that CNS depressants, CNS stimulants, NA and cannabis are significantly associated with impairment on the SFST, with prediction being highest for CNS stimulants. The pattern of signs on the various tests of the SFST varied by drug category, which provides support for the validity of using the SFST to identify persons who are impaired by drugs other than alcohol.

Consistent with Bosker et al., (2012), the current investigation found that cannabis adversely affected performance on the OLS test, but not the WAT and HGN tests. These results, however, contrast with those reported by Papafotiou et al. (2005b), who noted that cannabis was related to impairment on all three tests of the SFST battery. As noted in the DEC program, cannabis is not one of the drugs that produce HGN (Drummer, 2007). It is possible that the HGN displayed by participants in Papafotiou et al.'s (2005b) study may have occurred because they consumed drugs other than cannabis. In their report, Papafotiou and colleagues noted that the subject's blood samples were only tested for THC. Papafotiou et al. also documented that cannabis was significantly related to impaired performance on the WAT test, a finding not evident in the current study. In reconciling these differing results, it is possible that they may be the result of differences in cannabis use history. In the study by Papafotiou et al. (2005b), the reported frequency of cannabis use of the participants varied from once a week to once every 2-6 months. In contrast, the present study was based on DEC evaluations conducted on suspected drug-impaired drivers who had self-administered drugs in doses that would be expected to exceed those that are ethically allowed in laboratory settings. Previous research has shown that heavy cannabis users develop tolerance to the impairing effects of THC on neurocognitive measures (Ramaekers et al., 2011). It is conceivable that the cannabis users in the current study developed tolerance to the impairing effects of THC as well, which may have affected their performance on the WAT test. Although cannabis users in the current work did not exhibit performance deficits on the WAT test, they did present such deficits on the OLS test. In accounting for these seemingly contradictory results, it is possible that the OLS may be too sensitive for determining drug use and that many individuals may not have very good balance even when they are not under the influence of drugs. This highlights the need for normative data to evaluate the performance of individuals on the SFST battery who are not impaired by drugs.

Contrary to previous research (Downey et al., 2012; Silber et al., 2005), the present study found that CNS stimulants were significantly associated with impaired performance on the WAT and OLS. The apparent discrepancy in these results is most likely a consequence of different doses of drugs across studies. Both Silber and colleagues (2005) and Downey and colleagues (2012)

administered low doses of amphetamines under controlled conditions in a laboratory setting, whereas the current investigation was based on the results of DEC evaluations on suspected drug-impaired drivers who had self-administered drugs. The amount of drugs administered in the real world by drug users typically exceeds that ethically allowed in laboratory settings. Thus, higher doses of CNS stimulants were likely responsible for the differences in results between studies.

The findings observed in the current study provide support for the use of the SFST as a screening tool for law enforcement to identify impairment in persons who have used CNS stimulants, CNS depressants, cannabis or NA. It should be noted though, that the pattern of impairment is not necessarily the same as that displayed by persons who are impaired by alcohol. Foremost among the differences is the fact that CNS stimulants, cannabis, and NA do not produce HGN. The types of errors made on the various components of the SFST also appeared to differ by drug category. If replicated and validated by further research using larger samples with known drug-blood concentrations, these patterns of SFST signs would prove beneficial in identifying drug impairment and the identification of particular drug categories.

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