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Effect of nasal dilators on pleasantness, intensity and sampling behaviors of foods in the oral cavity*

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SUMMARY *The present study assessed the effect of nasal dilators on ratings of food intensity and pleasantness. Participants wearing the dilators rated foods in the oral cavity as less pleasant and more intense than did those participants wearing a placebo strip. In addition, they consumed less of the test stimuli. Significant interactions were noted between food stimuli and placebo vs. nasal dilator strip conditions, indicating certain food qualities, particularly initial pleasantness, combine to produce enhanced changes in perception. Changes in the intensity and pleasantness of foods was most pronounced in foods characterized as initially pleasant. A review of studies to date indicate that both foods and odors are perceived as more intense and less pleasant during nasal dilation, suggesting an impact of the dilators on both retronasal and orthonasal air flow.*

Key words: nasal dilators, perception, consumption, oral, taste/odor interaction

INTRODUCTION

Recently, a number of studies have examined differences in psychophysical ratings and stimulus perception made while wearing a nasal dilator. One such nasal dilator is the Breathe Right^{TM} Nasal Strip, which is a non-pharmacological device designed to increase the cross sectional area of the nasal valve and decrease nasal resistance. Studies to date have indicated that the increase in area induced by the strip results in a decrease in nasal airway resistance of at least 30% (Roithmannet al., 1995), and that the strips have proved effective in reducing the energy needed to breathe and reduce snoring, mouth dryness and sleepiness (Griffin et al., 1997; Hoffstein et al., 1993; Höijer et al., 1992; Petruson, 1994; Ulfberg & Fenton, 1997).

Hornung et al. (1997) examined the efficacy of these nasal dilators on altering perceived odor intensity. They found that while wearing the strips, subjects rated olfactory stimuli as being more intense, as compared to when not wearing the strips.

The following study was designed to further investigate the efficacy of nasal dilators in altering perceptions, specifically by examining differences in psychophysical ratings of foods in the oral cavity. While investigations with nasal dilators have been exclusively confined to the olfactory system, it is reasonable to examine possible differences in the way people respond to foods. Smell is usually thought of as a partner to taste since they work together at mealtimes to give the combined perception of flavor and intensity. Thus, ratings of the intensity and pleasantness were made for foods in the oral cavity, as well as recordings of stimulus consumption.

METHODS

Participants

Participants were 88 young adult volunteers (47 males, 41 females) drawn from a large sample of introductory psychology students at Wheeling Jesuit University. The mean age of the sample was 19.01 years (range 18 to 22, SD = 1.23). Participants received course credit for participation.

Stimuli

The 10 food stimuli consisted of chocolate icing (Duncan Hines), grape jelly (Smuckers), butterscotch pudding (Jell-O®), butternut squash (Heinz Stage III™ baby food), applesauce (Motts), peanut butter (JIF™), French onion dip (Kroger Co.), mixed berry sauce (Motts), plain yogurt (Dannon), and dill dip (Heartville Kitchen). These particular stimuli were chosen in an attempt to include foods expected to vary in level of pleasantness and intensity, and to consist of foods that were homogeneous in consistency (i.e., no lumps). Ten grams of each food were presented in individual 50 ml portion cups. Stimuli were prepared within 6 hours of use and were refrigerated until one half hour before sampling.

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Procedures

Participants were told that the experimenters were interested in people's reactions to tastes, and that they would be rating the intensity and pleasantness of a set of 10 food samples. They were told that the study was also assessing the efficacy of the Breathe Right™ Nasal Strip (CNS, Inc., Minneapolis, MN, USA), and that they would be wearing either a Breathe Right™ Nasal Strip or a comparable brand strip. Participants were not informed which foods they would be sampling. The experimenter applied either the Breathe Right™ Nasal Strip or a placebo strip, with each participant randomly assigned to their particular condition. The placebo strip was similar to the Breathe Right™ Strip, but did not contain the mechanism for opening the naris. Participants were presented with the foods and instructed to sample each food, using a separate spoon, and to rate both the pleasantness and the intensity of the taste. They used an 11-point scale (0-10), with end anchors “unpleasant/ pleasant” for pleasantness and “not intense/intense” for intensity. The order of the foods was randomized for each participant.

