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Short Communication

Smells like teen spirit: Associations between odours and stages of life – A preliminary study

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ABSTRACT

This work investigated, whether or not non-trained individuals would assign seven selected odours from different odour groups (i.e. *fruity-citrus, vanilla, floral, spicy-brown, confectionery, green* and *nutty*) according to the concepts of life stages (i.e. kids, adolescents, adults, elderly). Naïve participants were recruited from four different age groups: (i) kids 6–10 years of age, (ii) adolescents 11–20 years, (iii) adults 21–65 years, and (iv) seniors older than 65 years. Results show that six out of seven odours were significantly assigned to a specific life stage by the total of participants. The majority of the participants associated the odours *confectionery* and *vanilla* with the kids' group; *floral* and *spicy-brown* to the adults' group and *green* and *nutty* to the group of elderly people. No odour was clearly assigned to the adolescents' group. These assignments are largely consistent across the investigated age groups, although seniors seem to be less discriminant than the other groups. In contrast to other odours, *fruity-citrus* seems to be assigned differently by the different age groups. The data reveal small gender effects indicating that female test persons assigned the *floral* odour more often to their own age group and *vanilla* odour to kids more frequently compared to male participants. A positive correlation between odour identification and the liking was found, showing that odours correctly identified by the participants were liked significantly more compared to not identified odours. Furthermore, individuals who disliked a specific odour, assigned this odour more frequently to the senior age group compared to individuals liking the same odour.

1. Introduction

Perceiving sensory aspects of food is the starting point of a process, which influences and modulates our behaviour. We stop eating, we continue eating, we eat faster, slower, less or more and so on. But what happens between the initial step of perception and the final behaviour? How are objects, in our case food products, represented in our perceptional system? Object representation is often described in three aspects: (i) percept (what the object is), (ii) concept (what it means), and (iii) affective reaction (how much pleasure or reward it brings) (Carey, 2009; Thomson, 2015). These three aspects result in motivation for a certain behaviour and the behaviour itself. As a consequence, conceptualisations of sensory perceptions are important steps in the behaviour control process.

All objects have conceptual content, often referred to as 'associated meaning' (Carey, 2009). Individuals come to assign meaning to particular objects through personal experience and through learning from others (Thomson & Crocker, 2014). Recently, it has been proposed that some aspects of associated meaning may also be acquired innately (Carey, 2009). Thomson (2010) explains the apparent richness of the conceptual content of an object by its nature. Conceptualisations – although infinitely diverse – can be

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reduced to three broad categories: functional (e.g. '*will refresh me*', '*will wash my clothes cleaner*'), emotional (e.g. '*will make me happy*', '*will annoy me*') and abstract (e.g. '*is trustworthy*', '*is feminine*') conceptualisations. However, in case abstract conceptualisations finally end up in either emotional or functional conceptualisations, Thomson (2010) suggests describing conceptualisation in two types, those having emotional connotations and those having functional connotations.

There exists vast scientific literature about cross modal interactions, which are interactions between various perceptional modalities, for example of odours with colour, taste or sound (Crisinel & Spence, 2011; Gottfried & Dolan, 2003; Kurtz, Lawless, Wansink, & Acree, 2014; Maric & Jacquot, 2013; Nehmé, Barba, Maric, & Jacqout, 2016; Sagiv & Ward, 2006; Shimojo & Shams, 2001; Spence, Ngo, Percival, & Smith, 2013). Also associations of perception with affective reactions and concepts are in the focus of research and often described in literature (Gutjar et al., 2015; Köster & Mojet, 2015; Meiselman, 2015; Mennella & Forestell, 2008; Thomson, 2010; Thomson, Crocker, & Marketo, 2010). However, to the best of the authors' knowledge, our study is the first to investigate the association of odour perception with the concept of stages of life. Stages of life are abstract conceptualisations, which might have emotional connotations. Childhood and youth might be associated with positive feelings like optimism, atmosphere of departure and health, whereas high age might be associated with depression, illness and death.

