Validity of the SFST
for Drug Impaired Driving

Doug Beirness
Ottawa, Canada

St. Paul MN
October 2017

Overview

❑ Validation of the SFST

   ▪ Reliability

   ▪ Validity

❑ Validity of the SFST for Drugs

❑New tests/indicators?

What Problem are we trying to solve?

❑ SFST developed to detect *alcohol* impairment and we need evidence to support the *validity* and *reliability* of the SFST to assess impairment by *drugs*

2017-11-07

Reliability

Reliability is the extent to which a measuring instrument, device, or test provides consistency in measurement.

Reliability

❑ Reliability is concerned with consistency in measurement

❑ Different types of Reliability
  1. Test-retest reliability
  2. Inter-rater reliability

Reliability

Tharp, Burns & Moskowitz (1981)
Test-retest reliability

Tested same subjects on two separate occasions at same BAC by same officer.

➤ **HGN 0.66**
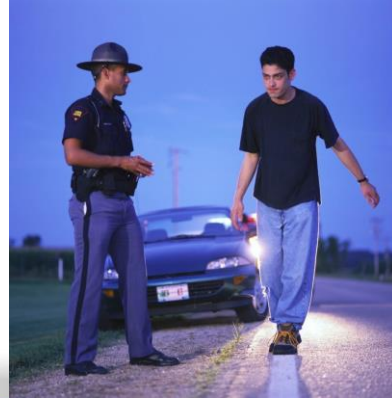➤ **WAT 0.72**
➤ **OLS 0.61**
➤ **Total 0.71**

Inter-rater Reliability

❏ **Data Collection**

- DRE certification sessions
- 2 evaluators scoring tests at the same time
- 248 paired observations
- data used assess inter-rater reliability

Reliability
Walk and Turn

Clue	Agreement
• Balance	87%
• Too Soon	92%
• Stops	75%
• Miss H/T	72%
• Off Line	79%
• Raise Arms	81%
• # Steps	91%
• Turn	81%
• 2+ Clues	87%

Reliability
One Leg Stand

Clue	Agreement
• **Sway**	**76%**
• **Arms**	**80%**
• **Hops**	**94%**
• **Foot down**	**90%**
• **# Clues**	**78%**
• **2+ Clues**	**87%**

Reliability
Horizontal Gaze Nystagmus

| Clue	Agreement	
• LSP	96%	(33)
• Max Dev	99%	(21)
• Onset <45	99%	(19)

(most subjects did not show HGN)

Validity

Validity is the extent to which a measuring instrument, device, or test measures what it is supposed to measure.

Validity

Some key components of Validity:

❑ ***Construct*** *validity – What is it supposed to measure?*

❑ ***Content*** *validity – Does it adequately sample from the construct you are trying to measure?*

❑ ***Face*** *validity – Does it look like it measures what it is supposed to?*

❑ ***Criterion*** *validity – Is it predictive of some criterion measure?*

Validity -- Intelligence
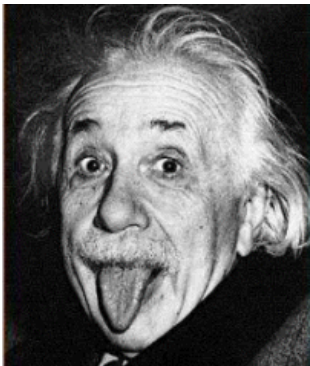
❑ ***Construct*** – Does the test measure intelligence?

❑ ***Content*** – does test adequately sample from the domain of "intelligence"?

❑ ***Face*** -- Does it look like a test of intelligence?

❑ ***Criterion*** -- Is it predictive of things we would expect of intelligent people?

Decision Matrix

	CRITERION	
TEST	**Negative**	**Positive**
Negative	True Negative	False Negative
Positive	False Positive	True Positive

Decision Matrix

	Disease Status	
Medical Test	**No Disease**	**Disease**
Negative	Correct	Incorrect
Positive	Incorrect	Correct

Validation of the SFST

❑ *Construct Validity* - What is Impairment?
- Change from alcohol/drug-free baseline
- Reduced ability to operate vehicle safely

❑ *Content* Validity
- Multitude of tests used in experimental literature
- Do tests measure impairment of driving skills?

