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Changes in Gustatory Function and Taste Preference Following Weight Loss

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Objective To investigate taste changes of obese children during an inpatient weight reduction treatment in comparison with normal weight children.

Study design Obese (n = 60) and normal weight (n = 27) children aged 9-17 years were assessed for gustatory functions using taste strips (taste identification test for the taste qualities sour, salty, sweet, and bitter), taste preferences, and experienced taste sensitivity. Obese children were examined upon admission (T1) and before discharge (T2). Normal weight children served as the control group.

Results Irrespective of taste quality, obese children exhibited a lower ability to identify taste (total taste score) than normal weight children ($P < .01$); this overall score remained stable during inpatient treatment in obese children. Group and treatment effects were seen when evaluating individual taste qualities. In comparison with normal weight children, obese children exhibited poorer sour taste identification performance ($P < .01$). Obese children showed improvement in sour taste identification ($P < .001$) and deterioration in sweet taste identification ($P < .001$) following treatment. Subjective reports revealed a lower preference for sour taste in obese children compared with normal weight children ($P < .05$). The sweet and bitter taste ability at T1 predicted the body mass index z score at T2 ($R^2 = .23$, $P < .01$).

Conclusions We identified differences in the ability to discriminate tastes and in subjective taste perception between groups. Our findings of increased sour and reduced sweet taste discrimination after the intervention in obese children are indicative of an exposure-related effect on taste performance, possibly mediated by increased acid and reduced sugar consumption during the intervention. Because the sweet and bitter taste ability at T1 predicted weight loss, addressing gustatory function could be relevant in individualized obesity treatment approaches. *(J Pediatr 2017;182:120-6).*

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Variations in taste perception, which may arise from cultural or social but also genetic factors, such as a diminished or an increased sensitivity to certain tastes, likely shape taste preferences and may even influence eating behavior.[1] In fact, most previous studies linking taste and eating behavior have focused on taste preferences and suggest that preferences are formed as the result of exposure.[2,3] These preferences seem to remain relatively stable over time[4] after their development, which already begins in vitro.[5] Studies have shown that taste preferences may be reflected in weight status and may also change with weight loss in adults.[6-9] Obese children also exhibit poorer taste identification ability compared with nonobese children.[10] Notably, many of these studies have focused largely on preference of food characteristics as opposed to taste preference[11] (eg, a decrease in preference for fatty foods has been observed after weight loss).[8,9] A higher preference for fatty foods was found in obese children of overweight families.[12] However, genetic variations also seem to be involved.[1,13-15]

Investigations of the relationship between body weight and specific taste qualities have yielded inconsistent results for bitter and sweet tastes, and have largely neglected salty and sour taste perception.[11] Studies on the ability to identify bitter tastes have focused on phenylthiocarbamide and 6-n-propylthiouracil, both compounds that are not commonly found in foods. Children who were able to identify 6-n-propylthiouracil favored higher concentrations of sucrose[16] and consumed higher amounts of sweet snacks.[17] Furthermore, it has been reported that levels of hormones (eg, leptin), produced by adipocytes, correlate with sweet taste sensitivity.[18] However, Alexy et al[4] found no differences in taste preferences and taste discrimination after weight loss intervention (WLI) in 72 obese children of the German "Obeldicks" population.[4] However, the study by Alexy et al[4] took place in an outpatient setting in which the children were likely exposed to various external and possibly confounding factors. Studies suggest that weight change, rather than weight status, may influence taste function in adults.[19-22]

BF	Bayes factor
BMI	Body mass index
WLI	Weight loss intervention

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The aims of the study were to test whether (1) taste perception changes during the course of a successful, controlled inpatient WLI by comparing patients with normal weight participants matched for age and sex; and (2) the ability to perceive certain tastes and taste preferences in obese children are predictive for the success of a supervised inpatient WLI.

Specifically, we hypothesize that in obese children, taste identification abilities will change over the course of WLI, and altered (increased or decreased) taste identification scores at the beginning of therapy will be associated with less successful intervention. Such findings could inform future strategies for individualized treatment approaches in obese children.

Methods

The analysis presented here was conducted as part of the DROMLIN study (PreDictor Research in Obesity during Medical care-weight Loss in children and adolescents during an INpatient rehabilitation),[23] which aims at identifying predictors that may play a role in successful weight loss and weight loss maintenance in children and adolescents (Germanctr.de: DRKS00005122). For the DROMLIN study, the sample size was n = 60 (both male and female). Accordingly, the sample size in the present study of n = 53 obese children allows to test for medium effect sizes of d = 0.4 (Wilcoxon signed-rank test, $\alpha = 0.05$, power = 0.8) as calculated with G-power.[24] The study protocol was approved by the Ethics Committee of the University Hospital Tübingen, Germany.