Within the last years, food industry aimed more and more to develop food products addressing specific consumer groups. Besides other criteria like for example life style, the belonging to a specific age group as for example the 'generation 50plus' has been emphasised in this context recently. The idea of conceptualisation and the existence of products for specific age groups led us to the question if consumers would intuitively assign food odours to the concept of life stages. If this is the case, this would provide additional opportunities for a targeted age-related product development by age-focused selection of food flavouring.

In order to test our hypothesis that naïve, non-trained individuals of different age would consistently assign the four main life stages to odours, we investigated if naïve participants of four different life stages (i.e. kids, adolescents, adults and seniors) would assign selected food related odours to four distinct age groups (kids, adolescents, adults, elderly). In addition, the relationship between the ability to identify smells, their familiarity, liking and conceptualisation was of interest in this study. Relationships between familiarity and liking as well as between the ability to identify and liking were discussed in several publications before, showing that familiarity with an odour generally leads to a higher pleasantness rating than of unfamiliar or unidentified odours, an effect that is generally known as mere exposure effect (Distel & Hudson, 2001; Distel et al., 1999; Nováková, Plotěná, Roberts, & Havlíček, 2015). A probable correlation of the two assumptions (i) conceptualisation of odours in terms of life stages and (ii) pleasantness rating depending on familiarity would open even more interesting connecting points for the design of age related food products.

2. Materials and methods

2.1. Odour samples

For this study seven different odours were selected: *fruity-citrus* (lemon oil), *vanilla* (vanillin), *floral* (linalool), *spicy-brown* (eugenol), *confectionery* (isoamyl acetate), *green* ((E,Z)-nona-2,6-dienal) and *nutty* (2-methoxy-3-methyl pyrazine). These seven odours were chosen for the following reasons: (i) the odours should cover a variety of flavour directions, (ii) they should cover associations throughout all life stages (based on results from preliminary investigations; results not shown) (iii) the odours should be commonly known food flavours or impact compounds. The number of odours was limited to seven in order not to overburden non-trained participants, especially kids.

With the exception of lemon oil (lemon oil Italian type, 100% citrus oil), pure chemical compounds with a purity of at least 95% were used. According to Regulation (EU) No. 872/2012, all compounds are registered in the European Union as flavouring compounds and are authorized to be used in all categories of flavoured foods. The pure substances were diluted in triacetin (purity > 95%) to obtain adequate odour intensities of the solutions (0.1% solutions for (E,Z)-nona-2,6-dienal, and 2-methoxy-3-ethyl pyrazine; 1% solutions for linalool, eugenol and isoamyl acetate; 2 % solution for vanillin). The lemon oil was used as a 5% ethanolic solution. The ready-to-use solutions were kindly provided by Symrise Austria. For the association task, the liking and familiarity evaluation and the identification of odours, sniffing strips made from filter paper were dipped into the solutions and put into cellophane covers until use.

2.2. Participants

The participants for this study were recruited from four different age groups: (i) kids 6 to 10 years; (ii) adolescents 11–20 years; (iii) adults 21–65 years; (iv) seniors 65+ years. We aimed at a total of at least 50 people per age group and used several recruitment approaches: 1) students at the Universities of the involved researchers 2) scholars from available Austrian schools, 3) participants of seminars, and 4) elderly people from a residential home for senior citizens. Students were approached during lectures and also at the University campuses to encourage participation. We did not provide any incentives, so participating individuals obviously had enough endogenous motivation. In total, 397 naïve individuals participated in this survey (76 kids, 103 adolescents, 163 adults, 55 seniors). The ethic committee of the University of Natural Resources and Life Sciences, Vienna confirmed that there was no need for an official ethical approval, as all investigated compounds are registered in the EU positive list of flavouring substances. However, the study was conducted according to the Declaration of Helsinki. For all subjects under the age of 18 years, parents provided written consent.

