Evaluation of a Forced-Choice, Paired-Comparison Tracking Procedure Method for Determining Taste Preferences Across the Lifespan

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INTRODUCTION

In 2006, the National Institutes of Health (NIH) developed the Toolbox Initiative, which seeks to assemble brief, comprehensive assessment tools for cognition, emotion, motor functioning and sensation that will be useful to clinicians and researchers in a variety of settings, with a particular emphasis on measuring outcomes in longitudinal epidemiologic studies and prevention or intervention trials across the lifespan. As part of this Initiative, we analyzed an existing dataset of 854 subjects to evaluate the reliability and outcome of a method that was developed by Cowart and Beauchamp in 1990 to assess taste preferences across the lifespan.

Advantages of the method include:

- Sensitivity to behavioral capacities of pediatric populations. This method is a forced-choice, paired comparison, tracking technique that is sensitive to the communicative and cognitive (attention and memory) limitations of pediatric populations. Because children often answer in the affirmative, the method minimizes the impact of language development (e.g., children point to the preferred solution).
- Minimizes position biasing. The method consists of two series in which pairs of solutions of different concentrations of the tastant are presented to subjects, who then indicate which of the pair they prefer. The weaker solution of the pair is presented first in series 1 whereas the stronger solution is presented first in series 2. The order in which stronger and weaker stimuli are presented prevents children from reaching criterion responding if they chose on the basis of first or second position bias.
- Does not require sustained attention. Because younger children are more prone to attention lapses and have shorter memory spans than older children and adults, the task is of short duration and does not rely on sustained attention or place demands on memory which could yield spurious age differences.

The goals of our analyses were three-fold. First, we examined whether there were age-related differences in the ability of subjects to complete the task. Second, we determined whether the method yielded age-related differences in intensity of sucrose preferred. Third, we assessed whether preference data obtained in series 1 were in agreement with preferences obtained in series 2, because NIH requires that the Toolbox task be brief (less than 5 minutes).

METHODS

Subjects. Between 2003 and 2007, the Monell Cowart and Beauchamp method was used to measure sucrose preferences in 854 subjects, of whom 361 were children (5-9.9 yrs), 166 were adolescents (10-19.9 yrs) and 327 were adults (20-55 yrs). The materials and procedures used were identical for children, adolescents and adults. All procedures were approved by the Office of Regulatory Affairs and informed consent was obtained from each adult and assent from each child 7 years of age and older.

Materials.

Medicine cups
Sucrose Solutions: 3%, 6%, 12%, 24%, 36% w/v
Water (for rinsing)
Timer

Procedures.

- Following acclimation to the room and personnel and a one-hour fast, children, adolescents and adults were individually tested at the Monell Center to determine their sucrose preferences. Preferences were recorded on a tracking grid, like that shown in Figure 2.
- Subjects were presented with pairs of solutions that differed in sucrose concentration. As shown in Figure 2, the first pair presented was from the middle range (6 vs. 24g/100ml).
- Subjects tasted each solution for 5 seconds without swallowing, and then pointed to which of the pair they liked better. Each subsequent pair was then determined by the subject's preceding preference choice. A timer was used to ensure that one minute elapsed between presentation of solution pairs. The procedure continued until the subject chose either a given concentration of sucrose when it was paired with both a higher and lower concentration or the highest (36 g/100ml) or lowest (3 g/100ml) solution two consecutive times.
- The entire task was subsequently repeated after a 3 minute break, with stimulus pairs presented in the reverse order (i.e., the weaker stimulus was presented initially in the first series whereas the stronger one was presented first in the second series). The geometric mean of the sucrose concentrations chosen in the first and second series provided the estimate of the subject's most preferred level of sucrose.

Figure 1. Solutions are placed on the table in the order they are to be tasted. The subject tastes both solutions (left panel) and then points to the one she prefers (right panel).

Series 1: Start Time: End Time:

A 3%	B 6%	C 12%	D 24%	E 36%	Additional Notes
	X		(X)		
		(X)	X		
	(X)	X			
X	(X)				"B" preference established

Series 2: Start Time: End Time:

A 3%	B 6%	C 12%	D 24%	E 36%	Additional Notes
	X		(X)		
			(X)	X	
		(X)	X		
	(X)	X			
(X)	X				
(X)	X				"A" preference established

Figure 2. Grids used for sucrose tracking procedure for Series 1 (top) and 2 (bottom). The underlined X indicates the member of the pair of samples that was presented first to the subject. The circled X represents solution chosen by subject. This subject tasted 4 pairs of solutions in series 1 and 6 pairs of solutions in series 2 before reaching criterion.

RESULTS

1. Completion of Task.

The task was of short duration (5-7 minutes to complete Series 1; 13-17 minutes to complete Series 1 and 2). As shown in Table 1, only 1.1% of children refused to participate and 4.2% completed one series only. All adolescent and adult subjects completed both series.