The obese children sample included overweight and obese children who were 9-17 years old, had a body mass index (BMI) over the 90th percentile[25] of age- and sex- specific norms,[26] and were undergoing inpatient WLI at the Children's Rehabilitation Hospital for Respiratory Diseases, Allergies and Psychosomatics, Wangen i.A., Germany. Children in this program are treated by a multidisciplinary team in accordance with the latest developments in medicine, and the program operates in close cooperation with regional educational institutions, such as the Obesity Academy in Baden-Württemberg (Adipositas-Akademie Baden-Württemberg e.V.). Children are treated in small therapeutic groups with peers of the same age and housed in residential units situated on a park-like hospital ground. The clinic has its own school with regular classes for all types of curricula. The obesity program focuses on exercise and a balanced diet to achieve weight loss. Smoking is forbidden during the inpatient stay. The obesity treatment method at the rehabilitation hospital is described in detail elsewhere.[23]

The normal weight children sample, used as a control group, was comprised of 27 normal weight age- and sex-matched children with a BMI between the 10th and 90th percentile.[26] These subjects were recruited from the catchment area of the University Hospital Tübingen, Germany.

Exclusion criteria included severe psychological comorbidities, linguistic or intellectual limitations, diabetes, malignant tumors, systemic disorders, or severe cardiovascular diseases. Children with a history of chronic medical illness or neurologic conditions (eg, schizophrenia, autism) were also excluded.

Testing took place in the afternoons (2:30-5:00 p.m.) about 2.5 hours after lunch. The inpatient group was tested twice, once upon admission (T1), and again before discharge (T2). The average time between investigations was 26.4 ± 8.2 days. Before every test session, body height and weight were measured without shoes. For height assessment, children were instructed to stand directly under a wall-mounted stadiometer (Seca, Hamburg, Germany) with the head positioned on the Frankfort horizontal plane. Weight was measured with a digital body weight scale (Soehnle, Nassau, Germany). The BMI was calculated according to the following formula: BMI = weight in kg/height in m^2. The BMI was transformed into the age- and sex-specific BMI z scores according to German reference values,[26] which provides a more appropriate measure of weight status in children as it accounts for the comparatively large interindividual variability.

Gustatory function was assessed using a standardized taste identification test (taste strips, Burghart Messtechnik GmbH, Wedel, Germany) and subjective reports of taste preference and taste sensitivity.

Taste strips are filter paper strips impregnated with taste solutions representative of 4 basic taste qualities at 4 different concentrations (sweet: 0.4, 0.2, 0.1, 0.05 g/mL sucrose; sour: 0.3, 0.165, 0.09, 0.05 g/mL citric acid; salty: 0.25, 0.1, 0.04, 0.016 g/mL sodium chloride; bitter: 0.006, 0.0024, 0.0009, 0.0004 g/mL quinine-hydrochloride), which have been validated for the use in both adults and children.[10,27,28] The method is well accepted especially by children and adolescents and has been used in several clinical and research contexts. The results of this test reflect a measure of the ability to identify 4 basic tastes.[10,28,29] The test-retest reliability compares well with other taste tests.[27] During this test, a taste strip is placed at the middle of the anterior tongue and the participant is to report the taste perceived (salty, sour, sweet, bitter, or nothing) by pointing at the corresponding word on a response chart. To familiarize participants with the procedure and to test whether they were able to identify the different tastes correctly, taste strips with the highest concentration of each taste ($taste_{high}$) were presented at the beginning of the paradigm in random order. Participants were asked to identify the taste using the response chart and received feedback after each presentation. Sixteen impregnated strips, 4 of each taste in 4 different concentrations, and 2 nonimpregnated blank strips were then presented in a pseudorandomized order with an intertrial interval of approximately 25 seconds. Correctly identified taste trials were scored as 1 and summated to a total taste identification score (maximum score = 16), as well as separated into taste identification scores for each taste quality ($taste_{sum}$; maximum score = 4). A test result below the 10th percentile (which corresponds to a total taste identification score of 9) indicates hypogeusia,[27] or a reduced ability to taste. Two different pseudorandomizations were used to minimize learning and carry-over effects. After completion of the test, participants received feedback on their overall performance.

Subjective taste preferences were assessed by asking if participants had a preferred taste. It was possible to give multiple answers (eg, sweet and sour), thus, each preference was