❑ *Face* Validity
- Balance, coordination, follow instructions

❑ *Predictive/Criterion* Validity
- Is test related to other measures of impairment?

What's the Criterion?

❑ Correlation between amount of alcohol (BAC) and degree of impairment

❑ Over time, operational definition of "impairment" has become "BAC" – i.e., if BAC> .08, driver is deemed impaired

❑ Criterion for impairment is BAC ≥ .08

❑ Compare with SFST performance

Decision Matrix

	Criterion	
SFST -- Officer Decision	**BAC < .08**	**BAC ≥ .08**
Not Impaired (Release)	True Negatives	False Negatives
Impaired (Arrest)	False Positives	True Positives

SFST Validation Studies

- Burns & Moskowitz (1977)
- Tharp, Burns & Moskowitz (1981)
- Burns & Anderson (1995) (Colorado)
- Stuster (1997)
- Stuster & Burns (1998) (San Diego)
- Burns & Dioguino (1998) (Florida)

Stuster & Burns (1998)

SFST Decision	Criterion	
	BAC < .08	BAC ≥ .08
Not Impaired	True Negatives 59	False Negatives 4
Impaired	False Positives 24	True Positives 210

Overall Accuracy

- All 3 = 91%
- HGN = 88%
- WAT = 79%
- OLS = 83%

Stuster & Burns (1998)

Sensitivity

Of all cases >.08, in how many did the SFST predict correctly?

- HGN = 98%
- WAT = 92%
- OLS = 92%
- All 3 = 98%

Stuster & Burns (1998)

	Criterion	
Decision	**BAC < .08**	**BAC ≥ .08**
Not Impaired	True Negatives 59	False Negatives 4
Impaired	False Positives 24	True Positives 210

High rate of False Positives

Specificity

Of all cases <.08, in how many did the SFST predict correctly?

- HGN = 63%
- WAT = 47%
- OLS = 59%
- All 3 = 71%

Validity of the SFST

- Has the elements required for a valid test of impairment due to alcohol
- Has good criterion/predictive validity – i.e., accurately detects drivers with BACs of at least .08
- Each component of the test (HGN, WAT, OLS) shows good performance statistics
- Watch for "false positives"

SFST and Drugs

Is the SFST a valid and reliable test to identify driver impairment due to drugs?

What's the Criterion?

- ❑ **For alcohol, used BAC ≥ .08**
- ❑ **Correlation between amount of drug and degree of impairment**
- ❑ **Per se limits for drugs?**
- ❑ **Examples for cannabis (THC)**
  - ▪ 5 ng/ml (WA, CO, MT)
  - ▪ 2 ng/ml (NV, OH) (UK) (Norway 1.3 ng/ml)
  - ▪ 0.4 ng/ml (PA)
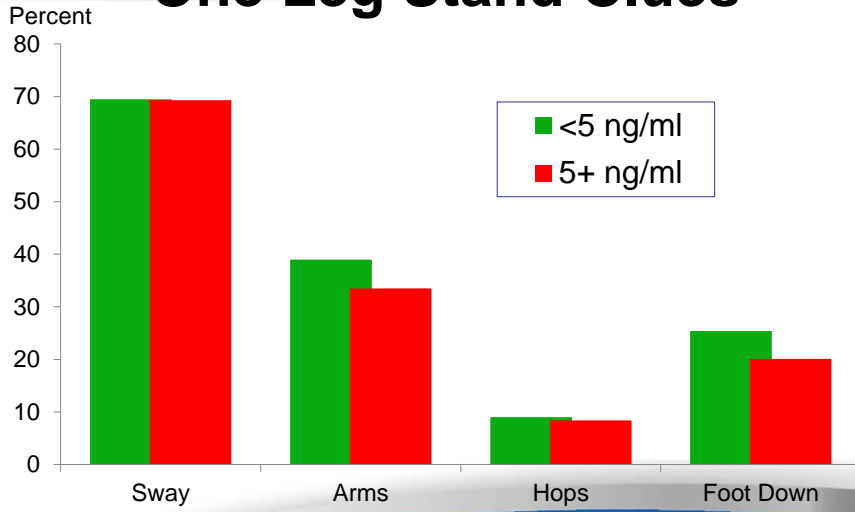 - ▪ Zero (11 states)

