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Measuring individual differences in active smelling to evaluate products – The ENFAS-Instrument

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ABSTRACT

Consumers evaluate products with all their senses but exhibit considerable variability in the extent to which they actively use and rely on a specific sense. We know little about the variability in consumers' propensity to actively engage their sense of smell in the context of product evaluation in purchase decision making. This research provides insights into this issue by conceptualizing the *need for smell* construct, detailing the development of the ENFAS scale, and providing state-of-the-art psychometric evidence of its validity. Ten studies contributed to a two-dimensional 11-item instrument, supporting the scale's external and cross-national validity, and establishing the position of need for smell in its nomological net. The results yield insight into how smell perception affects consumer choices and may help optimize product presentations for the retail context.

1. Introduction

Consumers use, to a varying extent, all their senses when they engage with physical products (Krishna, 2012). From an evolutionary perspective, the sense of smell is one of our older senses (Sell 2014). It plays a crucial role in determining our diet and health (Cavalieri 2022; Ahmed & Haboubi, 2010). Surprisingly, there is scant literature on how consumers actively engage their sense of smell when they evaluate products in purchase decision making. Recently, "Too Good to Go" launched their "Look, Smell, Taste, Don't Waste" Campaign in the UK, reminding consumers to use their sense of smell to determine whether a food item is still edible and enjoyable, rather than discarding it just to be safe. Such a strategy contributes to preventing food waste and helps tackle current societal challenges.

In our paper, we show that investigating peoples' active smelling behavior in consumption situations has consequences for the products and services they choose to buy and consume, as well as their shopping experience and, thereby, the shops and retail channels they prefer. In the marketing literature, the importance of smell has predominantly been recognized in research on ambient scent (Lwin et al. 2016; Madzharov et al., 2015; Morrin 2010; Krishna et al. 2010; Bosmans 2006; Schifferstein & Blok 2002; Bone & Jantrania 1992), where consumers passively perceive odors aiming at, for example, raising their mood and stimulating their purchase intentions in stores. In contrast, we focus on the active engagement of the consumer's sense of smell when it comes to evaluating products.

When we started our project in 2011, we observed how consumers interact with products at the point-of-sale, just to get a better exploratory feeling for the phenomenon (Koller et al. 2012a; Koller et al. 2012b). When we watched shoppers for fruits and vegetables, we observed different types of engagement with the products. Some patrons picked the products from the rack and put them directly into the shopping cart without further engaging their senses. Others, however, smelled the product before they decided whether they would take it. Apples, grapes, melon, banana, plums and peach were among the most frequently smelled produces. This was a first indication from the field that consumers indeed vary in terms of whether they actively engage their sense of smell when evaluating products. Many consumers smelling

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the products touched the product first, picked it up and brought it to their noses. Only a couple of customers did not touch the product but took a sniff by bending down and moving the nose to the product.

Prior research has shown that consumers making buying decisions may vary in their associated needs, such as the need for cognition (Cacioppo and Petty 1982), their need to evaluate (Jarvis and Petty 1996) or their need for touch (Peck and Childers 2003). The need-for-touch scale developed by Peck and Childers (2003) has paved the way for applied research investigating the implications of individual differences in terms of the importance of the sense of touch for product evaluation. However, there is no psychometric scale capturing the peculiarities of the olfactory sense that would allow researchers to obtain linear measurements of the individual need for smell when it comes to product assessment. Such validated measurement instruments are pivotal for gaining substantive knowledge (Haws, Sample, and Hulland, 2023). The aim of the present paper is to fill this gap.

For the sense of smell, two need-based scales have been proposed recently. Dörtyol (2021) developed the Need to Smell (NTS) scale. This two-dimensional instrument aims to measure the "degree to which an ambient scent is effective on consumers' shopping experiences" (p. 1). Thus, it focuses on ambient scents rather than product scents, even though confusingly there is one item related to product smell ("For feeling more confident, I desire to buy products that I can smell before purchase.") in the 6-item first dimension. The second dimension comprises only two items relating to a shop with an unpleasant scent being careless and to feeling uncomfortable in such a store. Again, this dimension captures ambient scent, and possibly store image. As the instrument lacks conceptual clarity, it is not considered fit for our purpose. In 2023, Pappu et al. published a scale measuring the motivational differences in need for smell. While in principle this candidate instrument has a better-defined conceptual focus, its development is not based upon a conceptualization taking the peculiarities of the olfactory modality into account. Rather, the authors adopt the whole conceptualization and even the question wording from the need for touch scale (Peck and Childers 2003), only replacing the word touch with smell. The resulting scale can therefore not be considered as generated on the basis of established principles of scale development (Churchill, 1979). Finally, both scales rely entirely on the psychometric analyses based on classical test theory (Lord and Novick, 1968) treating manifest item scores as interval scales, which they are arguably not. As a result, inferred measurements cannot be considered linear. What is more, no coherent scoring scheme is offered which would make measurements comparable from one study to another. Rather, the scale metric changes from one study sample to another.

In a series of ten studies (see Table 1), we first develop a conceptual framework explicating the consumer characteristic of need for smell, capturing the individual desire of consumers to smell products in a purchasing situation. Second, we develop a self-report measurement instrument that provides reliable and valid measurements of need for smell as a continuous latent variable. The instrument measuring need for smell is referred to as the Evaluation of the Need for Active Smell (ENFAS) scale. In previous conference papers presenting interim results (see, e.g., Koller et al. 2012a; Koller et al. 2012b; Koller et al. 2015; Koller et al. 2016; Salzberger et al. 2016) the scale was called the NFS scale. To avoid any confusion with ambient scent, we decided to name the final instrument ENFAS, highlighting the aspect of actively taking a smell.

Third, we empirically demonstrate implications and consequences of the proposed construct of need for smell in purchase decision making supporting its relevance.

2. Theoretical conceptualization of the need for smell

A thorough exploration of the conceptual underpinnings is the sine qua non for subsequent assessment of a scale's content validity. Generally speaking, the consumer's need for smell is the individual desire to actively obtain and use olfactory information in purchase decision-making. The conceptual definition of the domains of the need

Table 1
Overview of studies.

Study	Purpose	Principle objective	Principle method and analysis	Key finding
Development of a draft scale				
1a	Concept elicitation	Item generation	Three focus groups (n = 17) and expert rating, content analysis, in German	Generation of 72 items, final set of 35 items selected for further purification
1b	Initial psychometric assessment	Dimensionality, psychometric assessment at macro-level	Survey, RMT (n = 165), student sample, in German	Two dimensions identified, 35-item draft instrument
Scale purification				
2	Dimensionality and Reliability	Discriminant validity, further scale properties	RMT (CFA), n = 552, in German, Austrian national panel	Confirmation of two-dimensional structure, reduction to 6 informational/self-protective and 5 autotelic/affective items → final 11 item ENFAS instrument
3 (web appendix)	Cross national validity	Invariance testing	RMT, DIF, US n = 485, US MTurkers n = 179, Germany, student sample, n = 552, Austrian national panel; in German and English	ENFAS instrument stable across different nations (US, Germany, Austria)
4	External Validity I	Field study	Hidden observation of smelling behavior plus survey, n = 149, paper & pencil study, in German	Shoppers who have been observed smelling products at the point of sale have significantly higher ENFAS scores, confirming external validity
5	External Validity II	Importance of smell in shopping (trade-off between senses)	Crosstab, survey, n = 315, student sample, Qualtrics software, in German	High need for smellers would significantly less forego their sense of smell in shopping, they would rather give up hearing
Application of the ENFAS Scale				
6a	Consequences and nomological net I	Dimensions predict intentions along different product categories	Correlation, n = 109, paper & pencil study, in English	Two dimensions of ENFAS predict varying behavior in relation to different product categories
6b	Consequences and nomological net II	ENFAS predicts choice of retail format and channel	Correlation, n = 484, Prolific UK sample, Qualtrics software, in English	Need for smellers prefer unpacked food and brick-and-mortar stores for selected items
6c (web appendix)	Consequences and nomological net III	ENFAS predicts choice of services: virtual reality versus real sensory experience	Correlation, n = 93, student sample, Qualtrics software, in German	Choice of services: need for smell matters for multisensory but not for virtual reality experiences in a service context
7	Use of the scale for cross-modal consumer profiling	Segmentation based on ENFAS and NFT	Split analysis, n = 552, in German, Austrian national panel	Consumers have different cross-modal needs for sensory input in regard to smell and touch, there are consumers who rate smell over touch

for smell construct is based on the synthesis of a theoretical approach, reflecting existing research findings and theoretical contributions, and an empirical concept elicitation study involving experts and consumers in the instrument development process.

