

# Role of Flavorings in Sensory Perceptions of ENDS

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# Overview

- Qualitative and survey research: Consistent with the importance of flavor
- Reward value: By several measures, flavored e-cigs more rewarding for adult smokers
- What specific sensory effects might we expect based on knowledge of ENDS ingredients and the chemical senses?
- Some sensory studies in ENDS
- Key methodological considerations and needs for further work

# In online forums on vaping, flavor is one of the most discussed topics

“A sweet natural cherry e-juice that will definitely take you back to that Greek bar a few summers ago that served delicious cherries on ice. ...if you ever kissed a girl (and liked it!) with cherry lipbalm you’ll know how this tastes immediately.”

“The candy flavors are the reason I was able to quit smoking. They helped me realize ... I hate the way menthol cigs, and even clove cigs taste.”

Wang et al., 2015. Int J Environ Res Public Health. 12: 14916–14935.  
doi: 10.3390/ijerph121114916. Table 1.

# In surveys, flavor is cited as an important reason for use

- Adolescents more interested in trying e-cigarettes flavored like menthol, fruit, or candy than in tobacco flavors. Pepper et al., 2016. *Tob Control*. 25(Suppl 2):ii62-ii66. doi: 10.1136/tobaccocontrol-2016-053174.
- Variety of interesting flavors one of the most important reasons for young people in experimenting with e-cigarettes. Kong et al., 2015. *Nicotine Tob Res* 17 :847-854. DOI: 10.1093/ntr/ntu257
- About 60% of current E-cigarette users 18-34 cite “They come in appealing flavors” or “I like experimenting with various flavors” as important reasons for use. Berg 2016. *Int J Public Health* 61: 225. doi:10.1007/s00038-015-0764-x
- Former smokers who use E-cigarettes reported that variety of flavors was “very important” in reducing or quitting. Farsalinos et al. 2013. *J. Environ. Res. Public Health* 10:7272-7282. doi:10.3390/ijerph10127272
  - Majority reported that restricting variety in flavorings would make e-cigarettes less enjoyable.
  - 48.5% said it would make them more likely to crave cigarettes.
  - 39.7% said that it would have made it more difficult to quit

# In the laboratory, flavored e-cigarettes seem to have more reward value for smokers who do not use e-cigs

Subjective value: Satisfaction subscale of CES for e-cigarettes

- “Was it satisfying?”
- “Did it taste good?”

Absolute reinforcing value: In a free vaping session, took about twice as many puffs of flavored vs. unflavored e-cigs

Relative reinforcing value: Worked harder for puffs of flavored vs. unflavored e-cigs

Audrain-McGovern et al., 2016. Drug and Alcohol Dependence 166:263-267.  
doi: 10.1016/j.drugalcdep.2016.06.030.

What kinds of sensory effects might we expect based on ENEs ingredients and what we know regarding the chemical senses?



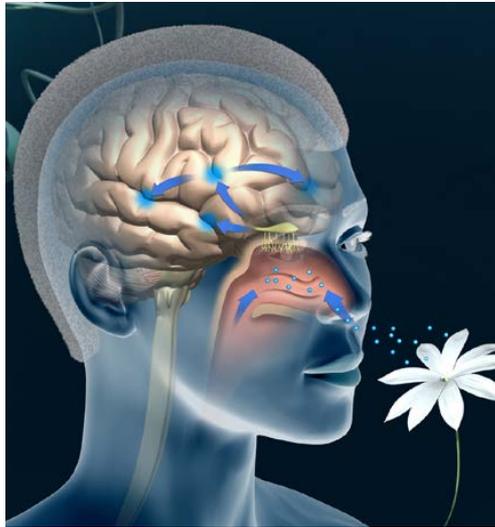
Taste: Sweet,  
sour, salty,  
bitter, savory



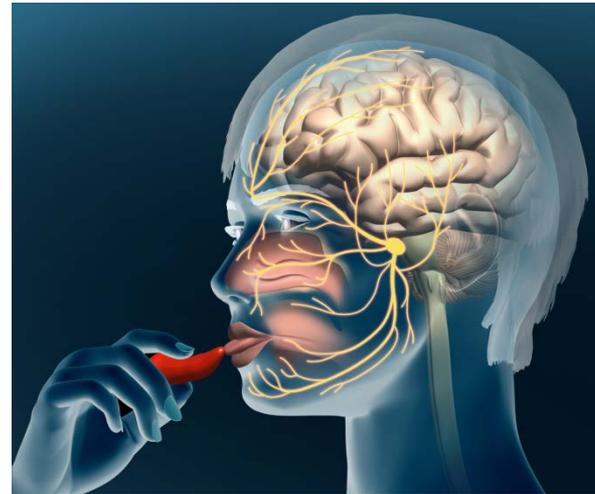
Smell: Most of  
characteristic  
flavors(e.g., most  
of wine and  
scotch flavor)



