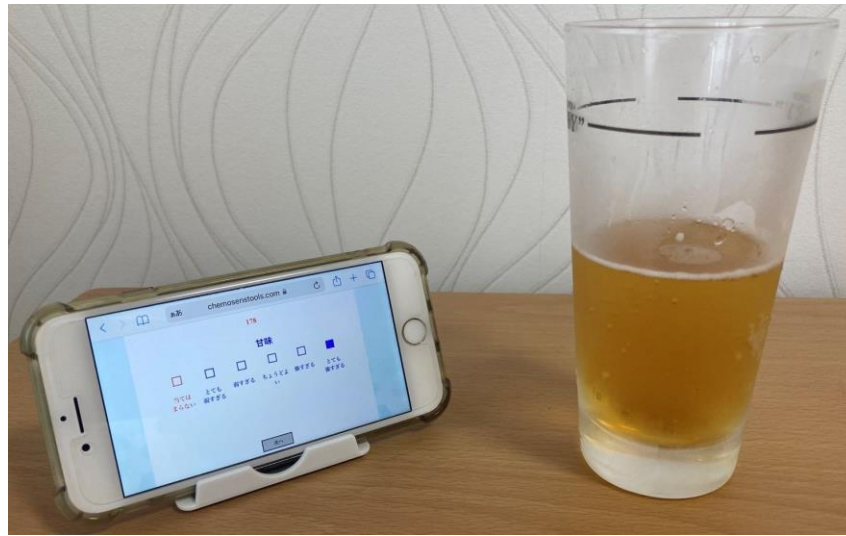


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Sensory drivers of beer satisfaction in users and non-users of reduced- and non-alcoholic beers

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The logo for Asahi, featuring the word "Asahi" in a stylized, blue, sans-serif font.

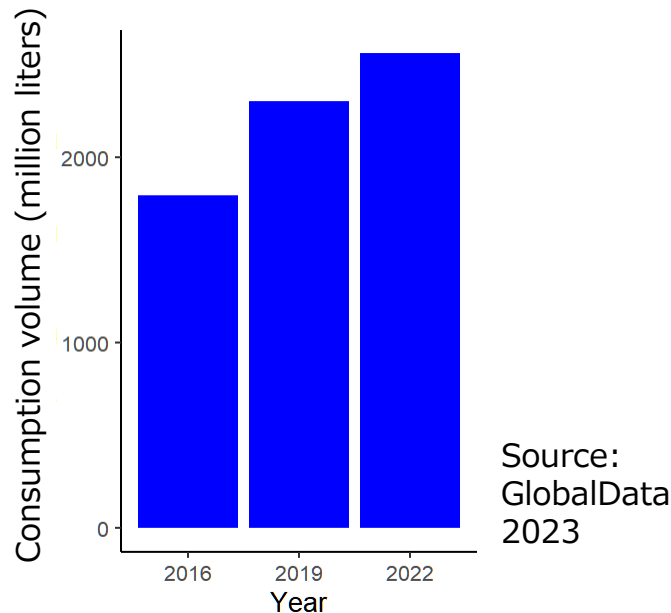
The logo for INRAE, featuring the word "INRAE" in a bold, teal, sans-serif font.



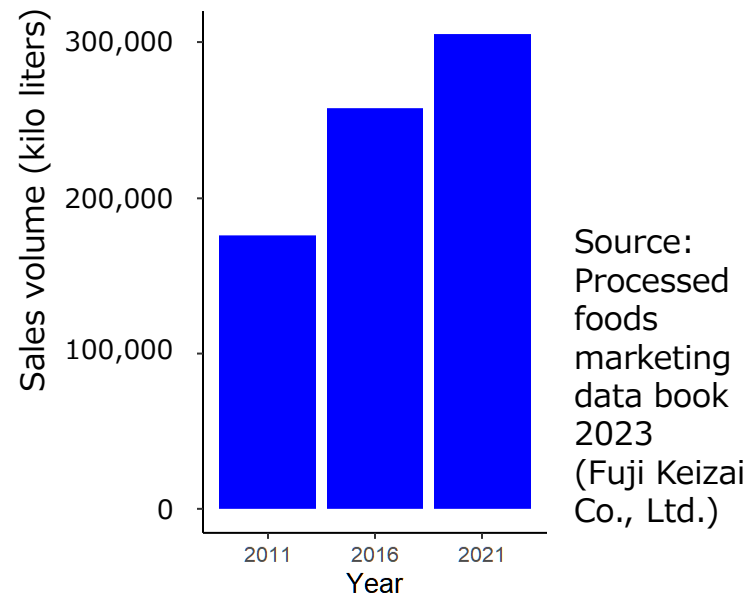
Background

- ✓ Globally, various alternative products are emerging with the growth of interest in health and sustainability.
(ex.) plant-based meat, victimless meat, plant-based milk, insect-based proteins, plant-based sea foods, ... , etc.
- ✓ Non-alcoholic beers are also growing, as alternative products with the aim of enjoying beers without any intake of alcohol.

Sales of non-alcoholic beers in the world

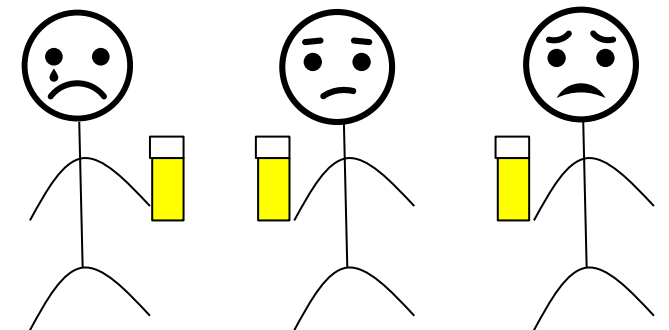


Sales of non-alcoholic beers in Japan



But, many beer drinkers are **not yet satisfied** with them very much.