2.1. Characteristics of smell

Even though the human central olfactory bulb is relatively small, we perceive and distinguish many different odors (Bushdid et al. 2014). Olfactory input is not only consciously processed by the primary olfactory cortex but is also directly linked to memory (Bastir et al. 2011). In this way, a particular smell can transport us back to a past memory far more vividly than any other sense—a sensation known as the Proust phenomenon (see Herz and Schooler 2002). What is more, olfactory information is relayed directly to the limbic system including the amygdala and the hippocampus, where emotions are evoked (Engen 1982; Kemps and Tiggemann 2007; Wrzesniewski et al. 1999). On the one hand, the emotions triggered by olfactory information make the sense of smell a crucial motivator of human behavior (Engen 1982). On the other hand, noticing an odor that contributes to positive emotions can mean that smelling in itself can be a pleasurable experience.

The role the sense of smell plays for the individual is likely to vary, as processing of olfactory information has been shown to be linked to the ability to handle and utilize information, and to retain olfactory representations in memory (Danthiir, Roberts, Pallier, and Stankov 2001).

In conclusion, smell is an important source of information and emotion. As such it is a powerful stimulus in product purchase, but for some people more than for others.

2.2. Dimensionality of the need for smell

The need for smell construct ought to reflect the functions of smell in a product evaluation context. Smell serves as a source of information but is also a trigger for affective experiences. In the case of smell, information is not only of cognitive importance, but also has a warning function that serves to protect the individual from hazards such as rotten food, smoke, or other harmful chemicals. The self-protective purpose corresponds to a key function of smell from a biological perspective (Shepard 2004), where olfaction is closely related to survival, linking the sense of smell to biological fitness (Platt and Padoa-Schioppa 2009). In a product evaluation context, threats might not only be physical but also may take the form of material, financial or psychological harm.

In contrast, the perception of floral scents as another function of the sense of smell from a biological viewpoint (Shepherd, 2004) stresses the affective, pleasurable experience of smell as an end in itself. This function is equally relevant in the context of purchase decision making and product evaluation. Thus, the need for smell construct is proposed to consist of two broad domains, one informational and self-protective, the other affective and representing an end in itself.

A similar dichotomy is also featured in various need-based constructs, most notably the need for touch (NFT; Peck and Childers 2003), but also for the need for cognition (Cacioppo and Petty 1982) and the need to evaluate (Jarvis and Petty 1996), all of which distinguish information and affect. As argued by Peck and Childers (2003) in the context of need for touch, the two-dimensional structure is in accordance with the implicit versus self-attributed dual motivation model by McClelland et al. (1989). Self-attributed motives relate to analytical, information-based decision making with a clear goal in mind, while implicit motivation is largely driven by affect and emotion with no explicit cognitively reflected goal. Hence, NFT is based on motivational rather than ability-based differences among individuals. Peck and Childers (2003) labelled the two dimensions instrumental (essentially sensory information as a crucial means of making a decision) and autotelic (basically collecting sensory information as an end in itself), respectively. While a similar structure lends itself as a starting point for the conceptualization of the need for smell construct, the instrumental domain is more complex for smell. For this reason, we refer to this domain as informational/self-protective. In fact, whether one dimension may indeed capture both the information-processing aspect and the self-protective facet is essentially an empirical question. The second domain resembles the autotelic dimension in the NFT construct but also captures smell as a trigger of emotions. Thus, this domain is not entirely autotelic but also affective in nature. Hence, we refer to this domain as autotelic/affective.

With regard to the informational dimension, the question arises as to what type of information smell can convey. First of all, the smell of a product can provide an indication of the quality of a product, specifically when it comes to judging food items and beverages or regarding the authenticity of a product in terms of the material it is made of. On the one hand, a product's smell may contribute to a favorable evaluation increasing the likelihood that we buy it. On the other hand, smell can also reveal negative properties of a product that make us turn away from the product. The latter implies that smell involves a facet of self-protection, which other senses may entail to a lesser extent. Sensing an unpleasant or even disgusting smell of a food has a self-protective function, just like smelling smoke, harmful gases or other toxic substances help us avoid potentially life-threatening consequences.

The autotelic dimension applies when the act of smelling is enjoyed for its own sake and potentially produces positive feelings or evokes past memories. The olfactory sense is particularly powerful and effective in this regard because of its direct link to emotion-related parts of the brain.

The provisional dichotomy of the informational/self-protective and the autotelic/affective dimension of smell is a theoretical distinction in the conceptualization of the construct of need for smell. In practice, both aspects are arguably simultaneously relevant to most, if not all, olfactory perceptions, with the relative importance depending on the product or context. It is highly likely that individuals with a high need for smell score high on either dimension, whereas those with a low need for smell score low on both. As a consequence, we expect the dimensions to be correlated, yet conceptually and psychometrically differentiable. The perception of the smell of a wine, aptly called its "nose", is a case in point. From an autotelic/affective perspective, the smell may simply trigger a positive emotion, for example a feeling of warmth, or memories of a nice evening or beautiful holiday. At the same time, discerning various flavors in a glass of wine also serves evaluative, thus informational, aspects answering questions as to whether the wine features properties that are typical for the variety, or whether it is free of defects such as corking, invoking the self-protective function of smell. While the autotelic/affective domain is more related to approach behavior, the informational/self-protective domain is more related to avoidance. This dichotomy agrees with Gibson (1966) who argues that we aim to maximize good smells and minimize bad smells. Gibson (1966) also emphasizes the importance of gathering information through smell to influence later behavior, emphasizing the role of smell in purchase decision making.

Next, we aimed at verifying the theoretically based duality of dimensions and filling them with concrete aspects allowing for generating draft items to be evaluated psychometrically.

3. Need for smell – development of a draft scale

3.1. Study 1a – Concept elicitation

Three focus group discussions (17 participants in total, 12 female, 5 male, aged between 20 and 49 years) served as a qualitative concept elicitation study. The focus group participants were mostly consumers (various occupations including four students), five of which happened to be related to the food industry (nutritionists and food technologists). The discussions focused on the role of smelling products when shopping. Three marketing scholars independently identified and then consolidated the emerging key themes from transcripts of the sessions applying

qualitative content analysis without any theoretical guidance from the provisional two-dimensional conceptualization.

Participants said they smell products to get additional product information; to evaluate products; to assess their quality; and to contribute to forming an opinion about the product. Other mentions concerned the safety of products and their authenticity: smelling products as a warning function to avoid harmful consequences; product scent as an indicator of the product being new and the material it is made of; smelling products to gain trust and security; suspicious or unpleasant smell of products as a purchase barrier. With respect to grocery items, scent was mentioned as an indicator for freshness. Some said they smell products out of curiosity as a general shopping habit. All the aforementioned aspects may be subsumed under an informational/self-protective domain of the need for smell construct.

Participants also said that smelling products is fun and contributes to wellbeing; smelling products is also an emotional issue; smell can bring up childhood memories. These themes indicate hedonic aspects of smelling and the autotelic character of the sense. Some discussants also pointed out that the perceptibility of the smell of products depends on how products are presented (wrapped or unwrapped). Thus, the focus groups broadly confirmed the tentative theoretical framework even though a possible differentiation between informational and self-protective aspects remained a viable option.