Predictive/Criterion Validity

❑ Data from DRE evaluations provide a wealth of information that can be used to help determine validity of SFST
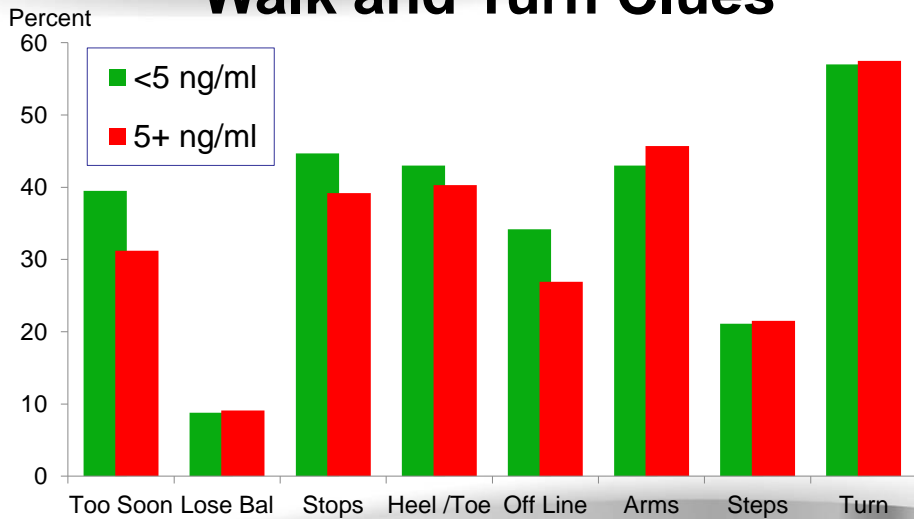
❑ Use Cannabis as example

HGN Clues
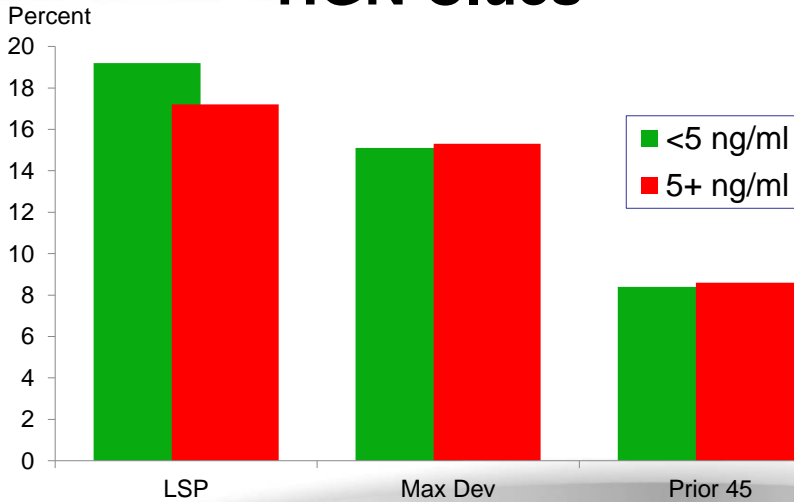
One Leg Stand Clues

Walk and Turn Clues

Predictive/Criterion Validity

- Use data in manner similar to original SFST validation studies for alcohol

Test Score	Criterion	
	THC < 5 ng/ml	THC 5+ ng/ml
Not Impaired	True Negatives	False Negatives
Impaired	False Positives	True Positives

HGN

HGN Score	Criterion	
	THC < 5 ng/ml	THC 5+ ng/ml
<4 Clues (Not Impaired)	374 (True Negatives)	431 (False Negatives)
4+ Clues (Impaired)	54 (False Positives)	31 (True Positives)