We are not happy!



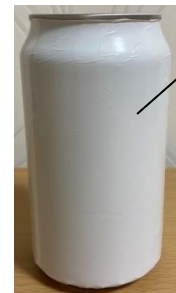
Objective

- ✓ To identify potentially important sensory aspects which could help consumers of regular beers better accept beer alternative products.

Test design

- ✓ 221 Japanese beer consumers, aged 20 to 39, tested four beers, whose alcohol content was 5%(P1), 0.5%(P2), 0.5%(P3), 0%(P4), respectively.
- ✓ P1 and P2 were tested twice (P1_rep, P2_rep) by each consumer without letting them know that they were the same (i.e., different sample codes).
- ✓ 74 were regular consumers (**users**) of beer alternative products with less than 1% alcohol content, while 147 were not regular consumers (**non-users**).
- ✓ They kept their drinking mode, either “directly from the can” or “from a glass,” constantly.

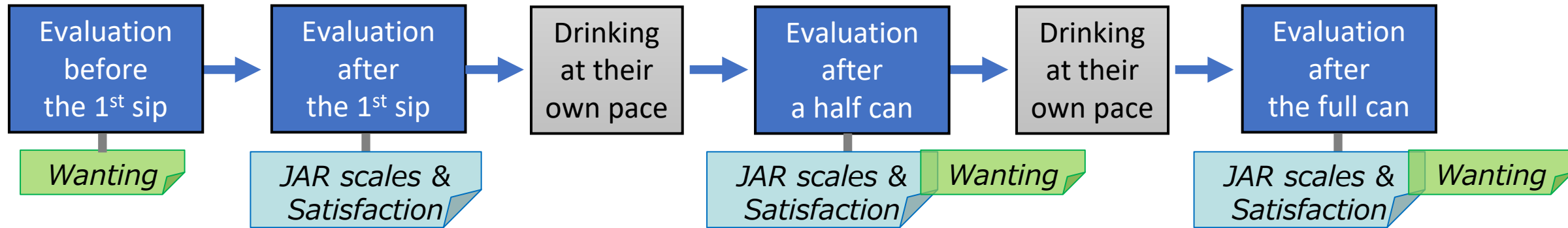
Test product



Blinded by a masking film with a 3-digit code.

Methodology

- ✓ The consumers evaluated full portions of the beers with their own smartphones at home, at the 1st sip, after half of the portion, and after the full portion. **3-step evaluations.**



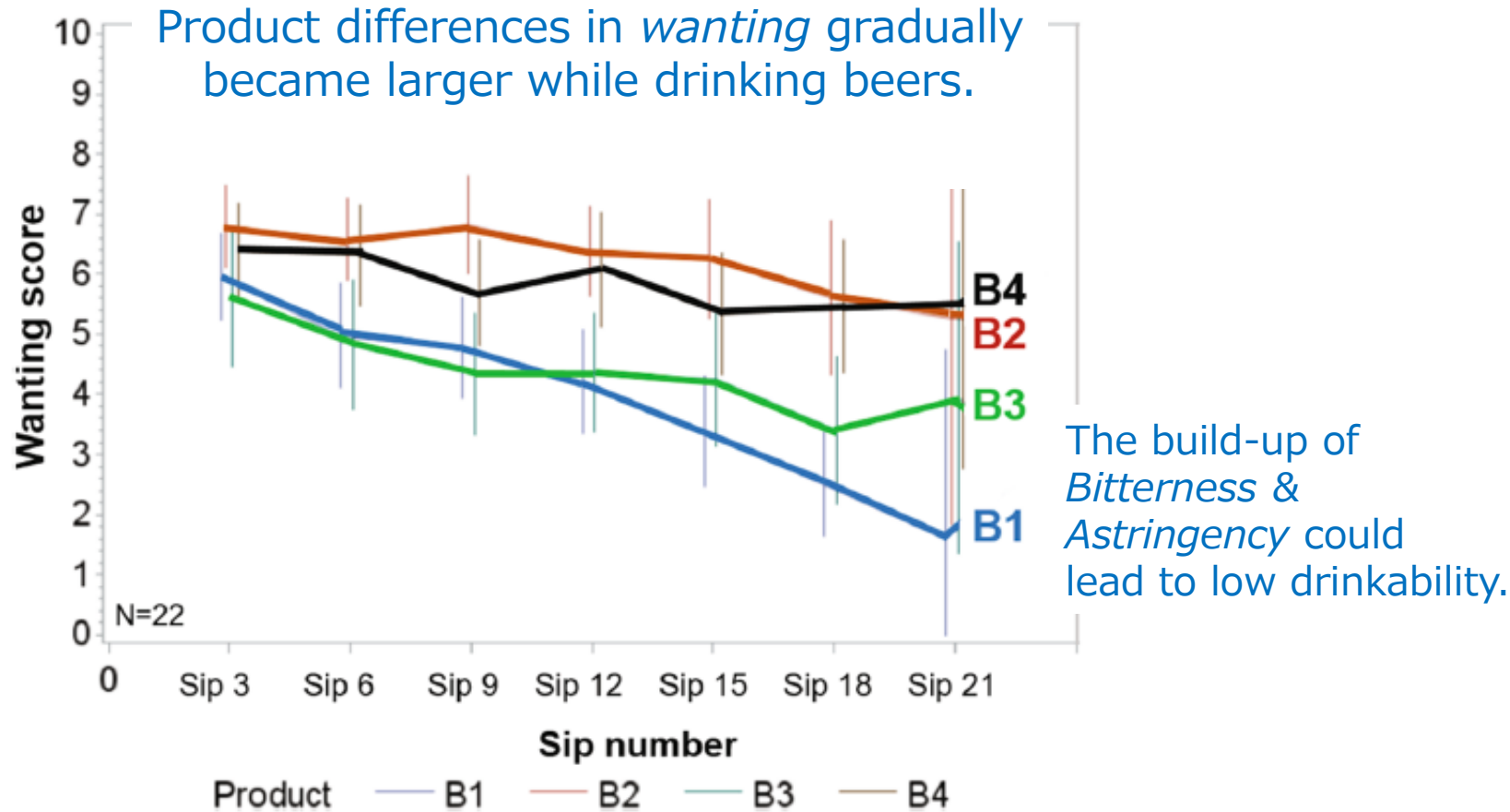
- ✓ 10 sensory attributes with Just-About-Right (JAR) scales:
Sweet taste, Sour taste, Bitter taste, Body of tastes, Stimulation of carbonation, Aftertaste, Alcohol feeling, Malt-like aromas, Fruity aromas, Refreshing aromas.
- ✓ Data were collected using the TimeSens© V2 web app (INRAE, Dijon, France).