3.2. Item generation

At first, we generated a deliberately over-inclusive pool of 72 potential items based as much as possible on actual expressions recorded in the focus groups. Next, we scrutinized the draft items in terms of their fit to the construct definition, dismissing items that were not related to using one's sense of smell in a purchase-decision making context when shopping. Furthermore, we eliminated items that were obviously redundant, that covered personal anecdotes lacking generalizability, and items on smelling behavior regarding very specific products (such as herbs) while more general items referring to grocery items were retained. Finally, with a view to the scale's cross-national applicability, we discarded items that included idioms that lacked straightforward translatability to other languages. The qualitative purification resulted in 35 items (see Table 2) with 23 items tentatively assigned to the informational/self-protective domain (coded enfas01 to enfas23), and 12 items to the autotelic/affective domain (enfas24 to enfas35). The draft instrument was then subjected to a quantitative psychometric analysis.

3.3. Psychometric scale validation

The empirical validation of the proposed scale was mainly based on state-of-the-art methods of modern test theory (Embretson and Reise 2013; Andrich 1988), specifically, the Rasch model for measurement (RMM; Rasch 1960). The RMM and related item response modeling have recently gained popularity in marketing research (Raykov and Calantone, 2014) due to its unique advantages over traditional approaches based on classical test theory (CTT) and their reliance on correlations. In the RMM, observed item scores are considered to be ordinal scaled. Sum scores across all items in a dimension are then transformed to a linear interval scale measure. The principles of the RMM and the psychometric procedures are summarized in the Web Appendix A. For data analysis RUMM 2030 (Andrich et al., 2009) was used. The whole scale development process largely followed established guidelines to develop multi-item measures of marketing constructs as suggested by Churchill (1979). CTT based criteria remain, to some extent, informative. An assessment of internal construct validity from a traditional CTT (Lord and Novick 1968) perspective can be found in Web Appendix E, which also lists item means and standard deviations. Relying on different psychometric approaches reflects current best practices as recommended by Boateng et al. (2018).

The quantitative assessment of the instrument's internal validity was based on two studies. At first, the 35-item draft instrument was administered to a convenience sample of consumers (Study 1b) to explore the functioning of the items and identify obvious problems, if

Table 2
Informational/self-protective ENFAS – Purification and psychometric properties.

Dimension 1: informational/self-protective need for smell				
$Chi^2 = 56.0$, $df = 54$, $p = 0.40$; person separation index PSI = 0.87, restricted RM/rating scale model, n = 549				
Retained items in final ENFAS scale, ordered by item location (from less need for smell required to more need for smell required to approve the item)				
Code	Item wording	Item overall location (lowest/highest threshold location)	Fit residual	p (chi^2)
enfas4	Certain products have to be smelled first in order to be sure that they are worth buying.	–0.29 (–1.38/1.27)	1.19	0.41
enfas6	The scent of products has a certain warning function for me.	–0.25 (–1.63/1.62)	–0.37	0.67
enfas10	I can tell from the smell of some products the authenticity of their material.	–0.17 (–1.06/1.41)	3.03	0.12
enfas5	I trust my sense of smell when judging products.	0.12 (–1.12/1.95)	–2.10	0.02
enfas2	When I smell a product, it helps me judge its quality.	0.24 (–0.89/2.32)	–0.91	0.50
enfas18	I can get a better idea of the product if I can smell it.	0.36 (–0.83/2.44)	1.01	0.40
Discarded items (presented in sequence of item elimination)				
Code	Item wording	Reason for item elimination		
enfas7	I smell food in the shop to determine whether it is fresh or not.	underdiscrimination, misfit		
enfas9	If there is food I am not familiar with, I smell it before buying it.	underdiscrimination, poor fit		
enfas23	Smelling food in a shop also gives one an idea of what it tastes like.	underdiscrimination, misfit		
enfas1	I feel safer if I can smell a product before buying it.	overdiscrimination, bad fit, strong local dependence		
enfas3	I smell products or their packaging in shops because I want to know what I am buying.	overdiscrimination, bad fit, local dependence		
enfas8	I don't buy certain products in a shop if I can't smell them.	misfit, local dependence		
enfas21	When browsing in shops, it is important for me to smell as many products as possible.	overdiscrimination, poor fit, local dependence		
enfas13	I have more trust in products which I can smell before I buy them	overdiscrimination, poor fit		
enfas20	While shopping, curiosity leads me to smell certain products.	slight underdiscrimination local dependence		
enfas11	When I go through shops, I smell at all sorts of products.	local dependence		
enfas12	My sense of smell is very important for me when shopping.	local dependence		
enfas17	The scent of the products plays a big role for me when I go shopping.	local dependence		
enfas22	It bothers me when the packaging of certain products hinders me from smelling it.	poor fit		
enfas19	The scent of a product is what draws my attention to certain offers.	local dependence		
enfas16	If products had no scent, I would feel like something was missing when I go shopping.	local dependence, slight underdiscrimination		
enfas14	If I can't smell certain products in the store, I'm reluctant to buy them.	local dependence, slight underdiscrimination		
enfas15	I smell products in shops because my sense of smell gives me important information about the products.	local dependence, slight underdiscrimination		

any. Subsequently, all retained items were applied in a nationally representative sample big enough to assess item fit and derive the final instrument (Study 2). Finally, various aspects of external validity (consequences for purchase behavior) were assessed (Studies 3 to 7).

3.4. Study 1b –Initial psychometric assessment

The first quantitative test in a small convenience sample (n = 165; predominantly students; 56% female; aged between 21 and 64 years) aimed at assessing psychometric features at a macro-level. We presented all items with a seven-point rating scale (fully agree to fully disagree as the extremes). When analyzing all 35 items as a unidimensional set, there was, as expected, indication of multidimensionality. In the principal component analysis of item residuals (difference between expected and observed response), at least one eigenvalue clearly stood out suggesting a two-dimensional construct, while under unidimensionality no particular structure would have been expected. We therefore conducted separate analyses of the items theoretically grouped into the two domains. The patterns of residual correlations among the 35 items widely confirmed this grouping empirically, too.

The analysis of the 23-item draft scale for informational/self-protective need for smell demonstrated that the scale showed good psychometric potential. One item showed misfit, though, while several items exhibited correlated residuals suggesting item redundancy, which was to be expected at that stage. In terms of dimensionality, items reflecting the self-protective aspect and items referring to a more general product assessment (informational) appeared to represent potentially different, yet highly correlated, dimensions. The 12-item draft scale of autotelic/affective need for smell showed some issues with item redundancy and underdiscrimination of one item. To investigate this in more detail, all items were retained for further data collection and analysis. At that stage, reliability assessed by the person separation index (PSI), comparable to Cronbach's alpha, was very high for both domains (informational/self-protective 0.93; autotelic/affective 0.91) demonstrating high internal consistency of the items.

4. Study 2 – Scale purification – Validation

For scale purification and reduction to a manageable number of items, we utilized a nationally representative sample (n = 552, 51.4% female, 14–19 years 14.5%; 20–29 years 17.4%; 30–39 years 21.0%; 40–49 years 25.2%; 50–59 years 21.9%; online panel, 7-point rating scale with 1 indicating low need for smell and 7 high need for smell) in study 2. The goal of this study was to derive a final item-reduced scale as an efficient instrument that meets state-of-the-art psychometric criteria.