RESULTS

One between (strip type), one within (food) mixed-model ANOVAs were performed with ratings of pleasantness and intensity and measures of consumption serving as the dependent variables. To further characterize the effects noted in the ANOVAs, correlations were performed on the dependent measures.

Pleasantness Ratings

A significant difference was found between the strip conditions [$F(1,84)=12.11$, $p<.001$] and among the foods [$F(9,774)=139.04$, $p<.0001$]. Participants found the foods less pleasant when wearing the dilator strips ($M=5.27$, $SD=3.24$) than when wearing the placebo strips ($M=6.01$, $SD=3.36$). A significant interaction was also noted, $F(9,774)=6.37$, $p<.001$. A decrease in pleasantness rating was noted for all foods, with the exception of jelly, onion dip, and dill dip. The most dramatic decrease in pleasantness ratings are seen for icing, pudding, peanut butter, berry sauce and yogurt (see Figure 1).

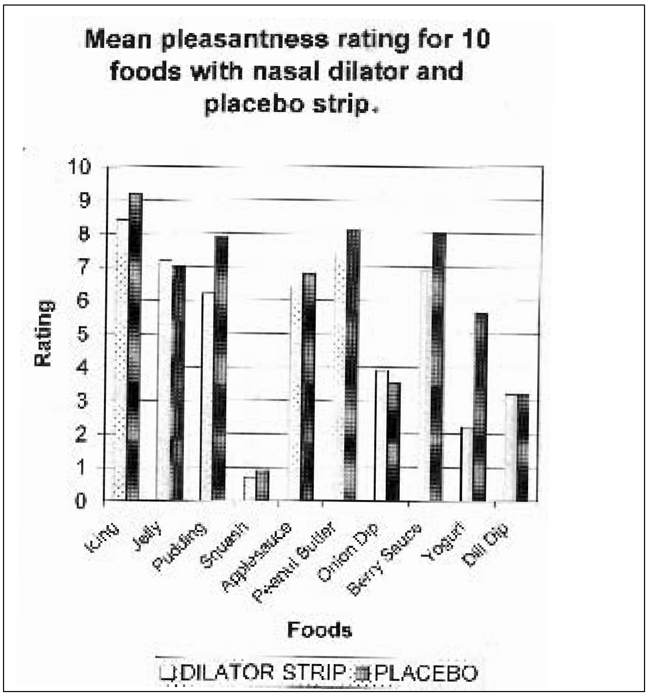

Figure 1. Mean pleasantness rating for 10 foods with nasal dilator and placebo strip.

Intensity Ratings

A significant difference was found between the strip conditions [$F(1,86)=34.10$, $p<.001$] and among the foods [$F(9,774)=30.19$, $p<.0001$]. Participants found the flavors more intense when wearing the dilator strips ($M=7.25$, $SD=2.04$) than when wearing the placebo strips ($M=5.66$, $SD=2.14$). A significant interaction was also noted, $F(9,774)=6.26$, $p<.001$. While an increase in intensity rating was noted for all foods, this increase in intensity was most pronounced for jelly, squash, dill dip and onion dip (see Figure 2).