Smartphone stand to facilitate data entry while drinking

Reasons behind the methodology

- ✓ Previous researches proved the importance of real-time data collection during a full portion of consumption. Thus, **3-step multiple evaluations** were conducted in the present study.

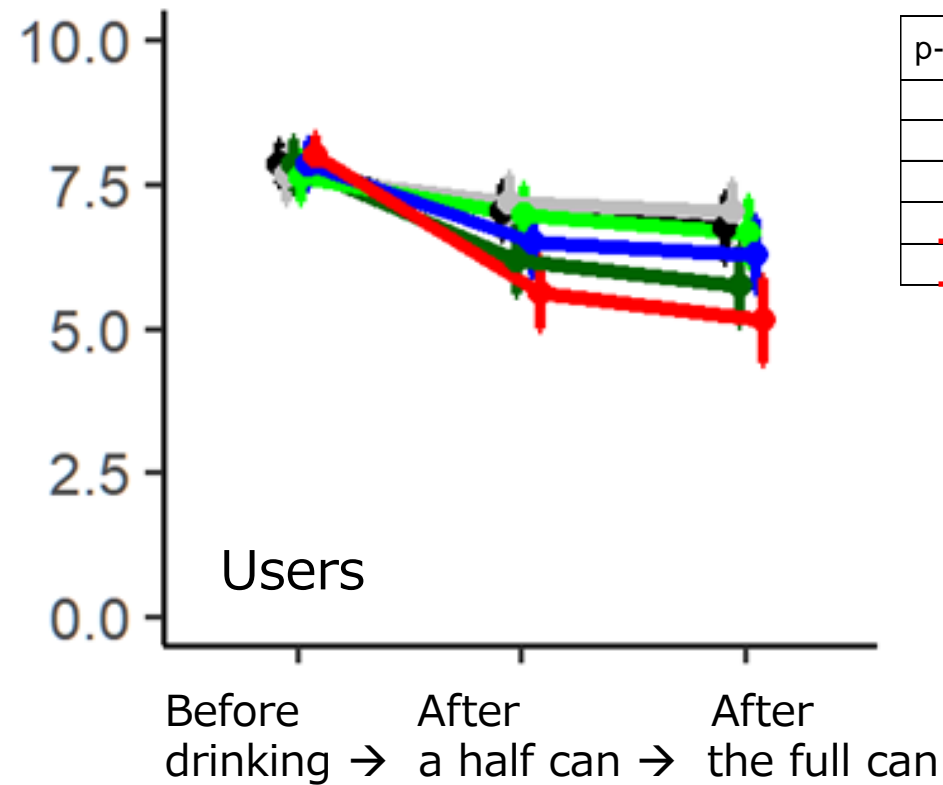
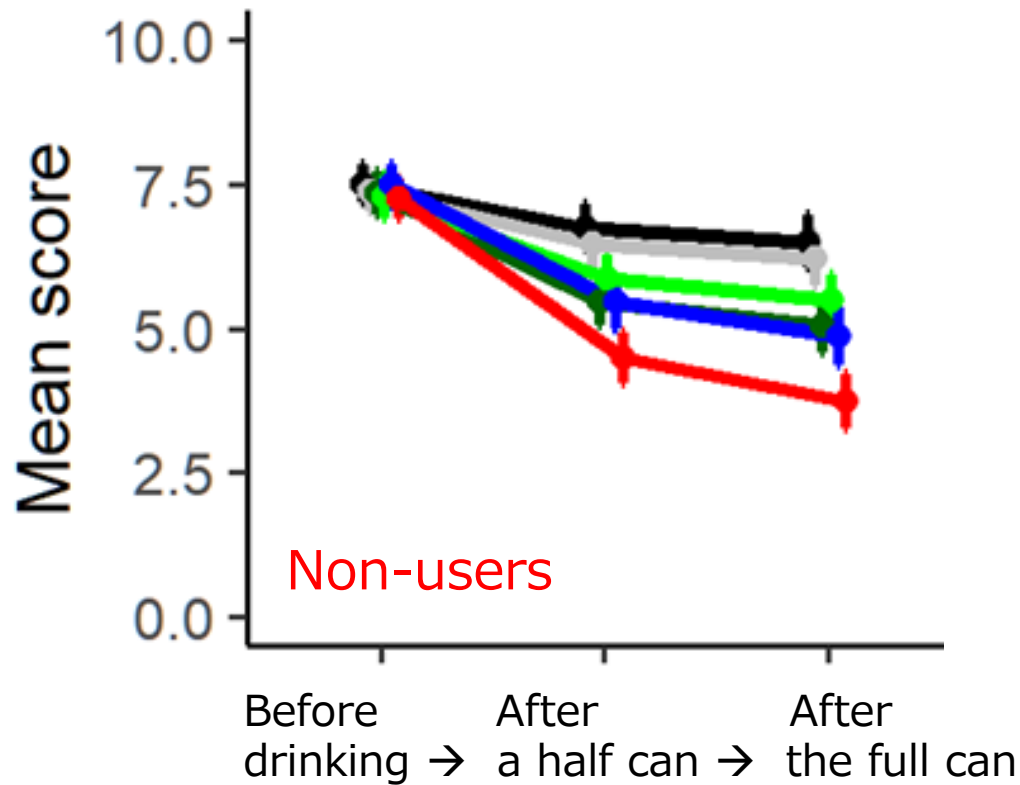