❏ Accuracy = 46%

❏ Sensitivity = 7% (ability to detect true positive cases)

❏ Specificity = 87% (ability to detect true neg cases)

Walk and Turn

WAT Score	Criterion	
	THC < 5 ng/ml	THC 5+ ng/ml
<2 Clues (Not Impaired)	91 (True Negatives)	103 (False Negatives)
2+ Clues (Impaired)	326 (False Positives)	351 (True Positives)

❑ Accuracy = 51%

❑ Sensitivity = 77%

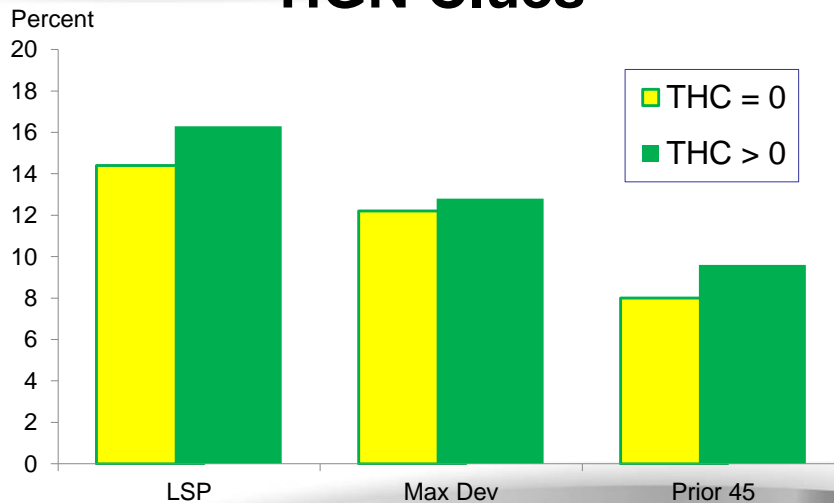❑ Specificity = 22% (False positive 78%)