4.1. Dimensionality and reliability of the ENFAS-scale

The two need for smell domains were analyzed separately. Both scales turned out to be unidimensional, but some items indicated psychometric problems, such as misfit (assessed by a χ^2 fit statistic, which should be non-significant applying a Bonferroni-adjusted type-one error rate of 0.01 overall), underdiscrimination or overdiscrimination (assessed by a fit residual statistic, which should be within ± 2.5, where values < –2.5 indicate overdiscrimination and values > 2.5 indicate underdiscrimination; Pallant and Tennant 2007), and local dependence with other items (assessed by the residual correlation, Yen's Q3, which should be smaller than the mean of all residual correlations plus 0.2; Christensen et al. 2017), requiring item-reduction. This process was conducted iteratively implying a reanalysis of the set of items remaining after eliminating an item. The identification of the least appropriate item as a candidate for exclusion was based on a comprehensive review of statistical indicators of fit as well as considerations of item content. In the interest of a balanced representation of the two domains in the final instrument, a similar number of items per domain ought to be retained eventually. A minimum of five items was considered reasonable to provide enough information to sufficiently estimate precise measurements while minimizing response burden.

We also explored how items eliminated at an earlier stage performed when reintroduced at a later stage, when other items had been deleted from the scale. In all cases, the decision to omit an item was confirmed providing evidence that the sequence of item reduction did not impact the composition of the final scale.

Tables 2 and 3 show the item wording, the location parameter for each item (indicating the magnitude of the respective domain the item represents), the fit residual statistic, the p-value of a chi-square-based test of item fit as well as an overall fit statistic (summarizing the fit of all items as a set) and the person separation index as a measure of reliability.

Both the 6-item ENFAS scale for informational/self-protective need for smell and the 5-item ENFAS scale for autotelic/affective need for smell are unidimensional with no statistical indication of item redundancy. Two items represent the self-protective component of informational/self-protective need for smell (*The scent of products has a certain warning function for me; I can tell from the smell of some products their material or authenticity*). For the informational/self-protective dimension, a more restricted model constraining the item thresholds to the same structure for all items (known as the Rasch rating scale model; Andrich 1978) was applied as it did not result in a significant decrease in overall fit. For the autotelic/affective dimension, the unrestricted model (also referred to as the Rasch partial credit model; Masters 1982; Andrich 1988) was retained, since the restricted model resulted in a significant drop in fit. As expected, the two dimensions were highly correlated (r = 0.81, p <.001, n = 549).

4.2. Further ENFAS scale properties

Apart from item fit and dimensionality, it is important that the items target the respondents properly. Good targeting means that the intensity of the items expressed by their locations on the latent continuum matches the distribution of the respondent measures located on the same continuum. This ensures that extreme scores are rare, measurement precision is high, and the power of the tests of fit is high as well. Poor targeting means that items are generally either too easy to endorse (many respondents strongly agree to all items) or too hard to endorse (many responses are "strongly disagree"). The targeting of the two scales was satisfactory, which was evidenced by small proportions of extreme scores (see Table 4) and items being well aligned with respondents (see Fig. W1 in the Web Appendix B). The standard error of measurement for person measures was ≤0.5 logits (implying a 95% confidence interval of about 1 logit) for 86.1% for informational/self-protective need for smell and 73.6% for autotelic/affective need for smell. Uncertainty in the order of 0.5 logits is generally considered acceptable (Linacre 1994). Informational/self-protective need for smell showed a floor effect of 5.1%. Therefore, only for about one in twenty respondents, the sense of smell did not seem to contribute to the perception and evaluation of products at all. For 6.7% a floor effect was observed for the autotelic/affective dimension. Ceiling effects played an even smaller role with proportions below 3% for either dimension.

4.3. Estimation of ENFAS respondent measures

In RMT, the sum raw score is converted to a linear estimate by a non-linear transformation of the raw score to a linear logit metric, which is the same for respondents and items and extends theoretically from minus to plus infinity. In practice, the range varies depending on the number of items, their distribution, and how well the respondents discriminate between statements when selecting their responses. The scale origin is defined by the mean of all item parameters. Thus, a respondent measure of 0.0 logits implies an average score relative to the items. For informational/self-protective need for smell, the logit measures ranged from − 3.27 to + 3.96. The range for autotelic/affective

Table 3
Autotelic/affective ENFAS – Purification and psychometric properties.

Dimension 2 (Autotelic/affective): *$Chi^2 = 67.3$, $df = 45$, $p = 0.02$; person separation index PSI = 0.87, unrestricted RM/partial credit model, n = 552*				
Retained items in final ENFAS scale, ordered by item location (from less need for smell required to more need for smell required to approve the item)				
Code	Item wording	Item overall location (lowest/highest threshold location)	Fit residual	p (chi^2)
enfas32	The scent of some products increases my sense of well-being.	–0.20 (–1.38/1.91)	0.13	0.15
enfas31	Smelling certain products is a joy for me.	–0.08 (–1.71/1.98)	–2.95	0.01
enfas24	I like to smell certain products.	–0.04 (–1.52/2.02)	0.97	0.20
enfas29	The scent of certain products is an incentive to buy for me.	0.15 (–0.90/2.25)	–0.44	0.29
enfas26	The way products smell influences my mood.	0.17 (–1.23/2.79)	2.31	0.40
Discarded items (presented in sequence of item elimination)				
Code	Item wording	Reason for item elimination		
enfas35	If I don't like the smell of a product, I try another variety or product.	underdiscrimination, misfit		
enfas27	I enjoy it when products smell good.	underdiscrimination, misfit		
enfas33	The scent of some products reminds me of my childhood.	underdiscrimination, misfit		
enfas34	The scent of some products brings forth pleasant feelings in me.	local dependence		
enfas30	I like to be reminded of lovely experiences by the scent of a product.	local dependence, poor fit		
enfas28	The scent of some products brings back memories.	underdiscrimination, misfit		
enfas25	I have fun smelling certain products while shopping.	local dependence		

need for smell was − 3.35 to + 4.26.

For practical purposes, the logit metric can be further transformed linearly to a more intuitive scale, such as a 0 to 100 metric, where 0 corresponds to the lowest logit measure (for the minimum raw score) and 100 to the highest (maximum raw score). Conversion and transformation tables for either domain are provided in the Web Appendix C. The ENFAS scale thus enables comparable linear measurement values to be estimated even in small-scale studies in which no meaningful psychometric analysis is possible.

4.4. Construct validity –Discriminant validity

Although need for smell may be theoretically related to other constructs, we would like to demonstrate that need for smell has discriminant validity, implying that the ENFAS scale measures a construct in its own right. In study 2, several measures were included for discriminant validity assessment. As those constructs were established using CTT, we used traditional CTT scores as construct measures. We tested whether need for smell as measured by ENFAS was sufficiently distinct from related constructs, such as the more general need to evaluate (NTE; Jarvis and Petty 1996) and the need for touch (NFT; Peck and Childers 2003). Although the evaluation aspect of the more general NTE construct implies some similarities to facets of need for smell, NTE represents information acquisition in the context of recurring evaluation rather than in a product-specific context as it is the case for need for smell. Hence, we expected need for smell and NTE to be related but different constructs. A correlation analysis confirmed our assumption (NTE with ENFAS informational/self-protective $r = 0.35$, $p < 0.001$, $n = 549$; with autotelic/affective: $r = 0.31$, $p < 0.001$, $n = 549$). The same was true for NFT, for which we expected a moderate overlap with need for smell due to an underlying general need for sensory stimuli in evaluations. This was confirmed by correlations in the order of 0.3 to 0.4 (NFT instrumental with ENFAS informational/self-protective $r = 0.37$, $p < 0.001$, $n = 549$; with ENFAS autotelic/affective $r = 0.33$, $p < 0.001$, $n = 549$; NFT autotelic with ENFAS informational/self-protective $r = 0.31$, $p < 0.001$, $n = 549$; with ENFAS autotelic/affective $r = 0.35$, $p < 0.001$, $n = 549$). The two NFT dimensions were correlated at $r = 0.77$, $p < 0.001$, $n = 549$, thus in the same order as the correlation observed for the two ENFAS dimensions.