2.3. General test procedure

Samples were presented sequentially monadic, coded in randomised order. To perform the test procedure the participants were asked to take the sniffing strips out of the covers and to sniff the offered odours. After sniffing, the participants were asked to answer questions on a paper questionnaire, which consisted of the following two parts: (i) question for the age-associated assignment: '*Which age group comes into your mind first, when you smell this odour? Please choose one.*' (kids, adolescents, adults, seniors); (ii) questions concerning the liking of the odours and the familiarity with the presented odours. '*I like the odour.*' (yes/no), and '*I know the odour.*' (yes/no), followed by a request to describe the odour. The questionnaire was intentionally designed very simple and short to allow school aged children to complete the questionnaire with minimal support by adults. The two parts of the questionnaire were randomized within the whole set of panellists in order to avoid effects based on the sequence of questioning. However, chi-square tests showed no significant order effects ($p > 0.05$) on life-stage association, liking or identification frequency (results not shown). The given descriptions were compared to a predetermined descriptor list and categorized as identified correctly or not.

2.4. Statistical data analysis

The data were analysed with a combination of descriptive techniques and chi-square tests with consecutive z-tests using Microsoft Excel 2013 (Microsoft Corporation) and SPSS 22.0 (2013, IBM Corporation, Armonk, USA) at 5% level of significance.

To investigate whether the selected odours were associated with different life stages chi-square tests with consecutive z-tests were performed on the frequency data of the total cohort and for each age group separately. Additionally, the adults' group – as the largest group – was split by gender and the same analyses performed to investigate gender effects. To examine whether liking/disliking influences the assignment of odours to the selected life stages, chi-square tests were conducted for each odour. Chi-square tests were also used to analyse the relationship between odour identification and liking/disliking for each odour individually and pooled for all odours.

3. Results and discussion

3.1. Associative assignment of odours to specific life stages

The data obtained from the total of 397 participants are summarised in Table 1 and for each age group individually in Table 2. The results of the chi-square test indicate that the odours are associated with different life stages ($p < 0.001$, for the total cohort and all age groups). The consecutive z-tests indicate that all used odours except *fruity-citrus* were significantly assigned to a certain life stage by the total of participants. These assignments are largely consistent throughout the age groups of participants, although seniors seem to be less discriminant than the other groups and the odour *fruity-citrus* seems to be assigned differently by the four age groups (Table 2). One possible reason for the less discriminative age group assignment, especially for *floral*, *fruity-citrus* and *spicy-brown*, could be that seniors are generally regarded as less sensitive than the average adult (Doty et al., 1984). This is also supported by the lower identification rate of seniors compared to adults (Table 2). However, odours like *green* and *nutty* – despite very low identification rates – were clearly assigned to specific age groups. To explain those differences in detail further studies with more participants in combination with odour threshold testing are required. Results show that *confectionery* and *vanilla* were assigned to the kids' group by 48% and 42% of all participants, respectively (Table 1). These values are significantly higher than the expected 25% by chance. *Confectionery* and *vanilla* flavours are widely used for food products designed for kids. As a consequence, we suppose that participants simply reproduced what they had learned by their own and their kids' consuming behaviour. *Floral* and *spicy-brown* were assigned to the adults' group by majorities of 40% and 39%. Flowers are often associated with reproduction and sexuality and therefore might be connected more closely to the adults' group. *Spicy-brown* is the flavour of ripeness and full development, which in terms of periods of life might be seen closer to adults than to other life stages. *Green* and *nutty* odours were associated with seniors by majorities of 44% and 53%, respectively. Two aspects might be the associative bridge from *nutty* odour to the elderly group. Nuts are fruits of the autumn and the surface of a nut is often – in analogy to the faces of old humans – very wrinkled. *Green* is also a smell of the harvest and maybe also the smell produced by elderly people cutting the lawn of their garden. For the *green* odour (E,Z) nona-2,6-dienal was chosen – a compound that is representative for the odour of cucumber. It is well known that vegetables belong to children's least accepted food category (Caporale, Policastro, Tuorila, & Monteleone, 2009; Poelman, Delahunty, & de Graaf, 2015). This aversion for vegetables and the corresponding odour could be the reason why the *green* odour is not associated with the groups of low age but rather to the group of elderly people. *Fruity-citrus* was the only aroma that was not clearly assigned to any of the four age groups by the total of participants. Only the group of adults clearly assigned it to the adolescent group (37%) and adolescents to the kids group (36%) (Table 2). An interesting, however, not significant observation, is, that seniors assign *fruity-citrus* to adults and adolescents by the majority, adults to adolescents and adolescents to the kids, each age group to the younger group respectively. Only kids assign *fruity-citrus* to their own group by a relative majority. So *fruity-citrus* odour might be the smell of the respective younger generation from the perspective of each smelling individual. Besides the aforementioned effects, the results are very consistent across age groups.