One Leg Stand

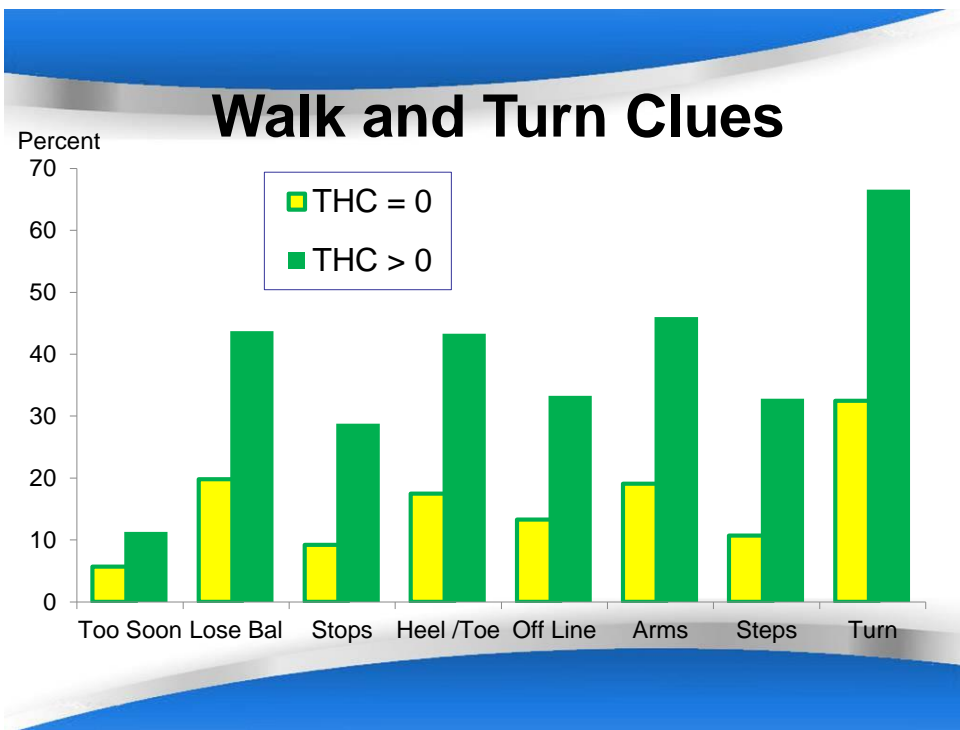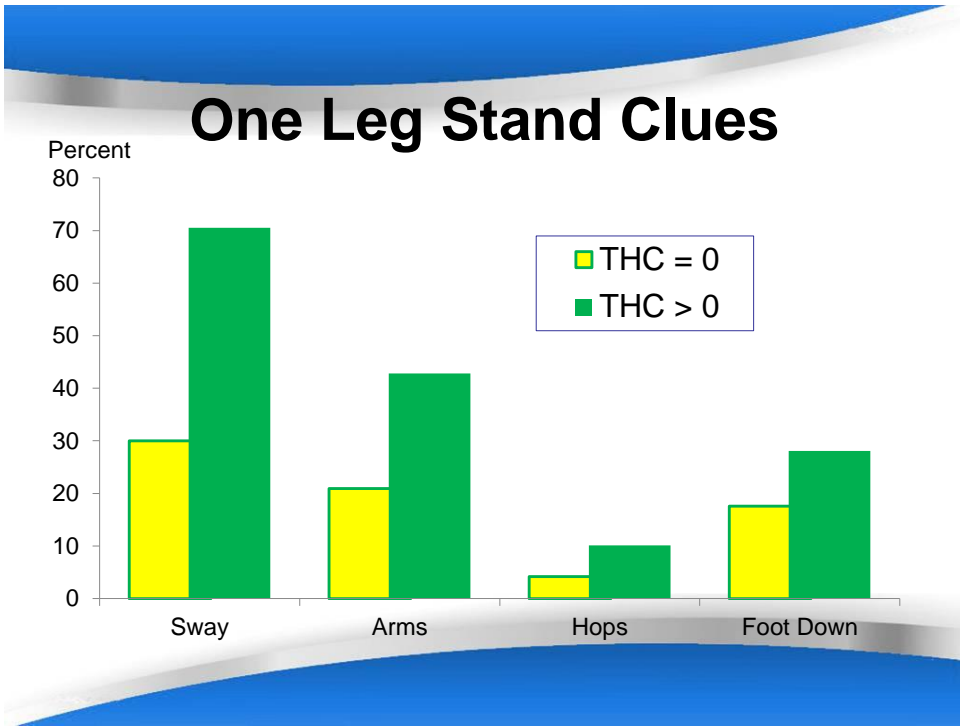| OLS Score	Criterion	
	THC < 5 ng/ml	THC 5+ ng/ml
<2 Clues (Not Impaired)	221 (True Negatives)	226 (False Negatives)
2+ Clues (Impaired)	202 (False Positives)	202 (True Positives)

❑ Accuracy = 48%

❑ Sensitivity = 47%

❑ Specificity = 52%

Validity of SFST for Cannabis

❑ SFST unable to distinguish between THC level above and below 5 ng/ml

❑ HGN not detecting positive cases accurately

❑ WAT & OLS many false positives

❑ Is it the test or the criterion?

HGN Clues

Percent

	THC = 0	THC > 0

Chart showing percentages for LSP, Max Dev, and Prior 45. Y-axis ranges from 0 to 20.

One Leg Stand Clues

Walk and Turn Clues

HGN

HGN Score	Criterion	
	THC = 0	THC > 0
<4 Clues (Not Impaired)	**407** (True Negatives)	**1403** (False Negatives)
4+ Clues (Impaired)	**28** (False Positives)	**160** (True Positives)

❑ Accuracy = 28%

❑ Sensitivity = 10% (ability to detect true positive cases)

❑ Specificity = 94% (ability to detect true neg cases)

Walk and Turn

WAT Score	Criterion	
	THC = 0	THC > 0
<2 Clues (Not Impaired)	**277** (True Negatives)	**276** (False Negatives)
2+ Clues (Impaired)	**147** (False Positives)	**1229** (True Positives)