A smartphone, in **natural consumption location** for tasting, allows a consumer to give **fast** and **intuitive** responses.

Results

Evolution of *Wanting*

- ✓ Sig. difference between products. Sig. drop while drinking. Sig. interactions.
- ✓ Drop in *wanting* along tasting was larger for reduced and non-alcoholic beers as compared to regular beers in both groups, but this effect was larger in the **non-user** group.



p-values of tests of fixed effects	
Product	< 0.001
Step	< 0.001
User	< 0.001
<u>Product*Step</u>	< 0.001
<u>Product*User</u>	0.013

Product	Alc.(%)
■ P1	5
■ P1_rep	5
■ P2	0.5
■ P2_rep	0.5
■ P3	0.5
■ P4	0

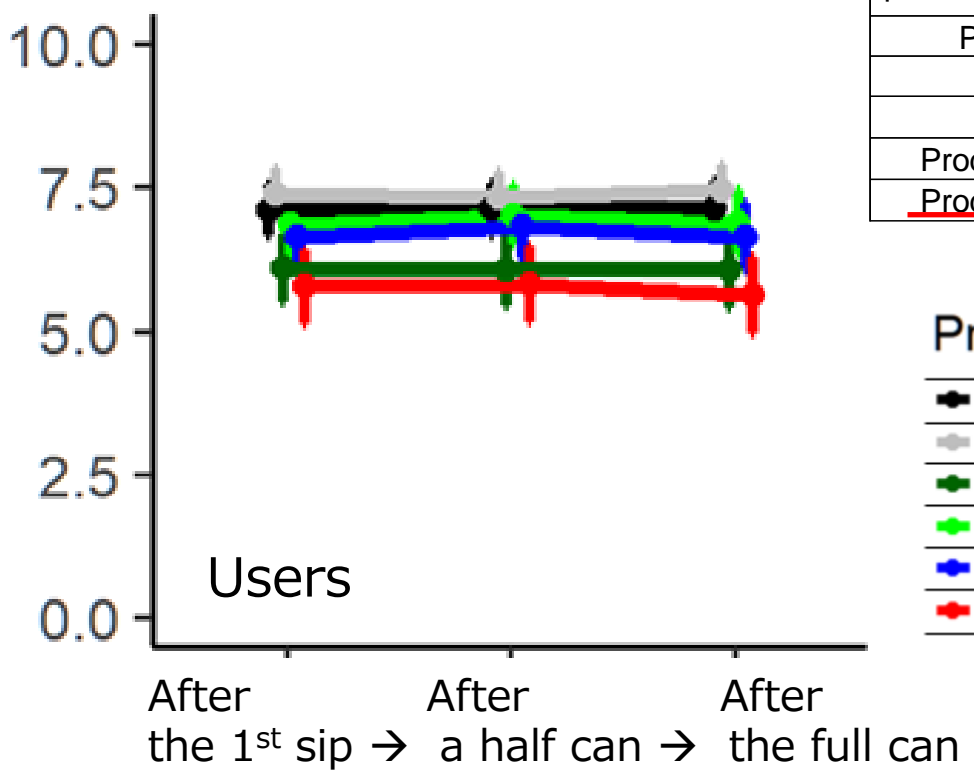
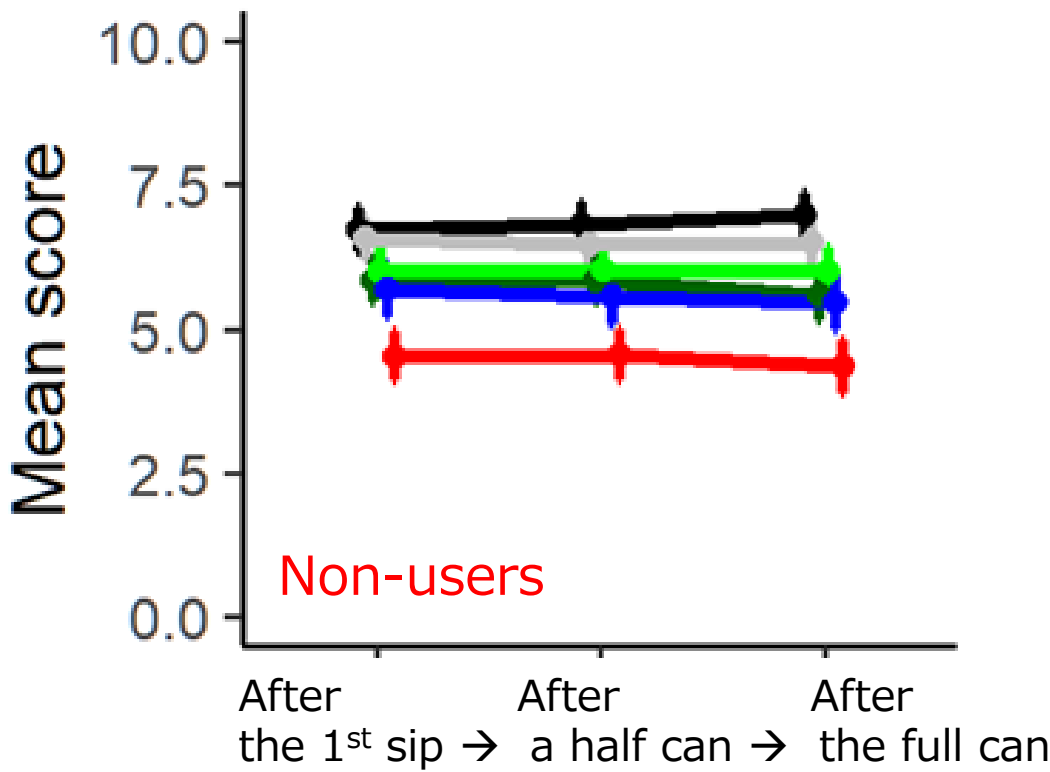
Q: How would you rate your wanting for drinking; a beer (1), this beer (2), this beer more (3) ?
 (1) Before drinking, (2) After a half can, (3) After the full can.