The data for the adult group reveal a small gender effect (Table 3). Female test persons assigned the *floral* odour more often to their own age group (50%) compared to the male group (34%). From perfumery science, it is well known that floral odours are strongly correlated with feminine fragrances and that most women would apply perfumes and fragrances showing floral components (Zarzo, 2015). This behaviour may also lead to the stronger assignment of *floral* odour by females to their own age group. Women also tended to assign *vanilla* odour to kids more frequently (45%) then men (32%), and men assigned *vanilla* more often to adolescents (30%) than women did (19%). On the contrary, men assigned *nutty* more often to the adult group (40%) compared to females (25%), who assigned this odour more often to adolescents (11%) than men (2%). However, at present, we cannot offer any explanation or evidence from other research areas for the observed gender effect.

3.2. Relationship between liking and life stage assignment

The results of this study showed a significant relation between the hedonic evaluation of the odours and the assignment of life stages for six out of seven odours (chi-square test $p < 0.05$, for all

Table 1
Assignments, liking and identification of seven odours for the total cohort. The chi-square test was highly significant ($p < 0.001$). Different letters indicate significant differences across age groups (z-test, $p < 0.05$).

	Kids [%]	Adolescents [%]	Adults [%]	Seniors [%]	Liking of odour [%]	Identification rate [%]
***Total cohort**, N = 379, females, 56.4%, average age 30.5 years*						
Confectionery	48^{c}	23^{b}	17^{a}	12^{a}	74	74
Floral	13^{a}	19^{b}	40^{c}	28^{b}	65	59
Fruity-citrus	27^{b}	31^{c}	27^{b}	15^{a}	85	85
Green	9^{a}	10^{a}	37^{b}	44^{c}	40	61
Nutty	9^{a}	11^{a}	27^{b}	53^{c}	19	45
Spicy-brown	19^{a}	17^{a}	39^{b}	25^{a}	78	82
Vanilla	42^{d}	27^{c}	22^{b}	9^{a}	87	80
Total	24	20	30	26		

Table 2
Assignments, liking and identification of seven odours for the total cohort. The chi-square test were highly significant for all age groups ($p < 0.001$). Different letters indicate significant differences across age groups (z-test, $p < 0.05$).