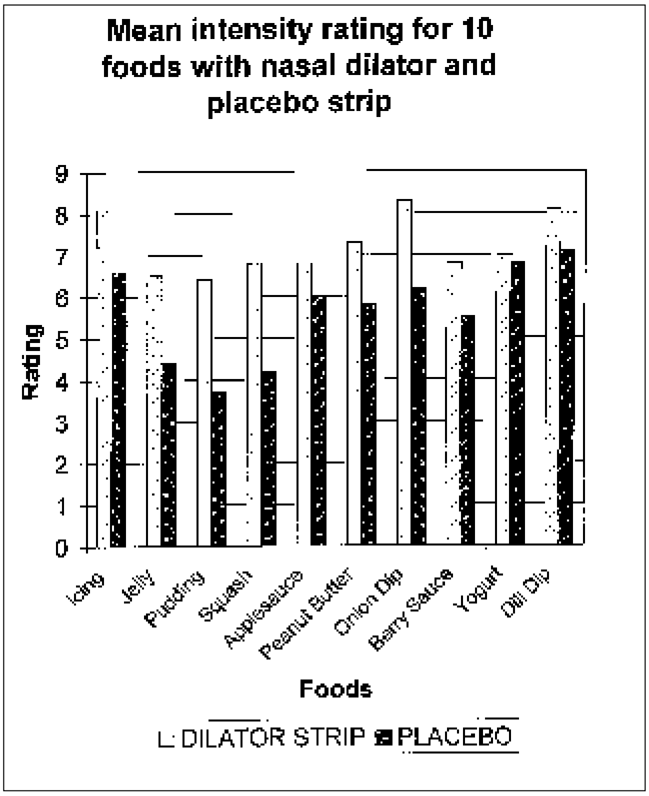

Figure 2. Mean intensity rating for 10 foods with nasal dilator and placebo strip.

Stimulus Consumption

At the end of each testing session, the amount of each food sampled was recorded to the nearest 0.01 gram. This measurement was derived by weighing the remaining food in the stimulus cup and the spoon (with any residual stimulus still adhered), computing a difference score from the full stimulus cup and the spoon, and then subtracting the weight of the stimulus cup and the spoon. This number was then subtracted from 10 grams to give the total amount of stimulus consumed.

A significant difference was found between the strip conditions [$F(1,84)=10.30$, $p<.01$] and among the foods [$F(9,756)=20.54$, $p<.0001$]. Participants ate less of the foods when wearing the dilator strips ($M=1.41$ grams, $SD=1.29$) than when wearing the placebo strips (M=2.32 grams, SD=2.70). Thus, a decrease in consumption of 61% was found with the dilator strips. A significant interaction was also noted, $F(9,756)=12.19$, $p<.001$. The most dramatic decreases in consumption occurred with icing, pudding, applesauce and peanut butter (see Figure 3).

Figure 3. Mean consumption for 10 foods with nasal dilator and placebo strip.

Correlations among variables

Correlations among the measures of mean liking rating, mean intensity rating, and mean food consumption were performed and can be found in Tables 1, 2, and 3. Supporting the above ANOVA findings, as intensity increased, both pleasantness and consumption decreased. Also, as pleasantness increased, intensity decreased and consumption increased.

DISCUSSION

The findings of the present study support the contention that the use of nasal dilators influences the perceived intensity and pleasantness of foods and modifies consumatory behaviors. While wearing the dilator strips, participants rated foods in the oral cavity as more intense and less pleasant. Furthermore, subjects ate less of the food stimuli while wearing the strips, which would not be surprising if the strips also resulted in a decrease in pleasantness.

One explanation for the differences seen with odors relates to the airway resistance of the nasal cavity. Youngentob et al. (1986) had subjects make ratings of stimulus intensity against four different levels of nasal resistance at each of four concentration levels of ethyl butyrate. They found that perceived stimulus intensity increased with decreasing resistance across all

Table 1. Correlations among pleasantness and intensity ratings for all foods. Each correlation has 86 degrees of freedom.

FOOD	PEARSON CORRELATION	SIGNIFICANCE
ICING	[illegible]	0.0001
JELLY	0.3[illegible]	0.01
PUDDING	-0.40	0.00[illegible]
SQUASH	-0.47	0.0001
APPLESAUCE	-0.38	0.001
PEANUT BUTTER	-0.41	0.0001
ONION DIP	0.47	0.00[illegible]
BERRY SAUCE	0.13	ns
YOGURT	0.23	0.01
DILL DIP	[illegible]	0.01

Table 2. Correlations among pleasantness ratings and consumption for all foods. Each correlation has 84 degrees of freedom.

