Olfactory performance can be influenced by the presentation order, background noise and positive concurrent feedback

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Background & Aim

- Sniffin' Sticks (Sn St) has become a popular procedure to measure overall olfactory functionality with three subtest: phenyl ethyl alcohol threshold test (T), discrimination (D) and identification (I) (Hummel et al. 1997).
- Several procedural components specified by the original paper has not been tested nor has the impact of deviations been measured.

Materials & Methods

Participants

- 120 healthy volunteers with a normal sense of smell (mean age ± SD = 28 ± 6 years).
- Participants were further randomly divided into three groups of 40, one for each modified testing conditions.

Sniffin' Sticks' Procedure

- The Sn St test is based on felt-tip pens that dispense a particular odor, at a specific intensity, depending on the subtests.
- For each test, the cap of the pen was removed and the tip of the pen was placed about 2 cm in front of both nostrils of the participant for 3 seconds.
  - **Threshold (T)**
    - In a triple-forced choice paradigm, participants have to detect the odor [phenyl ethyl alcohol (PEA)] from two blanks (filled with solvent propylene glycol), starting at the lowest odor concentration.
  - **Discrimination (D)**
    - Using a triangle test, participants have to discrminate which of three odor pens had a different odor.
  - **Identificaiton (I)**
    - Sixteen unique odors pens are presented, individuals have to choose the object that describes the odor the best through multiple forced choice from flash cards that had both the picture and name of the object.

Modified Testing Conditions

- For each experiment (N=40), half of the participants (N=20) were examined with the Sn St starting with condition A and the other half (N=20) were examined with condition B, then participants were given a 2 hour break and reexamined in the other condition.
- **Order of Presentation**
  - A: Tests were done in typical order - Threshold, Discrimination, and then Identification.
  - B: Tests were done in reverse order.
- **Background Noise**
  - A: Tests were done in a room without surrounding sound.
  - B: Tests were done in a room with non-verbal sound presented at 70 dB (via nearby speaker).
- **Verbal Concurrent Feedback**
  - A: During tests, participants were not informed on the correctness of their answer.
  - B: Participants were informed on their correctness.

Data Analysis

- Data analysis was performed with JMP (version 12.0) (SAS Institue, 2000; Sas Institute, Cary, NC, USA).
  - A Wilcoxon signed rank test was used to test differences in total TDI scores and their subtests (T, D, I) within each condition.
  - Post hoc power analysis was done with G*Power software (Faul et al. 2007).

Results

Order of Presentation

- As shown in Figure 1, reversing the presentation order of subtests had participants score significantly less on the overall TDI score than traditional testing order (TDI) ($Z = 3.01$, $p = 0.01$; $d = 0.71$).
- The threshold test was affected more than supra-threshold tests, identification and discrimination ($Z = 4.15$, $p = 0.2$ and $Z = 5.12$, $p = 0.7$ respectively), significantly decreasing in the reversal of presentation order ($Z = 2.59$, $p = 0.002$; $d = 0.77$).