	Kids [%]	Adolescents [%]	Adults [%]	Seniors [%]	Liking of odour [%]	Identification rate [%]
***Kids' group**, N = 76, females = 48.7%, average age = 8.6 years*						
Confectionery	38^{b}	20^{ab}	24^{ab}	18^{a}	83	62
Floral	21^{a}	22^{ab}	33^{b}	25^{ab}	71	51
Fruity-citrus	36^{b}	24^{ab}	25^{ab}	16^{a}	96	76
Green	18^{a}	14^{a}	29^{ab}	38^{b}	55	54
Nutty	14^{a}	11^{a}	20^{a}	55^{b}	28	43
Spicy-brown	29^{ns}	25^{ns}	29^{ns}	17^{ns}	78	80
Vanilla	46^{b}	25^{b}	16^{a}	13^{a}	92	75
Total	29	20	25	26		
***Adolescents' group**, N = 103, females = 43.7%, average age = 14.2 years*						
Confectionery	56^{c}	19^{b}	14^{a}	11^{a}	70	79
Floral	9^{a}	15^{b}	38^{c}	39^{c}	58	56
Fruity-citrus	34^{b}	26^{b}	23^{ab}	17^{a}	77	86
Green	10^{a}	8^{a}	36^{b}	47^{b}	32	68
Nutty	9^{a}	13^{a}	30^{b}	49^{c}	8	40
Spicy-brown	29^{ab}	17^{a}	36^{b}	17^{a}	83	84
Vanilla	40^{c}	39^{c}	16^{b}	6^{a}	88	80
Total	27	20	28	26		
***Total Adults' group**, N = 163, females = 67.5%, average age = 36.0 years*						
Confectionery	53^{c}	24^{b}	14^{a}	9^{a}	67	83
Floral	11^{a}	18^{b}	45^{c}	26^{b}	65	69
Fruity-citrus	22^{b}	37^{c}	29^{b}	12^{a}	85	93
Green	5^{a}	7^{a}	39^{b}	48^{c}	38	64
Nutty	6^{a}	8^{a}	30^{b}	56^{c}	18	46
Spicy-brown	9^{a}	7^{a}	47^{b}	37^{b}	75	85
Vanilla	41^{d}	23^{b}	27^{c}	9^{a}	83	85
Total	21	18	33	28		
***Seniors' group**, N = 55, females 56.4%, average age = 75.2 years*						
Confectionery	33^{b}	33^{b}	24^{ab}	11^{a}	80	56
Floral	16^{ns}	22^{ns}	42^{ns}	20^{ns}	69	45
Fruity-citrus	16^{ns}	31^{ns}	33^{ns}	20^{ns}	85	73
Green	9^{a}	15^{a}	45^{b}	31^{b}	42	49
Nutty	7^{a}	16^{a}	25^{a}	51^{b}	35	51
Spicy-brown	13^{ns}	33^{ns}	38^{ns}	16^{ns}	82	69
Vanilla	40^{b}	24^{a}	25^{a}	11^{a}	91	69
Total	19	25	33	23		

Table 3
Assignments, liking and identification of seven odours for female and male adults. The chi-square test were highly significant for both genders ($p < 0.001$). Different letters indicate significant differences across age groups (z-test, $p < 0.05$).

	Kids [%]	Adolescents [%]	Adults [%]	Seniors [%]	Liking of odour [%]	Identification rate [%]
***Female adults**, N = 110, average age = 34.1 years*						
Confectionery	54^{c}	25^{b}	12^{a}	10^{a}	65	85
Floral	9^{a}	16^{ab}	50^{c}	25^{b}	67	72
Fruity-citrus	21^{b}	35^{c}	31^{b}	14^{a}	84	93
Green	4^{a}	10^{b}	42^{c}	45^{c}	40	67
Nutty	6^{a}	11^{ab}	25^{b}	57^{c}	15	44
Spicy-brown	9^{a}	5^{a}	45^{b}	40^{b}	80	87
Vanilla	45^{c}	19^{b}	26^{b}	9^{a}	85	86
Total	21	17	33	28		
***Male adults**, N = 53, average age = 39.9 years*						
Confectionery	51^{c}	23^{b}	19^{ab}	8^{a}	72	79
Floral	15^{a}	23^{a}	34^{a}	28^{a}	60	64
Fruity-citrus	25^{b}	42^{c}	26^{b}	8^{a}	87	94
Green	8^{a}	2^{a}	34^{b}	57^{c}	34	57
Nutty	6^{a}	2^{a}	40^{b}	53^{b}	23	51
Spicy-brown	9^{a}	9^{a}	49^{c}	32^{b}	64	79
Vanilla	32^{b}	30^{b}	28^{b}	9^{a}	79	83
Total	21	19	33	28		

odours except *confectionery*, see Fig. 1). When odours were disliked, they were associated more often with the group of seniors which can be seen best for the odours *nutty* and *green*, but also holds true for the other odours under investigation (Fig. 1). On the other hand, if an odour was liked it was more likely to be assigned to the kids' group (Fig. 1). Schloss, Goldberger, Palmer, and Levitan (2015) reported that the preference for identified odours was strongly related to the preference for objects associated with this odour. The fear or unpopularity of higher age life stage might be a reason for these correlations.