Furthermore, we included the Attitude towards the Sense of Smell Scale suggested by Martin et al. (2001). This scale explores people's attitudes and beliefs about the sense of smell in general. The instrument captures a more fundamental, very broad individual position towards olfaction. The scale does not specifically aim at the role of the sense of smell in a purchase situation. Data analysis confirmed a significant correlation between ENFAS and the Attitude towards the Sense of Smell Scale (with ENFAS informational/self-protective $r = 0.50$, $p < 0.001$, $n = 539$; with ENFAS autotelic/affective $r = 0.55$, $p < 0.001$, $n = 539$), on a moderate level, supporting our assumption. Finally, a moderate correlation of ENFAS and the Odor Awareness Scale (OAS; Smeets et al. 2008) was identified (Odor Awareness Scale reversed sum score across all items with ENFAS informational/self-protective $r = 0.49$, $p < 0.001$, $n = 533$; with ENFAS autotelic/affective $r = 0.47$, $p < 0.001$, $n = 533$[1]). The OAS assesses individual differences in awareness of odors in the environment. As such, it is not directed towards individual differences in the use of one's sense of smell as a source of information (informational/self-protective) or pleasure (autotelic/affective) in a purchasing context. On the one hand, the moderate correlation between OAS and the need for smell supports the conceptualization of the need for smell as comprising also some facets of odor awareness in a consumption setting. On the other hand, it underlines that need for smell extends beyond mere awareness of odors confirming the need for smell being discriminant in this regard.

Table 4
ENFAS Scale targeting statistics.

ENFAS Dimension	Respondents with S.E.M. ≤ 0.5	Respondents with floor effect (negative extreme)	Respondents with ceiling effect (positive extreme)
(1) Informational/ self-protective	86.3%	5.1%	2.4%
(2) Autotelic/ affective	73.6%	6.7%	2.9%

S.E.M.: standard error of measurement.

4.5. Known-group validity

Firm evidence in the literature is scarce for known differences in the role that different sensory modalities play among different groups. However, there is good reason to expect differences between the sexes. Citrin, Stem, Spangenberg, and Clark (2003) found that women exhibited a greater need for tactual input in making product evaluations than men. Herz (2004) revealed that women attributed a larger role to odors in determining the pleasantness of various experiences than men, even though these effects have not been found consistently (Peck and Childers 2003; Wrzesniewski et al. 1999). A meta-analysis by

[1] When differentiating positive and negative OAS items as proposed by Smeets et al. (2008), ENFAS informational/self-protective correlates r=0.43 with positive OAS items and r=0.49 with negative OAS items, while ENFAS autotelic/affective correlates r=0.45 with positive OAS items and r=0.46 with OAS negative items.

Table 5
ENFAS Scale: means.

Sample	Informational/self-protective Mean (sd; n), *p mean difference*		Autotelic/affective Mean (sd; n), *p mean difference*	
	Logit metric	0-to-100 metric	Logit metric	0-to-100 metric
All respondents	–0.14 (1.38; 549)	43.3 (19.1)	–0.26 (1.52; 549)	40.6 (20.0)
Sex				
female	–0.03 (1.51; 282)	44.8 (20.9)	0.01 (1.60; 282)	44.1 (21.0)
male	–0.26 (1.22; 267)	41.6 (16.9)	–0.54 (1.39; 267)	36.9 (18.3)
	0.04		***<0.0001***	
Age				
14 to 19 y	–0.17 (1.22; 80)	42.9 (16.9)	–0.43 (1.24; 80)	38.3 (16.3)
20 to 29 y	–0.35 (1.40; 94)	40.4 (19.4)	–0.27 (1.38; 94)	40.4 (18.1)
30 to 39 y	–0.20 (1.28; 116)	42.5 (17.7)	–0.23 (1.37; 116)	41.0 (18.0)
40 to 49 y	–0.09 (1.44; 138)	44.0 (19.9)	–0.16 (1.69; 138)	41.9 (22.2)
50 to 59 y	0.03 (1.48; 121)	45.7 (20.5)	–0.27 (1.73; 121)	40.4 (22.7)
	0.36		*0.80*	
Education				
lower	–0.11 (1.49; 144)	43.7 (20.6)	–0.28 (1.56; 144)	40.3 (20.5)
middle	–0.07 (1.42; 240)	44.3 (19.6)	–0.21 (1.50; 240)	41.2 (19.7)
higher	–0.27 (1.21; 165)	41.5 (16.7)	–0.30 (1.53; 165)	40.1 (20.1)
	0.34		*0.82*	

sd: standard deviation; n: sample size; p: p-value of mean comparison (t-Test, analysis of variance); sample sizes and p-values also apply to 0-to-100 metric.

Sorokowski et al. (2019) indicated that women, who have far more neurons (6.9 million vs. 3.5 million in men) and glia cells in the olfactory bulb than men, outperform men in olfactory abilities. This suggests that differences are due to biological characteristics rather than gender identities and societal roles. Cupchik and Phillips (2005) identified sex differences regarding the perception of odors and their relevance in various domains. We, therefore, expected females to score higher on the two need for smell dimensions.

Indeed, looking at the data of study 2, women scored significantly higher on ENFAS informational/self-protective (p =.04) and ENFAS autotelic/affective (p <.0001) confirming known-group validity. No differences were found on both dimensions by age and education (see Table 5).

4.6. Composite summary variable of need for smell

Especially in applied research, unique summary variables are sometimes preferred over multidimensional measures as they allow for a more parsimonious characterization and a unique ordering of respondents. The analysis showed that a composite variable of need for smell combining both dimensions into one measure is warranted, when an overall assessment of need for smell is sufficient (see Web Appendix D for further details). However, since the distinction between informational/self-protective and autotelic/affective need for smell is lost, it is generally advisable to consider separate measures of the two dimensions.

4.7. Cross-national validity

Broad applicability of the ENFAS instrument requires evidence of its validity in many cultural and national settings. We therefore undertook the first steps toward checking for cross-cultural invariance in study 3, comparing the need for smell instrument across Germany (n = 179, business students), the US (n = 485 MTurkers), and Austria (n = 552, representative online panel data of study 2 re-analyzed for this purpose). The two-dimensional structure was confirmed both in Germany and the US with items showing acceptable fit. A combined analysis of all data revealed some differential item functioning (DIF) for ENFAS informational/self-protective in three items in the US versus Austria and Germany, and minimal DIF in one item in Germany relative to Austria and the US. As the DIF observed for the US went in different directions (one item was endorsed more easily in the US, while two items were harder to agree with), a compensatory effect was present. For ENFAS autotelic/affective, only one item worked differently for the US.

In conclusion, the ENFAS instrument turned out to be applicable in cultures other than the one in which it was developed. However, care needs to be taken when comparing scores across different countries or cultures. If items work slightly differently, proper adjustments for DIF are required (see Web Appendix F for more details on Study 3 and the assessment of cross-cultural validity).

4.8. Evaluation of the ENFAS scale – Classical test theory

We also evaluated the ENFAS scale properties using CTT (see Web Appendix E). The application of the ENFAS instrument in a traditional CTT/SEM setting is warranted.

5. Need for smell – study 4 – Field study

Study 4 aimed at assessing the external validity of the ENFAS measurements in a hidden observation study on the premises of a large European grocery store. We first observed the smelling behavior of 149 patrons (128 female, mean age 31.26, SD 11.97) and then approached them to fill in the two-dimensional 11-item ENFAS instrument (paper & pencil). Our focus was on fruits and vegetables, as smell was expected to be particularly important for these grocery items. Consumers who smell products were expected to have a higher ENFAS measure than consumers who do not. The group of observed smellers (n = 29) indeed scored significantly higher on the two ENFAS dimensions compared to non-smellers (n = 120) (see Table 6), confirming our hypothesis and providing evidence for the external validity of need for smell and the 11-item ENFAS measurement instrument.