"I do not want it at all."

"I want it very much."

Evolution of *Satisfaction*

- ✓ Sig. difference between products. No sig. change while drinking. Sig. product by user interaction.
- ✓ **Non-users** were less satisfied than users with the beer alternatives.



p-values of tests of fixed effects	
Product	< 0.001
Step	0.745
User	< 0.001
Product*Step	0.994
<u>Product*User</u>	< 0.001

Product	Alc.(%)
■ P1	5
■ P1_rep	5
■ P2	0.5
■ P2_rep	0.5
■ P3	0.5
■ P4	0

Q: How would you rate your satisfaction with this beer?

"I am not satisfied with it at all."

"I am satisfied with it very much."

Perception of "Not Enough" and "Too Much" for attributes

- ✓ Sig. product effect for all the attributes. Sig. step effect (= change in perception) for *aftertaste* and *bitter taste*, while drinking beer samples.

- ✓ Sig. step by product interaction for *aftertaste*, *malty* and *sour taste*.



Changes in perceptions were different among products.

	p-values of tests of fixed effects					
	Not Enough			Too Much		
	Product	Step	Product* Step	Product	Step	Product* Step
<u>Aftertaste</u>	< 0.001	0.004	0.042	< 0.001	0.775	0.442
<u>Alcohol</u>	< 0.001	0.491	0.649	< 0.001	0.691	0.592
<u>Bitter</u>	< 0.001	0.107	0.743	0.002	0.038	0.337
<u>Body</u>	< 0.001	0.324	0.189	< 0.001	0.559	0.148
<u>Carbonation</u>	< 0.001	0.220	0.458	< 0.001	0.484	0.533
<u>Fruity</u>	< 0.001	0.864	0.608	< 0.001	0.662	0.263
<u>Malty</u>	< 0.001	0.527	0.012	< 0.001	0.763	0.975
<u>Refreshing</u>	< 0.001	0.677	0.069	< 0.001	0.515	0.961
<u>Sour</u>	0.002	0.236	0.567	< 0.001	0.476	0.041
<u>Sweet</u>	< 0.001	0.947	0.838	< 0.001	0.050	0.631

Q: How would you rate the level of sensory perception toward this beer?

A: "Not applicable," "Much too weak," "Too weak," "Just about right," "Too strong," "Much too strong."

"Not Enough"

"JAR"

"Too Much"

ANOVA model: Sensory perception (% of citations) = Product + Step + User + Product*Step + Product*User + Step*User + error

Evolutions of *aftertaste* and *bitter taste*

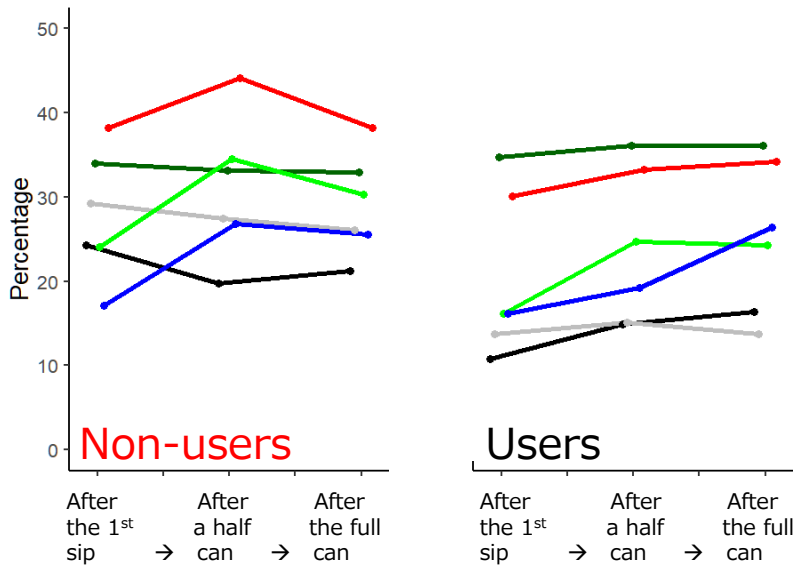
- ✓ Post-hoc tests indicated significant **increase** of “Not Enough” for “Aftertaste” and “Too Much” for “Bitter taste.”