3.3. Relationship between odour identification and liking

Fig. 2 shows that odours, which were identified correctly, are liked to a significantly higher percentage than those, which were not identified. This relationship is statistically significant

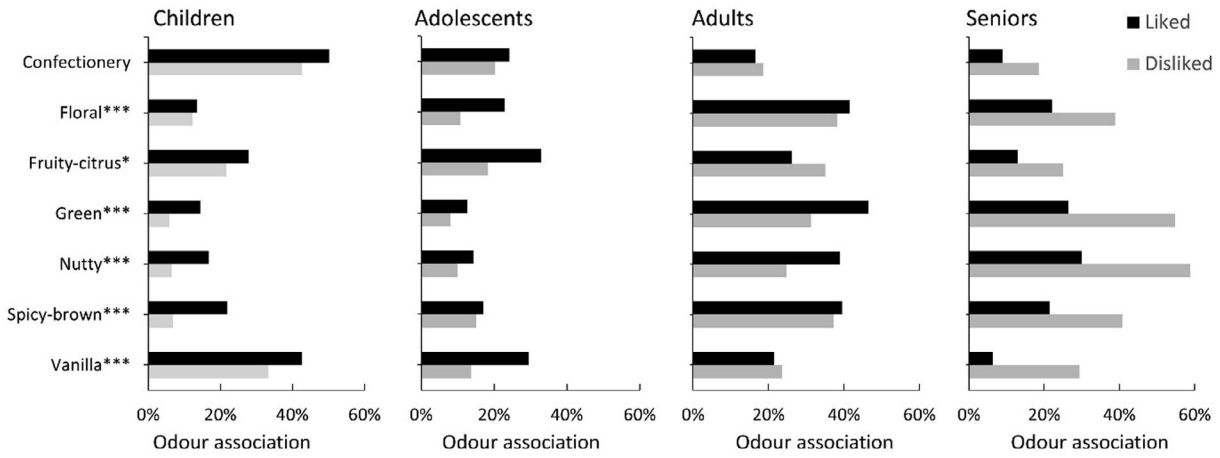

Fig. 1. Assignments to the four age groups dependent on odour liking. Statistically significant differences based on the results of the Chi-square test are marked with * for $p < 0.05$ and with *** at $p < 0.001$.

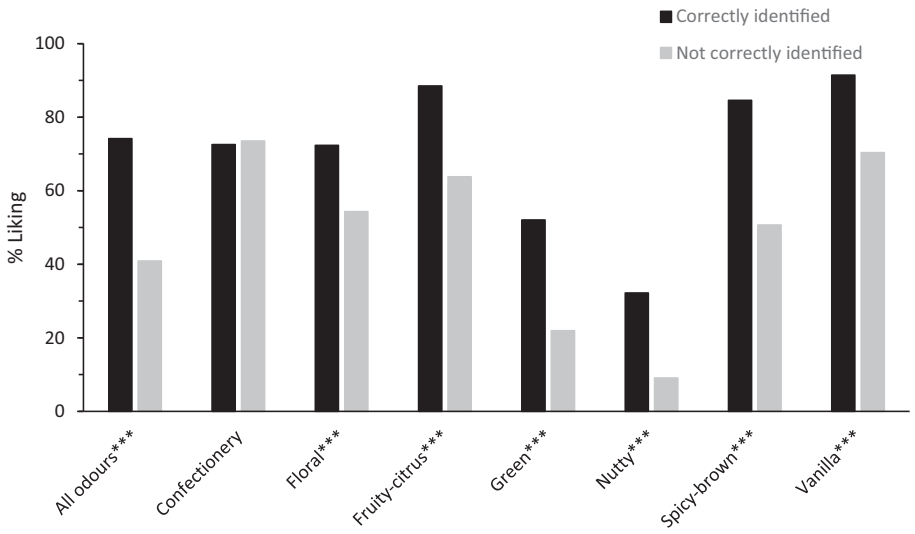

Fig. 2. Proportion of participants liking the odour (participants indicated if they like or dislike the odour) depending on correct and incorrect identification of the odours. (*** denotes a statistically significant difference in liking between identifiers and non-identifiers, $p < 0.001$).