Table 1. Number of subjects in each age group who completed task

Age Group	# who completed both series	# who completed only first series	# who refused to participate	Number of Subjects
Children	342	15	4	361
Adolescents	166	0	0	166
Adults	327	0	0	327
TOTAL NUMBER OF SUBJECTS				**854**

For subjects who completed both series (N=835), we determined the number of pairs each subject tasted before reaching criteria for both series 1 and 2. We found a significant interaction between age group (children, adolescents, adults) and series (1,2) in the number of pairs the subject tasted before they reached criterion ($F(2,832)=4.14$; $p=0.02$). As shown in Table 2, adults required less pairs to meet criterion than children and adolescents in Series 1. Although there were no differences between the series in adults, children and adolescents required less pairs in Series 2 than Series 1.

Table 2. Pairs of solutions needed to reach criterion for Series 1 and 2

Age Group in Years:	Average number of pairs in Series 1	Range of pair presentations in Series 1	Average number of pairs in Series 2	Range of pair presentations in Series 2	Number of Subjects
Children	3.7 ± 0.05^a	3-9	3.5 ± 0.04^c	3-9	342
Adolescents	3.6 ± 0.07^a	3-8	3.4 ± 0.06^c	3-7	166
Adults	3.5 ± 0.05^b	3-7	3.5 ± 0.04	3-6	327
TOTAL NUMBER OF SUBJECTS					835

[a]*Means with different superscript letters are significantly different.*

2. Age-Related Differences in Sucrose Preference

For each subject, we determined the geometric mean of sucrose solutions preferred for the 1st and 2nd series (for those 15 children who completed only one trial, we used the data obtained from one series only). Consistent with a large body of research, Figure 3 shows that children and adolescents preferred a higher intensity sucrose solution than adults ($F(2,847)=20.09$; $p<0.00001$). As expected, adults had lower sucrose preference than adolescents and children, both *t*'s > 4.67, both Cohen's *d* >= .44, *p's* <.05). The age-related change in sucrose preference was also evident when we looked at the sugar content of the subject's favorite cereal ($F(2,776) = 49.33$; $p < 0.0001$, Figure 4). Across age, results of the forced-choice test correlated significantly with the sugar content of their favorite cereal ($r = .12$, $p = .001$) and beverage ($r = .11$, $p = .014$).

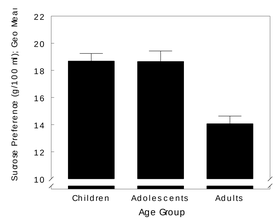

Figure 3. Mean sucrose preference by age group. 3, 6, 12, 24, and 36 g/100ml is equivalent to 0.09M, 0.18M, 0.35M, 0.70M, 1.05M, respectively.

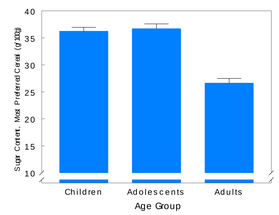

Figure 4. Mean sugar content (g/100g) of subject's preferred cereal by age group.

3. Reliability Between Series 1 and Series 2 by Age Group

For the 835 subjects who participated in both series, we assessed reliability between the two trials by determining intraclass correlations between data obtained from series 1 and series 2 by age group. To this end, we also determined the number of subjects who: 1) preferred the same solution of sucrose during both trials; 2) preferred solutions that differed by one step (e.g., 24 during series 1 and 36 during series 2), 3) preferred solutions that differed by 2 steps (e.g., 12 during series 1 and 36 during series 2), and 4) preferred solutions >2 steps apart. Intraclass correlations showed that reliability between the two series was adequate for children (ICC=.43, N=342), adolescents (ICC=.46, N=166), and adults (ICC=.64, N=327). Sucrose preferences obtained in series 2 were higher than those obtained in series 1 for 40% of children, 36% of adolescents, and 32% of adults. A main effect of trial emerged, $F(1, 832)=26.01$, $p<.0001$, but no interaction effect was found between age group and trial. The agreement varied with age ($\chi2$ [6]= 28.63, $p <.0001$); 87% of adults, 77% of adolescents and 77% of children chose the same or the next closest concentration of sucrose in the two series.

Table 3. Reliability between most preferred solution in Series 1 and 2 for each age group

Age Group	# who preferred same solution	# who preferred solutions that differed by 1 step	# who preferred solutions that differed by 2 steps	# who preferred solutions that differed by more than 2 steps	Number
Children	123 (36.0%)	140 (40.9%)	49 (14.3%)	30 (8.8%)	342
Adolescents	62 (37.3%)	66 (39.8%)	32 (19.3%)	6 (3.6%)	166
Adults	166 (50.8%)	118 (36.1%)	32 (9.8%)	11 (3.3%)	327
TOTAL NUMBER OF SUBJECTS					**835**

CONCLUDING REMARKS AND FUTURE DIRECTIONS

This method is fast and reliable for detecting age-related changes in sucrose preferences. Additional research is needed to determine the reliability and usefulness of this task for younger (3-4 year old) subjects.

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