➡ Important to understand change in sensory perception while drinking.

- ✓ Non-users and users **perceived** characteristics of the products **differently**.

Product	Alc.(%)
P1	5
P1_rep	5
P2	0.5
P2_rep	0.5
P3	0.5
P4	0

“Not Enough (%)” for Aftertaste

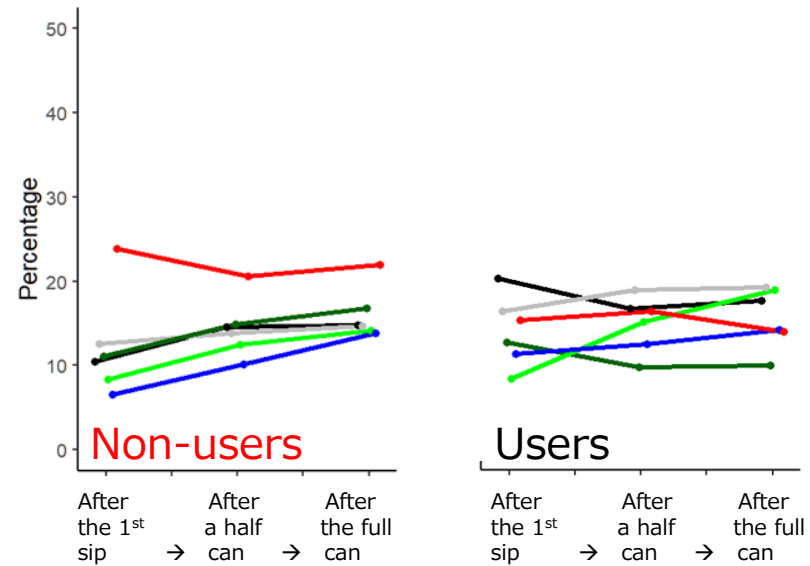


Step LS-Means		
After the 1st sip	After a half can	After the full can
0.241a	0.271b	0.274b

Means with two different letters are significantly different ($p < 0.05$).

p-values of tests of fixed effects	
User	< 0.001
User*Product	< 0.001
User*Step	0.097

“Too Much (%)” for Bitter taste



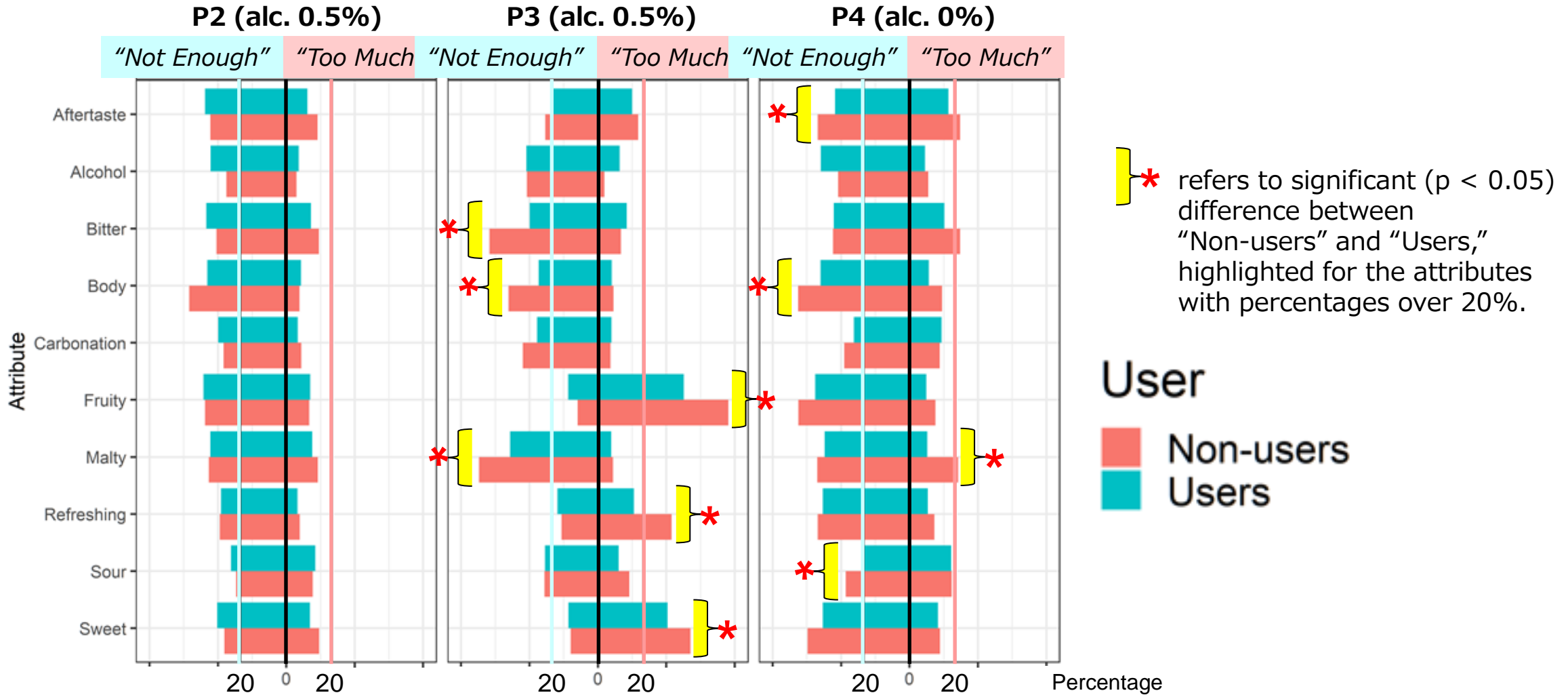
Step LS-Means		
After the 1st sip	After a half can	After the full can
0.131a	0.146ab	0.158b