❑ Accuracy = 78%

❑ Sensitivity = 82%

❑ Specificity = 65%

One Leg Stand

OLS Score	Criterion	
	THC = 0	THC > 0
<1 Clues (Not Impaired)	261 (True Negatives)	353 (False Negatives)
1+ Clues (Impaired)	165 (False Positives)	1204 (True Positives)

❑ Accuracy = 74%

❑ Sensitivity = 77%
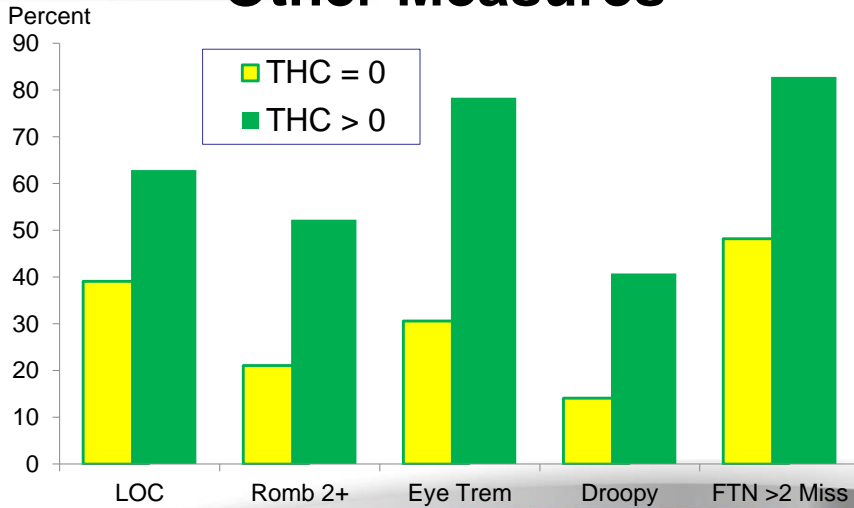
❑ Specificity = 61%

Validity Indicators for SFST

	Sensitivity	Specificity	Accuracy
All Drugs	0.607	0.867	0.634
Depressants	0.961	0.867	0.913
Stimulants	0.629	0.867	0.724
Narcotic Analgesics	0.698	0.867	0.793
Cannabis	0.414	0.867	0.513

Additional Tests/Indicators

- ❑ Romberg
- ❑ Finger to Nose
- ❑ Finger to Finger
- ❑ Finger Count
- ❑ Hand Pat
- ❑ Coin pick-up
- ❑ Head Movement/Jerks
- ❑ Lack of Convergence
- ❑ Eyelid Tremors
- ❑ Backwards Alphabet

Other Measures

Percent

Legend:
- ▢ THC = 0
- ▮ THC > 0

X-axis: LOC, Romb 2+, Eye Trem, Droopy, FTN >2 Miss

Other Indicators

Other Indicators for Cannabis

Test/Indicator	Sensitivity %	Specificity %	Accuracy %
LOC	63	61	62
Romberg 2+	52	79	58
Eyelid Tremors	78	69	77
FTN 3+	83	52	76
Droopy Eyelids	41	86	51

SFST + FTN + Eyelid Tremors

	Sensitivity	Specificity	Accuracy
All Drugs	**0.949**	**0.681**	**0.915**
Depressants	0.992	0.681	0.842
Stimulants	0.943	0.681	0.783
Narcotic Analgesics	0.949	0.681	0.782
Cannabis	0.937	0.681	0.879

In conclusion…

❑ There is evidence to support the reliability and validity of SFST to detect drug use in drivers

❑ Focus on cannabis…

❑ HGN specific to drug category

❑ May want to consider supplemental tests/indicators

❑ Work is ongoing…

Next Steps

❑ Develop a standard scoring scheme for FTN

  ❑ number of misses

  ❑ Uses pad

  ❑ Uses wrong hand

  ❑ Fail to return hand to side

  ❑ Other – balance, eyes open

Doug Beirness
DBeirness@magma.ca