($p < 0.001$) for six out of seven investigated odours; only *confectionery* is equally liked when identified and not identified. The fact that odours were rated more pleasant (or in case of this study, were liked by a higher proportion of participants, see Fig. 2) when identified compared to the same odours when not identified was described earlier (Distel & Hudson, 2001). Recently, Martinec Nováková, Plotena, Roberts, & Havlicek (2015) described a positive relationship between odour identification and affective responses for unpleasant odours like garlic or fish but not for pleasant odours. In contrast to their findings and in agreement with Distel and Hudson (2001), we found a positive relationship between the affective responses and the identification rate also for pleasant odours including *vanilla, fruity-citrus* and *spicy-brown* (see Fig. 2). In our study, only the odourant *confectionery* is liked to the same extent no matter if it was identified or not. All other odours were liked more (in terms of frequency) when they were identified and liked less when they were not identified.

4. Limitations and future research directions

Even though this preliminary study shows several clear effects, it also bears some limitations. Firstly, only seven odours were used. Since human beings are able to perceive several thousands of odours, the investigated odours represent only a small cut-out of the whole picture. The odours (with exception of *fruity-citrus*) were used in terms of adequate solutions of pure chemical compounds. Working with such simple types of odour samples is advantageous in terms of definition of the stimuli, but detrimental in terms of near to life considerations. Future studies might consider using more complex aromas, which are closer to everyday food or nature. A second limitation refers to the definition of age stages. The age stages, to which the odours had to be associated, were not defined to the participants prior to the test. We simply used the terms 'kids', 'adolescents', 'adults' and 'seniors' hoping, that the test persons would intuitively have similar conceptions of these age stages. However, the fact that we did not use a free association method, but probably rather guided the participants into the direction of age associations, might be a further limitation of this study. Full conceptional profiling might provide deeper insights regarding the importance of age associations compared to the whole conceptualisation of odours. Furthermore, due to the limited number of participants, gender effects were only analysed for the adult age group. However, with respect to a detailed segmentation within the age groups investigating gender or life style effects, the participant number should be increased in future studies. Despite the

interesting results obtained from our investigations, this study did not gain any insight into the causes of the found associations. A way to get ideas, why people are associating odours to age stages, would be to ask and discuss that question with test persons in form of focus group discussions or one-on-one interviews. Although unconscious associative processes are out of access to cognitive thinking, one might despite that fact get several starting points to explore this background.

5. Conclusions and perspectives

The results from this study imply that associative assignments of odours to certain life stages actually do exist for selected odours. As some associations like the association of *vanilla* with the kids' group might seem rather obvious, others were unexpected or even surprising. The finding that participants assigned pleasant smells to the youth and unpleasant smells to the elderly might appear a bit offending, but this matter of fact could have its roots in certain conceptions of the final period of life. However, food industry is aiming more and more to develop products designed for specific age groups. Knowledge about associations between specific periods of life and odours will deliver valuable information for product development targeting specific age groups. Nonetheless, based on the results of this preliminary study it has to be shown in future research, how stable these odour-age associations are. Cross-cultural effects may also be expected and explored in a more complex test design.

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References

Caporale, G., Policastro, S., Tuorila, H., & Monteleone, E. (2009). Hedonic ratings and consumption of school lunch among preschool children. *Food Quality and Preference, 20*, 482–489.

Carey, S. (2009). *The Origin of Concepts* (1st ed.). Oxford, UK: Oxford University Press.

Crisinel, A.-S., & Spence, C. (2011). Crossmodal associations between flavoured milk solutions and musical notes. *Acta Psychologica, 138*(1), 155–161.

Distel, H., Ayabe-Kanamura, S., Martínez-Gómez, M., Schicker, I., Kobayakawa, T., Saito, S., & Hudson, R. (1999). Perception of Everyday Odors—Correlation between Intensity, Familiarity and Strength of Hedonic Judgement. *Chemical Senses, 24*(2), 191–199.

Distel, H., & Hudson, R. (2001). Judgement of odour intensity is influenced by subjects' knowledge of the odour source. *Chemical Senses, 26*, 247–251.