Means with two different letters are significantly different ($p < 0.05$).

p-values of tests of fixed effects	
User	0.394
User*Product	0.004
User*Step	0.451

Different perceptions between Non-users and Users

- ✓ **Non-users** perceived the beer alternatives (P3 and P4) *"Not Enough"* or *"Too Much"* significantly more than users for most of the attributes (eight out of ten).



Calculation of penalty scores

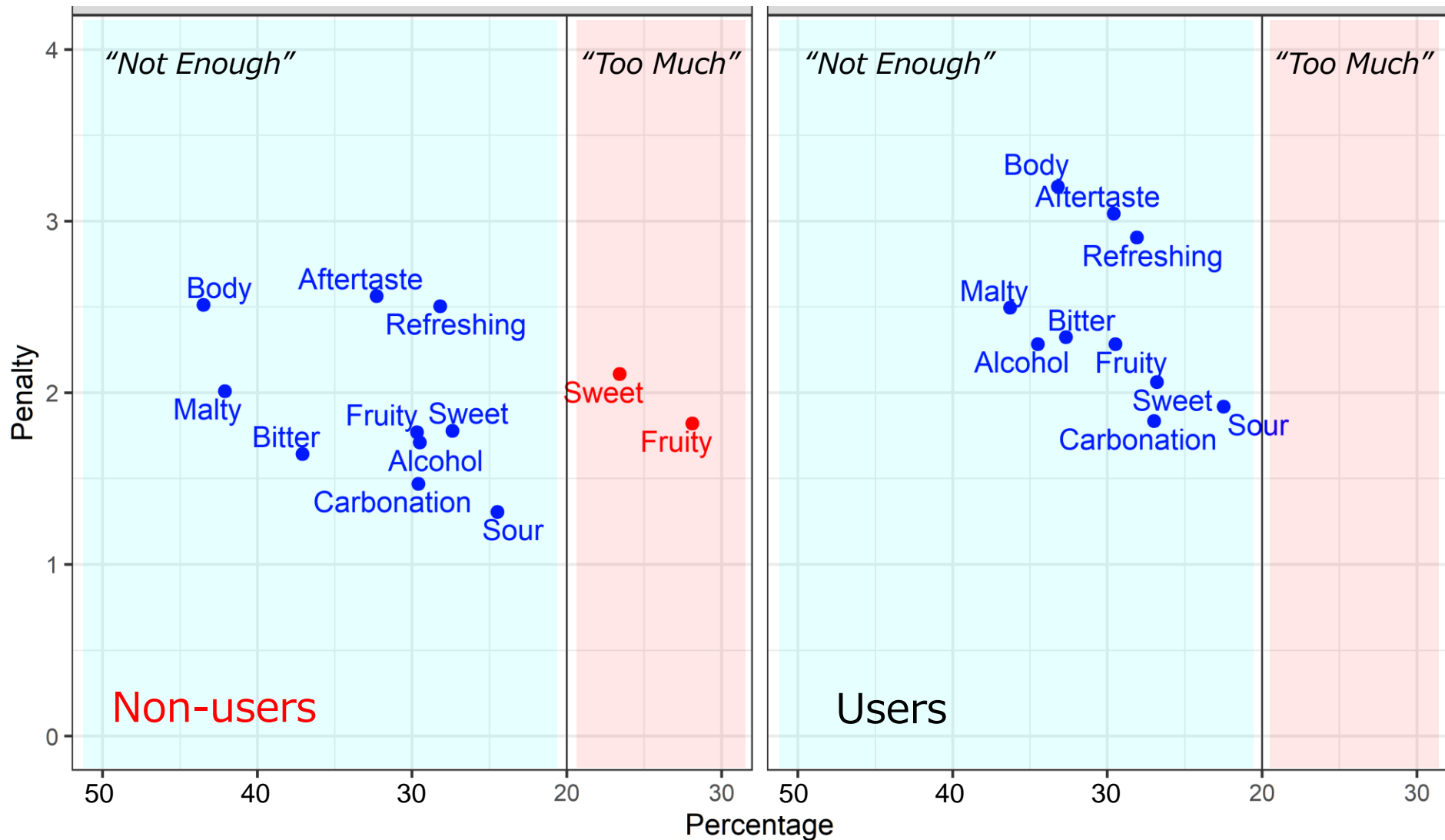
- ✓ Penalty scores of "Not Enough"
= satisfaction scores among "JAR" group – satisfaction scores among "Not Enough" group.
- ✓ Penalty scores of "Too Much"
= satisfaction scores among "JAR" group – satisfaction scores among "Too Much" group.