FOOD	PEARSON CORRELATION	SIGNIFICANCE
ICING	0.41	0.0001
JELLY	0.25	ns
PUDDING	0.42	0.0001
SQUASH	0.82	[illegible]
APPLESAUCE	0.31	0.01
PEANUT BUTTER	0.36	0.001
ONION DIP	0.4[illegible]	0.0001
BERRY SAUCE	0.17	ns
YOGURT	[illegible]	ns
DILL DIP	0.31	0.01

Table 3. Correlations among intensity ratings and consumption for all foods. Each correlation has 84 degrees of freedom.

FOOD	PEARSON CORRELATION	SIGNIFICANCE
ICING	-0.29	0.001
JELLY	-0.05	ns
PUDDING	[illegible]	.0001
SQUASH	-0.31	0.01
APPLESAUCE	0.40	0.000[illegible]
PEANUT BUTTER	[illegible]	0.01
ONION DIP	0.33	[illegible]
BERRY SAUCE	[illegible]	ns
YOGURT	0.08	ns
DILL DIP	[illegible]	.05

concentrations. One explanation offered for this phenomenon relates to the concept of a perceptual constancy model of olfaction (Teghtsoonian et al., 1978). According to this model, subjects are aware of the resistance and vigor of their sniffs, which manifests itself as an alteration of their odor intensity perception (i.e. a decrease in nasal resistance decreases perceived sniff vigor and leads to an increase in perceived odor intensity). Alternatively, people may actually be altering their sniffing behavior, which leads to differences in perceived intensity.

To help explain their results, Hornung et al. (1997) attempted to determine whether nasal airflow was affected by the strips in two subjects rating four odorants. They measured nasal airflow using a No. 2 Fleisch pneumotachograph. While they note that their findings should be viewed as preliminary, they found no evidence that the flow rate, sniff volume or sniff duration were altered by the strips, although there was an increase in self-reported odor intensity.

With only one exception (jelly), the strips had a much larger impact on decreasing the pleasantness of pleasant foods (as indicated by pleasantness ratings in the placebo condition) than they did on non-pleasant foods. This effect suggests something akin to what has been noted in environmental odor research (e.g., Doty, 1975), which indicates that increasing the intensity of a pleasant odor at first raises the appreciation for that odor, but that after a certain critical level of intensity, the appreciation starts to diminish. In contrast, for disliked odors, increasing the intensity results in a decrease in the pleasantness of that odor. Since the stimuli in the present study were all commercially available foods, it is reasonable to expect that their taste qualities were produced at or near the optimal level to produce optimal liking. Therefore, increasing the intensity of these foods resulted in a marked decrease in liking. However, continuing the argument, the question then remains why the less pleasant foods do not change in pleasantness as much as the more pleasant foods. One possibility may be in the initial intensity of the food. Squash, onion dip and dill dip were rated as very high in initial intensity. Perhaps increasing the intensity (through the use of the nasal dilator) of these already highly intense, more disliked foods does not produce as dramatic an effect.

While the present study was primarily exploratory in nature, the results lend themselves to further characterize the differences seen in olfactory ratings when wearing a nasal dilator. Combining the results of the present study with those of Youngentob et al. (1986), Hornung et al. (1997), and Raudenbush et al. (1998) indicates that decreasing the resistance of the nasal cavity alters the perception of both foods and odors, suggesting an impact of the strips on both retronasal and orthonasal air flow. In both cases, odors are perceived as more intense and less pleasant. It is possible that the reduction in pleasantness, the increase in intensity, or a combination of both then leads to decreased sampling of the stimuli, either in terms of sniffing odors less vigorously, or choosing to consume less foods.

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