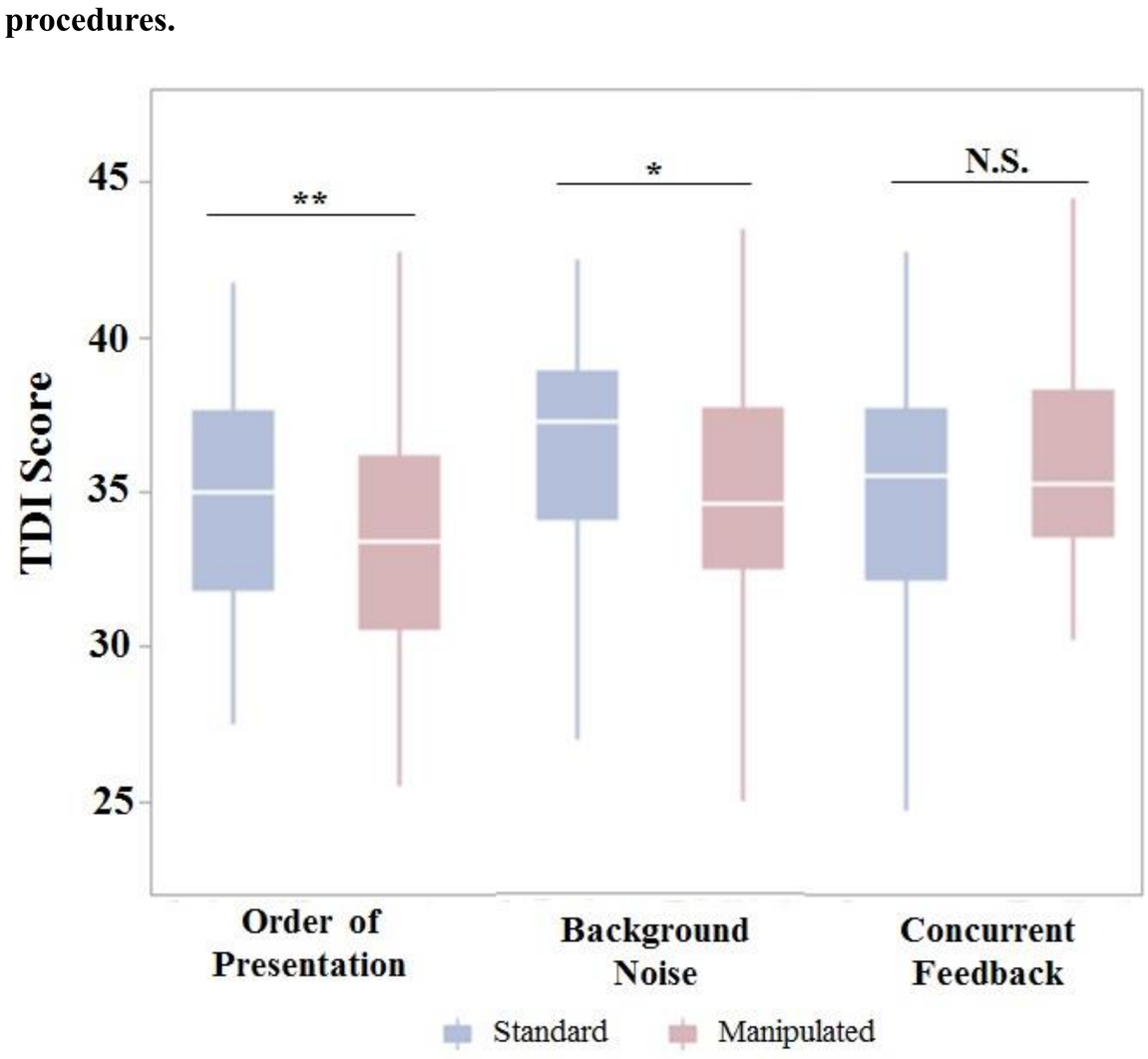
Background Noise

- Participants tested in a quiet environment scored significantly higher overall TDI scores than being tested in a nosier environment ($Z = 3.22$, $p = 0.03$; $d = 0.64$; see Figure 1).
- No difference was seen between individual subtests.

Concurrent Feedback

- No significant differences on the overall TDI score was seen for testing procedures that verbally confirmed the correctness of a participants' choice ($Z = 3.66$, $p = 0.11$; see Figure 1).
- Threshold scores significantly decreased in testing condition that informed participants that their answer were correct ($Z = 3.52$, $p = 0.04$; $d = 0.47$).

Figure 1. Olfactory performance differences among modified Sniffin' Sticks procedures.



Conclusion

- If standard practices are not followed there is an increased chance of misclassification and false-positives for decreased olfaction.
- For this reason, we suggest to keep the original presentation order (TDI) against a silent background without given feedback.
- In future studies it should be stated if olfactory test procedures were proceeded with any deviations from standard practices, as it may result in confounded outcomes and studies difficult to reproduce.

Literature

- Hummel, T., Sekinger, B., Wolf, S.R., Pauli, E., and Kobal, G. 1997. "Sniffin" Sticks': Olfactory Performance Assessed by the Combined Testing of Odour Identification, Odor Discrimination and Olfactory Threshold. Chem Senses. 22:39–52.
- Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behavior Research Methods, 39, 175-191