Doty, R. L., Shaman, P., Applebaum, S. L., Giberson, R., Sikorski, L., & Rosenberg, L. (1984). Smell identification ability: Changes with age. *Science, 21*, 1441–1443.

Gottfried, J. A., & Dolan, R. J. (2003). The nose smells what the eye sees: Crossmodal visual facilitation of human olfactory perception. *Neuron, 39*(2), 375–386.

Gutjar, S., Dalenberg, J. R., de Graaf, C., de Wijk, R. A., Palascha, A., Renken, R. M., et al. (2015). What reported food-evoked emotions may add: A model to predict consumer food choice. *Food Quality and Preference, 45*, 140–148.

Köster, E. P., & Mojet, J. (2015). From mood to food and from food to mood: A psychological perspective on the measurement of food-related emotions in consumer research. *Food Research International, 76*(2), 180–191.

Kurtz, A. J., Lawless, H. T., Wansink, B., & Acree, T. E. (2014). Chapter 4 – The impact of vision on flavor perception. In V. Ferreira & R. Lopez (Eds.), *Flavour science* (pp. 21–25). San Diego, USA: Academic Press.

Maric, Y., & Jacquot, M. (2013). Contribution to understanding odour-colour associations. *Food Quality and Preference, 27*(2), 191–195.

Martinec Nováková, L., Plotena, D., Roberts, S. C., & Havlicek, J. (2015). Positive relationship between odor identification and affective responses of negatively valenced odors. *Frontiers in Psychology, 6*, 1–9.

Meiselman, H. L. (2015). A review of the current state of emotion research in product development. *Food Research International, 76*, 192–199.

Mennella, J. A., & Forestell, C. A. (2008). Children's hedonic responses to the odors of alcoholic beverages: A window to emotions. *Alcohol, 42*(4), 249–260.

Nehmé, L., Barba, R., Maric, Y., & Jacqout, M. (2016). Influence of odor function and color symbolism in odor-color associations: A French-Lebanese-Taiwanese cross-cultural study. *Food Quality and Preference, 49*, 33–41.

Poelman, A. A. M., Delahunty, C. M., & de Graaf, C. (2015). Vegetable preparation practices for 5–6 years old Australian children as reported by their parents; relationships with liking and consumption. *Food Quality and Preference, 42*, 20–26.

Sagiv, N., & Ward, J. (2006). Crossmodal interactions: Lessons from synesthesia. *Progress in Brain Research, 155*, 259–271.

Schloss, K. B., Goldberger, C. S., Palmer, S. E., & Levitan, C. A. (2015). What's that smell? An ecological approach to understanding preferences for familiar odors. *Perception, 44*, 23–38.

Shimojo, S., & Shams, L. (2001). Sensory modalities are not separate modalities: Plasticity and interactions. *Current Opinion in Neurobiology, 11*(4), 505–509.

Spence, C., Ngo, M. K., Percival, B., & Smith, B. (2013). Crossmodal correspondences: Assessing shape symbolism for cheese. *Food Quality and Preference, 28*(1), 206–212.

Thomson, D. M. H., & Crocker, C. (2014). Development and evaluation of measurement tools for conceptual profiling of unbranded products. *Food Quality and Preference, 33*, 1–13.

Thomson, D. M. H., Crocker, C., & Marketo, C. G. (2010). Linking sensory characteristics to emotions: An example using dark chocolate. *Food Quality and Preference, 21*(8), 1117–1125.

Thomson, D. M. H. (2015). Expedited procedures for conceptual profiling of brands, products and packaging. In J. Delarue, J. B. Lawlor, & M. Rogeaux (Eds.), *Rapid sensory profiling techniques* (pp. 91–118). Cambridge, UK: Woodhead Publishing.

Thomson, D. (2010). Going beyond liking: Measuring emotional and conceptual profiles to make better new product. In S. R. Jaeger & H. MacFie (Eds.), *Consumer-driven innovation in food and personal care products* (pp. 219–274). Cambridge, UK: Woodhead Publishing.

Zarzo, M. (2015). Underlying Dimensions in the Descriptive Space of Perfumery Odours: Part II. *Food Quality and Preference, 43*, 79–87.