6. Need for smell – study 5 – Determining the role of smell among the five senses

The ENFAS instrument assesses individual differences between consumers in terms of the importance of the sense of smell in purchase decision making. In practice, consumers also use other senses when shopping. A high score on need for smell suggests that the sense of smell is more important in relation to other senses compared to consumers scoring low on need for smell. Study 5 put this proposition to an empirical test. We collected online survey data from n = 315 respondents of a student sample (158 female, mean age 43 years). Based on a median split we grouped the respondents in high versus low need for smell on the two domains separately. We asked the respondents to

imagine the scenario that they would have to forgo one of their senses forever while shopping (*"Imagine you would have to forgo one of your five sensory modalities in shopping forever, which one would it be? Vision, hearing, smell, taste, or touch"*). We hypothesized that participants scoring high on need for smell would be significantly less inclined to give up their sense of smell. Before testing this hypothesis, we had a look at the general results, in terms of which sense they would sacrifice, first. Our results showed that, across all participants, only 1.9% would give up their visual sense implying that this modality is by far the most important one when it comes to shopping. The second most important sense was touch, which only 11.1% would have wanted to sacrifice. The sense of smell ranked third with 16.8%. Almost one third (32.1%) would have chosen to give up the sense of taste, while hearing appeared to be the least useful sense (38.1%) when shopping. Thus, the sense of smell is generally among the top three senses. While it cannot rival the visual sense, it comes close to the sense of touch.

Respondents scoring low on ENFAS autotelic/affective versus respondents scoring high showed significantly different patterns of senses they would forgo (Chi^2 (4) = 10.87, p =.03, see Table 7). Comparing respondents scoring high versus low on ENFAS informational/self-protective, there was a similar trend (Chi^2(4) = 7.97, p =.09). As hypothesized, a smaller proportion of respondents with high need for smell wanted to forgo the sense of smell (13.7% in case of ENFAS informational/self-protective, 11.5% in case of ENFAS autotelic/affective) compared to respondents with low need for smell (20.1% and 22.0%, respectively), underlining the external validity of the concept. For ENFAS autotelic/affective, the difference in proportions between participants with low and high scores was significant for smell and hearing (p =.01), while for ENFAS informational/self-protective it was significant only for hearing (see Table 7). However, the pairwise tests are not independent within each need for smell domain, as a higher proportion for any one sense implies a smaller proportion elsewhere.

7. Need for smell – study 6 – Consequences and nomological net

In terms of criterion-related validity, we investigated the predictive validity of ENFAS measurements in its nomological net. Study 6 comprised three investigations (Studies 6a, 6b, 6c) of the impact of need for smell on consumer behavior for different product categories, retail formats and channels as well as service offerings.

7.1. Study 6a – Purchasing books and apparel

In Study 6a, we differentiated the two ENFAS dimensions with respect to their predictive validity of smelling behavior. In a US student sample (n = 109, mean age 19.70, SD 1.82) we investigated the purchase behavior for two very different product categories: books and apparel. The peculiar scent of books is a result of a complex mix of volatile chemicals. For the average reader, a new book's smell is not a quality indicator but rather a hedonic experience. We therefore expected only the ENFAS autotelic/affective dimension to be correlated with the individual urge to smell a new book, operationalized by a single item: "*When I buy a new book, I tend to smell it*" (5-point rating scale).

By contrast, smelling apparel items fulfils a more multifaceted purpose. After all, we get in close proximity and have prolonged skin contact with clothes. A garment's smell may tell us what it is made of and whether it is safe to wear; it may be a source of pleasure. As harmful chemicals may affect our skin, the self-protective aspect of the informational/self-protective dimension plays a role, too. Thus, we expected both ENFAS dimensions to contribute to the tendency to smell garments, measured by a single item: *"When shopping for apparel, I notice how the garments smell"* (5-point rating scale).

The correlations confirmed the expected patterns. Smelling books was significantly associated with the autotelic/affective dimension, while the association with the informational/self-protective dimension was weaker and insignificant. In contrast, smelling garments was related to both ENFAS dimensions approximately equally strongly and significantly (see Table 8).

Table 6
Observed smelling behavior and ENFAS scores.

Observed behavior	ENFAS Informational/self-protectivemean (sd)	ENFAS Autotelic/ affectivemean (sd)
Smellers (n = 29)	65.1 (18.8)	54.0 (18.2)
Non-smellers (n = 120)	46.6 (18.1)	39.0 (20.7)
	t = 4.89 (df = 147), p <.001	t = 3.58 (df = 147), p <.001

sd: standard deviation.

7.2. Study 6b -Choosing different retail formats

In study 6b, we linked the concept of need for smell to shopping preferences for selected items depending on different retail formats. We hypothesized that people with higher need for smell refrain from buying scent-intensive products online and prefer shopping in a brick-and-mortar store. We asked study participants (n = 484, UK online panel; 32% female, mean age 26.81, SD 8.71) if they preferred buying products for which scent is a major feature (such as perfume or scented candles) online or in a brick-and-mortar store. Additionally, respondents indicated whether they preferred unpacked or packed food items, and whether they would rather go to a butcher or buy meat in a supermarket. We expected a positive relationship between ENFAS measurements and preferences for brick-and-mortar stores, where smelling products is possible. Likewise, we anticipated a positive correlation between ENFAS and the preference for unpacked food and buying meat from the butcher.

Bivariate correlation analyses (see Table 9) confirmed that participants who scored high on ENFAS autotelic/affective preferred buying perfume and scented candles in brick-and-mortar stores rather than online and preferred to buy foods unpacked. Similarly, buying unpackaged goods, buying meat from the butcher, and buying scented candles in a store were significantly associated with higher ENFAS informational/self-protective. The other two correlations were also positive, although they failed to reach statistical significance. Thus, the evidence demonstrates that consumers' need for smell affects the preferred retail format and distribution channel for items for which smell is a particularly relevant property. Apparently, consumers may thus select different channels based on their need for olfactory input. Correlations may seem small suggesting that many other factors influence retail format choices and distribution channels. However, need for smell is another important factor that could make the difference in highly competitive markets with tight profit margins.

7.3. Study 6c – Choosing different service offerings

In Study 6c (see Web Appendix G), we tested whether need for smell also impacts the choice of service offerings. The context of the study was unorthodox coffee houses, one providing particular multisensory experiences (SUPERSENSE) and the other virtual reality experiences (VREI). Correlation analyses confirmed the expected association of need for smell and interest in the offerings and in spending time in the case of a SUPERSENSE, whereas need for smell played no role for VREI (see Web Appendix G).

Studies 6a to 6c suggest that consumers select retail formats that suit their needs in terms of need for smell. Any analysis of existing customers and consumers frequenting business premises, for example based on big data, is likely to underestimate the role of the sense of smell and associated consumer needs, as people will not frequent locations that do not address their needs. If retailers want to target consumers who avoid them, they need to assess their needs and reach out to them pro-actively by accommodating these needs.

Table 7
Number of participants choosing a modality to forgo while shopping.

Forgone sense	ENFAS Informational/self-protective			ENFAS Autotelic/affective		
	frequency (%) low	high	Δ(p)	frequency (%) low	high	Δ(p)
Vision	3 (1.9%)	3 (1.9%)	−0.08% (0.96)	3 (1.9%)	3 (1.9%)	+0.04% (0.98)
Hearing	47 (30.5%)	73 (45.3%)	**+14.82% (0.01)**	49 (30.8%)	71 (45.5%)	**+14.70% (0.01)**
Smell	31 (20.1%)	22 (13.7%)	−6.47% (0.13)	35 (22.0%)	18 (11.5%)	**−10.47% (0.01)**
Taste	53 (34.4%)	48 (29.8%)	−4.6% (0.38)	51 (32.1%)	50 (32.1%)	−0.02% (>0.99)
Touch	20 (13.0%)	15 (9.3%)	−3.67% (0.30)	21 (13.2%)	14 (9%)	−4.23% (0.23)
Total	154 (100%)	161 (100%)	$\chi^2 = 7.97$; df = 4 (0.09)	159 (100%)	156 (100%)	**$\chi^2 = 10.87$; df = 4 (0.03)**

Δ = difference of proportions with two-tailed p-value for comparison within each sense; χ^2 = Pearson chi square value for each need for smell domain across all senses; df = degrees of freedom; significant differences (at 5% level) appear in bold.