Taste: Sweet, sour, salty, bitter, savory



Smell: Most of characteristic flavors (e.g., most of wine and scotch flavor)



Somatosensation:  
Chemesthesis  
(cooling, warming, tingling, burning, stinging), texture, temperature

# Possible soothing effects of menthol

- Counter-irritant/analgesic
  - Willis et al., 2011. FASEB J. 25:4434-44. doi: 10.1096/fj.11-188383
  - Wise et al., 2011. Nicotine Tob Res. 13:989-997. doi: 10.1093/ntr/ntr107.
- Anti-tussive
  - Plevkova et al., 2013. J Appl Physiol (1985). 115: 268–274]. doi: 10.1152/jappphysiol.01144.2012
  - Wise et al., 2012. Pulm Pharmacol Ther. 25:236-241. doi: 10.1016/j.pupt.2012.03.005.

# Desensitization of the cough reflex by nicotine

- Even brief use of an e-cigarette desensitizes the cough reflex in never-smokers. See: Dicipinigaitis, 2017. *Pulm Pharmacol Ther.* doi: 10.1016/j.pupt.2017.01.013.
- Adolescent children living in the homes of smokers also showed reduced cough sensitivity relative to children living with never-smokers. Wise et al., 2013. *Nicotine Tob. Res.* 15:603-607.

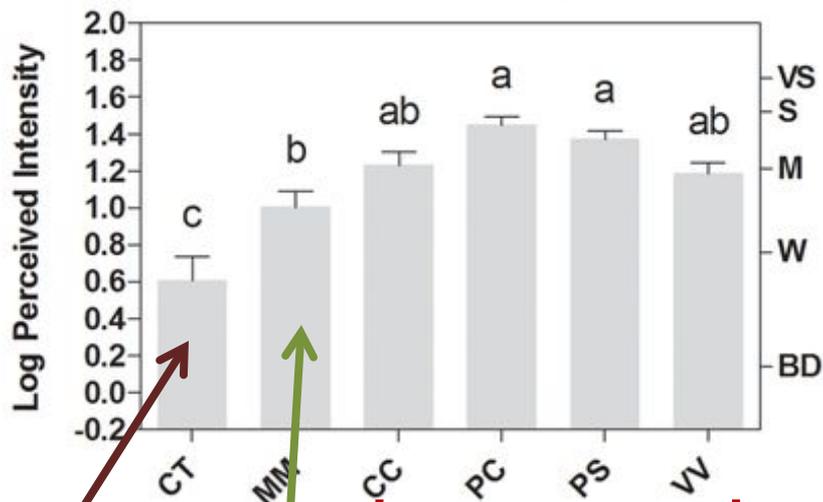
# Sensory studies of ENDs

# Sensory study on commercial e-cigarettes

- blu<sup>®</sup> Tanks “cig-a-like” products, 12 mg/ml nicotine: Classic Tobacco, Magnificent Menthol, Cherry Crush, Pina Colada, Peach Schnapps, and Vivid Vanilla.
- Adult regular vapers or dual use, abstinent 2 hours before testing
- Rated sweetness, bitterness, coolness, harshness, liking

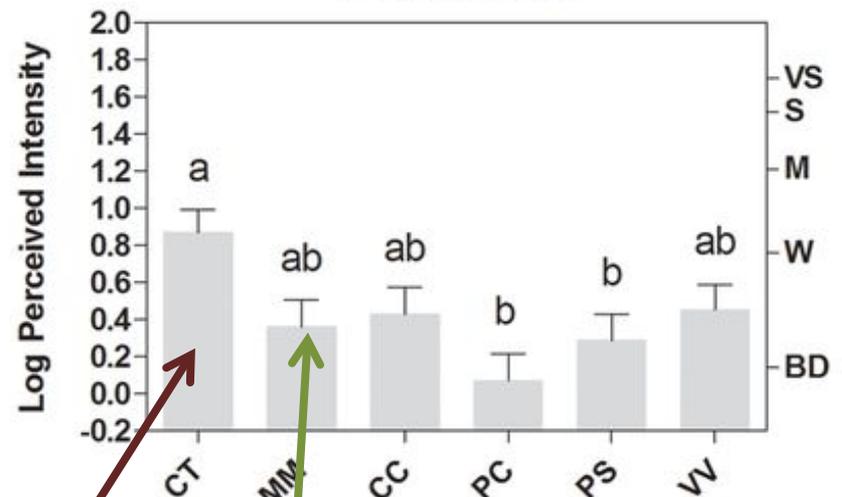
“Sweet” flavored e-cigs are rated as sweeter and less bitter than tobacco flavored e-cigs