Examples:

		Satisfaction scores among those who perceived the product as ...			Penalty scores of ...	
		(A) Just-About-Right	(B) Not Enough	(C) Too Much	Not Enough (= A - B)	Too Much (= A - C)
Attribute	User					
	Users	7.42	4.38	5.37	3.04	2.06
	Non-users	6.60	4.04	3.96	2.56	2.65

Sensory penalty on the beer alternatives

- ✓ Effects of sensory perception on satisfaction were **different between users and non-users**.
- ✓ *“Too much”* perception of sensory attributes affected more negatively among **non-users**.



JARGroup

- NotEnough
- TooMuch

Note) Penalty scores are plotted on the maps for the attributes whose percentages of *“Not Enough”* or *“Too Much”* are over 20%.

Note) Data for the beer alternatives of P2, P3 and P4 were used to depict the maps.

Summary of key results

- ✓ Non-users showed more drastic drop in *wanting* than users while drinking the beer alternatives. Significant increase was observed for “*Not Enough*” perception of “*Aftertaste*” and “*Too Much*” perception of “*Bitter taste.*”
 - ➡ Important to understand changes in hedonic and sensory perception while drinking.
- ✓ Non-users were less satisfied than users with the beer alternatives. Non-users perceived two of the beer alternatives “*Not Enough*” or “*Too Much*” significantly more than users for most of the attributes.
 - ➡ More effort required for improvement in beer alternatives to attract non-users.
- ✓ Sensory drivers of satisfaction were different between users and non-users.
 - ➡ Targeting is important when developing a new product of beer alternatives.

Conclusion

Conclusion

- ✓ Consumer evaluation at home revealed changes in wanting and sensory perception while drinking full portions of the beers.
- ✓ Comparison of results between users and non-users of beer alternatives clearly indicated non-users' lower level of satisfaction with the beer alternatives.
- ✓ Results of penalty analysis indicated sensory drivers of satisfaction, which were different between users and non-users.
- ✓ The research design applied in this study could be useful when developing a new product of beer alternatives.

Advertising

If you are interested in knowing about the methodological aspect, please visit our poster number **PX.XXX.!**

Thank you for your attention!

Asahi



Appendix

Calculation of penalty scores and weighted penalty

- ✓ Penalty scores of *“Not Enough”*
= satisfaction scores among *“JAR”* group – satisfaction scores among *“Not Enough”* group.
- ✓ Penalty scores of *“Too Much”*
= satisfaction scores among *“JAR”* group – satisfaction scores among *“Too Much”* group.
- ✓ Weighted penalty
= penalty scores weighted by those percentages of consumers who selected them as *“Not Enough”* or *“Too Much,”* for the attributes with percentages over 20%.

<i>Examples:</i>		P2							
		Not Enough							
Attribute	User	%	Penalty	Weighted Penalty	Attribute	User	%	Penalty	Weighted Penalty
Aftertaste	Users	35.6	2.86	1.02	Fruity	Users	37.7	1.73	0.65
	Non-users	33.3	2.39	0.80		Non-users	57.2	2.29	1.31

Weighted penalty on the beer alternatives

- ✓ Effects of sensory perception on satisfaction were **different between users and non-users**.
- ✓ *“Too much”* perception of sensory attributes affected more negatively among **non-users**.

Penalty Scores (Weighted*)		P2 (alc. 0.5%)		P3 (alc. 0.5%)		P4 (alc. 0%)	
Attribute	User	<i>“Not Enough”</i>	<i>“Too Much”</i>	<i>“Not Enough”</i>	<i>“Too Much”</i>	<i>“Not Enough”</i>	<i>“Too Much”</i>
Aftertaste	Users	1.02	n/a	0.50	n/a	1.16	n/a
	Non-users	0.80	n/a	0.55	n/a	1.05	0.60
Alcohol	Users	0.83	n/a	0.43	n/a	1.09	n/a
	Non-users	0.40	n/a	0.42	n/a	0.66	n/a
Bitter	Users	0.92	n/a	0.52	n/a	0.83	n/a
	Non-users	0.48	n/a	0.62	n/a	0.75	0.42
Body	Users	1.09	n/a	0.71	n/a	1.38	n/a
	Non-users	0.92	n/a	0.94	n/a	1.35	n/a
Carbonation	Users	0.60	n/a	0.24	n/a	0.64	n/a
	Non-users	0.34	n/a	0.46	n/a	0.51	n/a
Fruity	Users	0.61	n/a	n/a	0.65	1.21	n/a
	Non-users	0.51	n/a	n/a	1.31	0.67	n/a
Malty	Users	0.93	n/a	0.70	n/a	1.08	n/a
	Non-users	0.54	n/a	0.97	n/a	1.05	0.42
Refreshing	Users	0.78	n/a	n/a	n/a	1.25	n/a
	Non-users	0.65	n/a	n/a	0.68	0.94	n/a
Sour	Users	0.47	n/a	0.43	n/a	n/a	n/a
	Non-users	0.31	n/a	0.30	n/a	0.28	n/a
Sweet	Users	0.34	n/a	n/a	0.43	1.12	n/a
	Non-users	0.30	n/a	n/a	0.89	0.63	n/a

Note*) Weighted penalty = penalty scores weighted by those percentages of consumers who selected them as *“Not Enough”* or *“Too Much,”* for the attributes with percentages over 20%.

Users

Green highlight refers to **Top 3** scores of weighted penalty among users.

Non-users

Red highlight refers to **Top 3** scores of weighted penalty among Non-users.