Table 8
Correlation of ENFAS, smell of books and garments.

Correlation (Spearman)	Smell at new book ("When I buy a new book, I tend to smell it.")	Smell of garments ("When shopping for apparel, I notice how the garments smell.")
ENFAS Informational/ self-protective	0.13 (n = 108, p =.18)	**0.31 (n = 108, p <.01)**
ENFAS Autotelic/ affective	**0.28 (n = 109, p <.01)**	**0.26 (n = 109, p <.01)**

Significant correlations (at 5% level) appear in bold; all unsigned correlations are positive.

8. Study 7 –Segmentation based on need for smell and need for touch

One practical application of the ENFAS scale is to use it for segmentation purposes. Our observations revealed that when consumers smell a product in the store, they usually touch the product first, pick it up and hold it close to their noses. Only a minority moves their nose towards the product. Hence, smell in a purchasing situation seems to be closely related to touch. This is also in line with the results of study 5, which shows that touch is rated the second most important sensory modality in shopping, after vision. Therefore, it is worthwhile exploring consumer segments based on need for smell and need for touch and how they can be described along other purchase-related psychographic variables in order to use the segmentation for consumer profiling.

Following this theoretical reasoning, in study 7 we tested whether there were common patterns of need for smell and need for touch. Based on the online panel data of study 1 (n = 552), the two ENFAS and the two NFT scales were re-analysed using the Rasch model. For need for smell, we used a composite summary measure that included both domains as subtests. Since we also observed a very high correlation between the two NFT domains, we also formed a composite NFT variable following the same logic. The fit of these psychometric analyses was very good (p = 0.48 for ENFAS and p = 0.34 for NFT for the overall chi^2). More importantly, the PSI dropped only marginally (to 0.83 for ENFAS and 0.81 for NFT) due to the large proportion of true variance shared by the dimensions (0.91 for the two ENFAS dimensions and 0.87 for the NFT scales). The representation of need for smell and need for touch by one measure each facilitated the cross-classification of respondents based on their ENFAS and NFT measures. When classifying respondents in terms of high versus low need for smell or need for touch, we divided the respondents based on their person measures (logit metric) being greater versus smaller than the scale origin of zero, which represents the average item location. Person measures greater than zero implied that the majority of the items were agreed with, while a measure smaller than zero signified disagreement. Almost 23% had both high need for smell and need for touch. The two mixed segments were need for smell$_{low}$/need for touch$_{high}$ representing 22.8% and need for smell$_{high}$/need for touch$_{low}$ accounting for 11.4%. About 43% scored low on both need for touch and need for smell. These results indicate that the two sensory modalities indeed interact (correlation coefficient Phi = 0.31). However, there are also consumers who rate touch over smell or smell over touch (see Table 10).

Next, we looked at psychographic variables which were identified as important when it comes to the need for sensory input (touch) (Peck and Childers 2003), to get a more comprehensive understanding of the nature of the four segments as a basis for establishing consumer profiles. Levels of the need to evaluate (Jarvis and Petty 1996; Cronbach's α = 0.74), faith in intuition (Epstein et al. 1996; α = 0.90), shopping enjoyment (adapted from Faber and O'Guinn, 1988; O'Guinn and Faber, 1989; α = 0.89), and buying impulsiveness (Rook and Fisher, 1995; α = 0.85) served as descriptors of the four segments (see Table 11; all scores are mean scores).

Consumers scoring high on both need for smell and need for touch show significantly higher levels of all selected descriptive variables than consumers in any other segment with only one exception. This applies both to the more abstract need to (cognitively) evaluate as well as the faith in intuition, which represents a more affectively-toned evaluation. These results indicate that consumers with a high need for cognitive and affective evaluation cues at the same time also have a higher need for multiple sensory sensations in consumption. Tactile and smell cues might help them to guide their purchase decision-making and add to

Table 9
ENFAS evaluation of retail format and channel.

Correlation (Spearman)	I prefer to buy scented candles in the store.	I prefer to buy perfume in the store.	I prefer unpacked food items over packed food items.	I prefer to go to the butcher over buying meat at the supermarket.
ENFAS Informational/self-protective	**0.10** (n = 484, p =.03)	**0.**05 (n = 484, p =.29)	**0.16** (n = 484, p <.01)	**0.10** (n = 484, p =.02)
ENFAS Autotelic/affective	**0.12** (n = 484, p=<.01)	**0.10** (n = 484, p =.03)	**0.17** (n = 484, p <.01)	0.08 (n = 484, p =.07)

Significant correlations (at 5% level) appear in bold.

their consumption experience in this regard. Moreover, this segment also scores highest when it comes to actual behavior-related variables at the point of sale, like shopping enjoyment and buying impulsiveness, followed by the need for $smell_{low}$/need for $touch_{high}$ segment. The two mixed segments do not significantly differ along all four variables. When both need for touch and need for smell are low, the mean levels of all variables are also lowest. These results show that there are indeed segments of varying sensory perceptual needs, which also share further common purchase-related characteristics. Applying the ENFAS scale for segmentation purposes can significantly contribute to a better understanding of certain consumer groups.

9. General discussion and avenues for future research

So far, the lack of a fit-for-purpose instrument measuring the individual propensity to use one's sense of smell purposefully on a linear scale in a purchase situation has impeded consumer research in this regard. By filling this gap, the newly developed ENFAS instrument opens up new research opportunities. It conceptualizes two dimensions of the consumer's propensity to use the sense of smell in a purchase behavior context: first, to help consumers assess the quality of products (informational) and whether products are safe to buy and use (self-protective); and second, to experience pleasure from the perception and the use of products through their smell.

The scale development started in Austria as the lead country and was subsequently extended to Germany and the US. In all three countries, psychometric criteria, as set out by modern test theory, were satisfactorily met. Each ENFAS dimension consists of a manageable number of items (5 and 6, respectively) adding up to 11 items in total. The shortness of the instrument prevents the respondents from being burdened by its completion and makes the scale attractive for both academic and corporate market research. At the same time, measurement precision for each dimension is sufficient even for decisions based on small groups of consumers. For these reasons, we expect the ENFAS instrument to stimulate research in product marketing investigating the need for smell as an independent variable, a mediator or a moderator.

While the two ENFAS dimensions are conceptually and empirically distinguishable, they are also related to some extent. For applied research, this opens up three options that are not necessarily mutually exclusive. First, depending on the research question, researchers may select one dimension on a theory-driven basis and process the measurements accordingly. Second, a study can administer both dimensions providing two measures. Third, when using all 11 items, the items may also be combined into one composite measure summarizing the overall need for smell of a consumer. While this implies a slight loss of explained variance, the composite measure provides the basis for a unique ordering of respondents in terms of their general need for smell should this be needed (see Web Appendix Table W3).

In terms of the relevance of the need for smell in purchase situations, the results of our ten studies clearly show that a considerable proportion of consumers indeed rely on their sense of smell one way or another. It seems that a huge potential to stimulate consumers by their olfactory sense currently remains underutilized. Considering the results of our studies, research is very likely to benefit from further investigation into the consumer's active smelling behavior. The rather prominent role of food items in the focus groups suggests that the sense of smell is particularly relevant in this product category. Having said that, the ENFAS instrument is very general in this regard and can be used for a broad range of products. Empirical studies need to explore where the need for smell matters most and for which businesses there would be little benefit of providing consumers the opportunity to take a smell at the products offered.