Sweetness



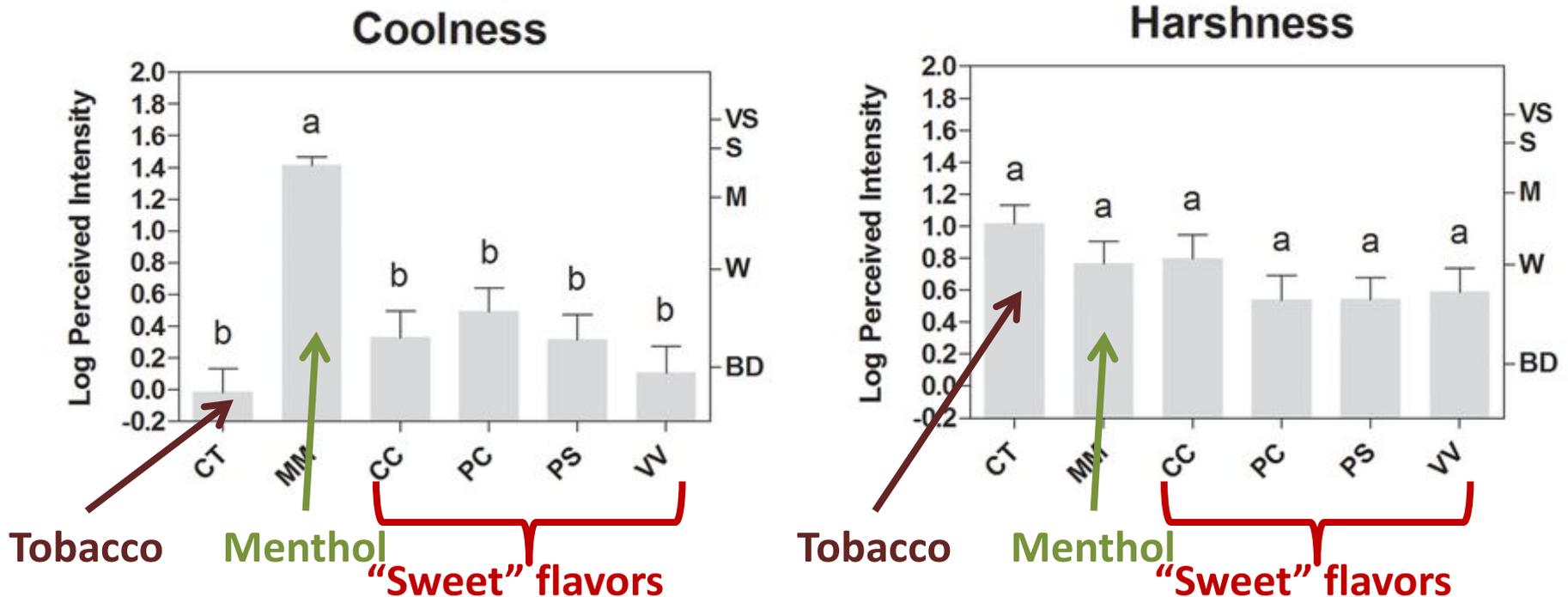
Tobacco Menthol “Sweet” flavors

Bitterness

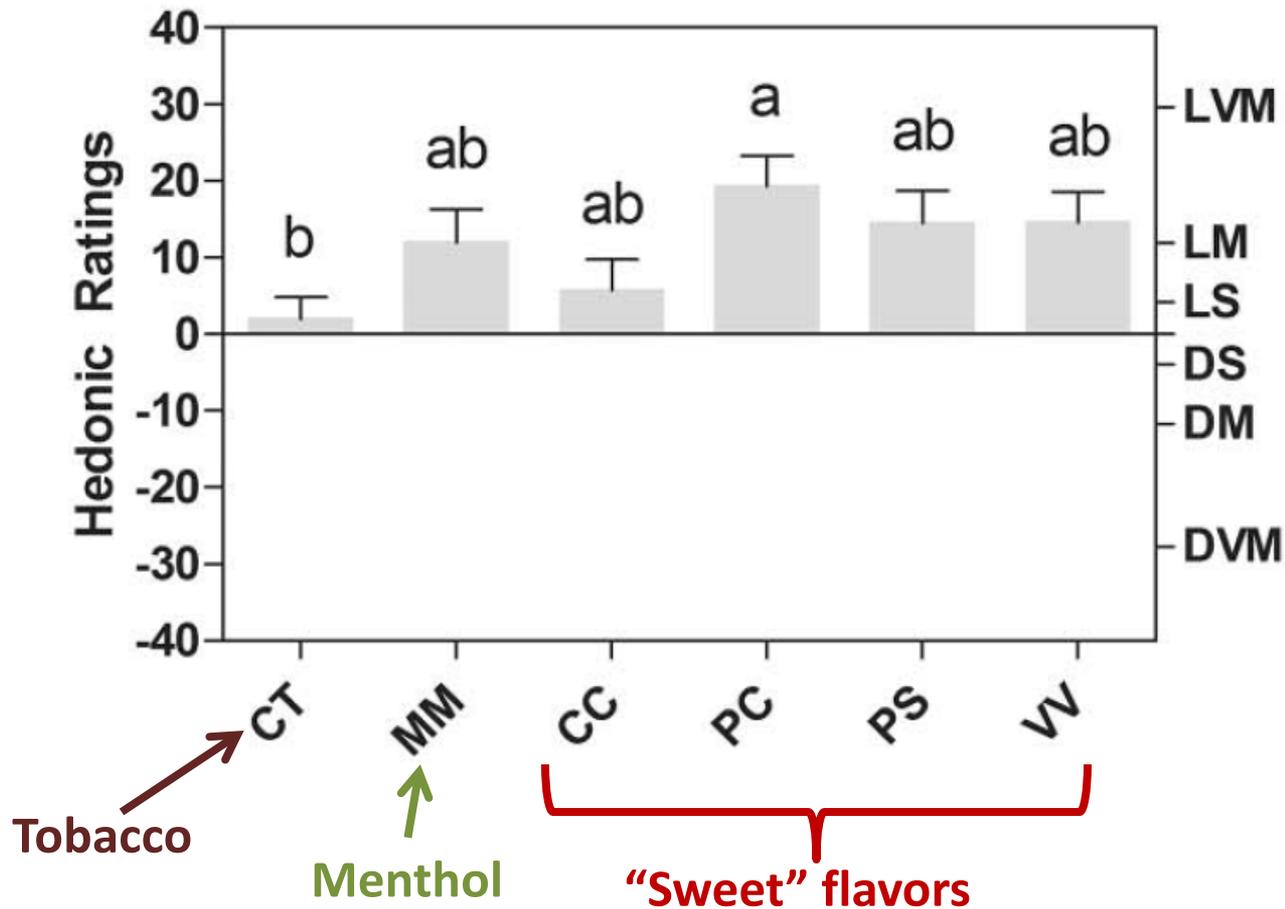


Tobacco Menthol “Sweet” flavors

Menthol flavor was rated as higher in coolness.  
Harshness was not significantly different among  
flavors



# Some differences in liking



# Interaction between nicotine and menthol in e-cigarettes

- V2<sup>®</sup> Standard E-Cigarettes from VMR
- Menthol (0.0, 0.5, 3.5%) X nicotine (0.0 to 24.0 mg/ml). No other flavorants
- Adult smokers (most menthol smokers), abstinent 10 hours before testing
- Rated cool/cold, irritation/harshness, liking

# Interaction between nicotine and menthol in e-cigarettes

- Cooling increased w/ menthol concentration, harshness increased with nicotine concentration
- 0.5% menthol had no effect on harshness
- 3.5% menthol increased harshness at low nicotine concentrations, but lowered harshness at the highest nicotine concentration
- Menthol tended to slightly increase liking, independent of nicotine concentration

# Important methodological concerns:

- Stimulus control
- Manage condition of the nose (adaptation or “fatigue”)
- Many sensory studies rely heavily on subjective ratings. Sanity checks are highly desirable
- Due to nature of sensory stimuli, blinding is not always possible

# Key needs for further research:

- Studies that combine sensory measures, including objective measures of airway irritation, with studies of vaping behavior, e.g. Litt et al. 2016. *Tob Control* 25:ii67–ii72. doi:10.1136/tobaccocontrol-2016-053223
- Studies in non-smokers, non-vapers
- Studies on the effects of secondary exposure on sensory response

# Summary: Flavorants seem to be important

- Qualitative and survey research suggests that flavor is an important factor in ENDS use
- By several measures, flavored e-cigs are more rewarding for adult smokers
- Known ENDS ingredients can impart or enhance positive sensations. Others can impart or ameliorate aversive sensations.
- The few sensory studies in ENDS are broadly consistent with flavors modulating sensory properties in ways that could be important for encouraging use
- Studies of non-users would be helpful, as would more studies directly linking vaping behavior with sensory properties (ideally in the same individuals)