With the ENFAS instrument, we can assess the role of product smell in a buying context, shed light on the contribution of smell to product evaluations, or study the enjoyment consumers derive from product smells. Our results highlight that key findings from other fields of enquiry in the context of the sense of smell in humans seem to generalize to purchase behavior. For example, the sense of smell appears to be more important for women compared to men, specifically when it comes to its role in their personal enjoyment of the buying process. Nonetheless, Herz and Bajec (2022) found that women were more willing to give up their sense of smell for access to various commodities than men. Studies using the ENFAS may help expand our understanding of how smells affect our daily interactions with products and other people. To date, little is known in terms of the extent to which olfactory aspects matter in the design of products and services for different target groups and under different conditions (e.g., Ludden and Schifferstein 2009).

Companies should consider developing strategies tailored to specific target segments differentiated by different needs in terms of using the sense of smell. Having a high need for smell implies that olfactory stimuli are expected to be more effective compared to consumers for whom the need for smell plays a relatively minor role in the context of purchase decision making. Consequently, the former constitute the prime target for smell-based marketing activities. Whether such activities may have adverse consequences in consumers with a low need for smell (other than a lack of effectiveness) requires further research for which the new need for smell scale will be useful.

The new measurement instrument opens up a potential for market segmentation and product positioning. On the one hand, providing olfactory product stimuli should be more effective when need for smell is high. On the other hand, depriving such consumers of the possibility of smelling a product is expected to have adverse consequences. While many companies emphasize the smell of a product in advertisements or TV commercials, or spend research efforts to create a specific product smell, in many cases consumers cannot smell the product when they make a purchase. For example, fruits and vegetables packed in Styrofoam and plastic foil prevent consumers from experiencing any olfactory sensation. To some extent, providing sensory descriptors may help

Table 10
Need for smell/need for touch segments.

	Need for touch high (above scale origin)	Need for touch low (below scale origin)
Need for smell high (above scale origin)	125 22.9%	62 11.4%
Need for smell low (below scale origin)	124 22.8%	234 42.9%

Table 11
Need for smell/need for touch – Description of segments.

Segment	Need to evaluate	Faith in intuition	Shopping enjoyment	Buying impulsiveness
1. Need for smell high / Need for touch high	5.08 Δ sig. 2, 3, 4	5.71 Δ sig. 3, 4	5.23 Δ sig. 2, 3, 4	4.82 Δ sig. 2, 3, 4
2. Need for smell high / Need for touch low	4.78 Δ sig. 1, 4	5.56 Δ sig. 4	4.18 Δ sig. 1	3.82 Δ sig. 1
3. Need for smell low / Need to touch high	4.69 Δ sig. 1, 4	5.19 Δ sig. 1	4.56 Δ sig. 1, 4	4.09 Δ sig. 1, 4
4. Need for smell low/ Need for touch low	4.44 Δ sig. 1, 2, 3	5.09 Δ sig. 1, 2	3.80 Δ sig. 1, 3	3.61 Δ sig. 1, 3
Overall	$F = 28.5$ (3, 541), $p < .001$	$F = 16.5$ (3, 527), $p < .001$	$F = 28.9$ (3, 541), $p < .001$	$F = 38.2$ (3, 541), $p < .001$

Δ sig.: significantly ($\alpha = 0.05$) different from segment(s) indicated in Scheffé tests).

consumers form an impression of the characteristics of the food products they can buy (Jürkenbeck & Spiller, 2021) and packaging characteristics like shape or color may provide some intuitive sensory cues (e.g., Veflen, Velasco, & Kraggerud, 2023). However, to enable consumers obtain a richer sensory impression, packaging designers should be stimulated to develop innovative types of packaging that allow people to smell the product while still complying with hygiene standards, handling demands, and legal requirements. This problem can be even more acute when it comes to online shopping, where olfactory stimuli are completely absent. Our results underline that consumers tend to select specific retail formats based on their need for smell. Consumers with a high need for smell may feel uncomfortable and miss out on a pleasant shopping experience if their smell is not being engaged, potentially resulting in fewer purchases or, in the worst case, a complete reluctance to buy any products. To what extent this danger arises for certain product categories should be investigated empirically.

The perception of any stimulus, whether it is a product, a service, or the environment, is a multi-sensory experience. It would, therefore, be interesting to investigate how people's need for smell is related to their propensity to use their other senses in a buying situation or in other everyday situations. In the current study, the relationship between the need for smell and the NFT subscales showed moderate correlations, suggesting that for some consumers the sense of smell is more important, while others rely more heavily on the sense of touch. Almost every 4th consumer relies to similar degrees on both smell and touch information when making their purchasing decisions. In practice, visual information and auditory inputs are important too, and it would be interesting to determine the respective contributions of all modalities on people's purchase decision.

What is more, consumers are also likely to differ in terms of the role that perceptions play at the point of sale compared to information they collected beforehand. All these differences might originate from variation in perceptual sensitivities, but also from differences in the cognitive abilities to process the information received through a specific sensory channel. In addition, long-term frequent exposure to a greater variety of odors may be linked to a better ability of odor identification and greater odor awareness (Nováková, et al. 2014), which on its turn is related to improved odor memory (Arshamian et al. 2011). Schifferstein and Smeets (2006) have referred to the differential usage of sensory information as a person's perceptual style. If people differ in the way they use different sensory channels, it may have consequences for how they gather, store, and use information (Shizuru and Marsella 1981). This will also affect how they shop, how they interact with products, and what they appreciate in a product. In this regard, our knowledge about the exact role of the sense of smell is still underdeveloped. The finding that frequent exposure to and engagement with odors can increase odor awareness (Nováková, et al. 2014) raises the question whether consumers' need for smell can also be increased over time by presenting them with smell-related tasks.

Investigating the relationship between ability to smell and the need for smell is another promising area for further research. Research in this regard could also extend into clinically relevant smell disorders and explore their interaction with the need for smell and possible implications for consumption behavior of this group of consumers. This also raises the question whether the recent Covid-19 pandemic, which has led to temporary or permanent smell loss in many patients (Borsetto et al. 2020), has affected people's use of smell in purchase situations.

Finally, it would be interesting to see what role the need for smell of individuals play within the concept of olfactory imagery (Schifferstein, 2009; Krishna et al., 2014; Elder & Krishna, 2021). Including the individual need for smell of consumers would facilitate profiling and could even enhance the effectiveness of olfactory imagery used in advertising.

10. Conclusion

Our understanding of actively using the sense of smell and its role in consumer behavior is still in its infancy. However, it is an emergent topic with growing relevance to researchers and companies alike. In this regard, the present research is a contribution towards a better understanding by providing a fit-for-purpose measurement instrument for the need for smell in the context of purchase decision-making. Our set of studies reveals the richness of the construct, as well as its utility for sensory perception research, retailing, and product marketing practice. Present-day marketing increasingly relies on complex consumer profiling based on various types of electronically registered data using artificial intelligence and machine learning. The data are derived from observed consumer behavior at the point-of-sale and social media activities. However, such analyses are prone to misinterpreting processes in the consumer's mind, as they may not live up to the very nature of the consumer as a multisensory being. The concept of need for smell and its measurement provides additional insight, complementing what we can learn from digitalization and big data.

Ethical statement

Participation in all studies was voluntary. Participants were assured of the anonymous processing of all data. No personal data beyond basic demographic descriptors were stored.

CRediT authorship contribution statement

Monika Koller: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Writing – original draft, Writing – review & editing. **Thomas Salzberger:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Arne Floh:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Writing – original draft, Writing – review & editing. **Alexander Zauner:** Conceptualization, Data curation, Writing – review & editing. **Maria Sääksjärvi:** Data curation, Writing – review & editing. **Hendrik N.J. Schifferstein:** Data curation, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

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