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Behavioral and physiological determinants of food choice and consumption at sensitive periods of the life span, a focus on infants and elderly

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ABSTRACT

Infancy and old age are two crucial periods in the human life span. During infancy, early exposure to a large variety of flavor and texture plays a key role in shaping food acceptability and later eating habits. In elderly people, food history is one of the major determinants of food choice. In both populations, sensory and oral motor skills are important determinants of food choice. During eating, the formation of a food bolus that can be safely swallowed is a complex oral process, and the oral capacity to perform this process impacts directly food acceptability or rejection both in infants or elderly. Food liking in elderly is also impacted by chemosensory impairment. The specificities of these populations imply to conduct active researches aiming at proposing novel food products better adapted to them but also guidelines to caregivers who are widely involved in their feeding practices.

1. General introduction

Every day, we choose our food according to our food history, i.e. early exposures, life and education events. However, our food choices do not rely only on our past experience but also on our physiological capacity (chewing, salivation and digestion) for consuming food. Early in life, we are already exposed in utero to sensory stimuli delivered by the food consumed by the mother (Cooke & Fildes, 2011; Nehring, Kostka, von Kries, & Rehfuess, 2015). At birth, feeding is realized in a liquid form via breast milk or infant formula and around 4–6 months, the food complexity increases with the introduction of complementary foods. In parallel, during this period, the child begins to develop its own capacities to consume more and more complex foods along the development of new functionalities of the oral cavity (Nicklaus, Demonteil, & Tournier, 2015) and of the rest of the digestive system. This is a crucial and sensitive period of nutritional and food transition impacting future food preferences but also the development of motor oral skills of the child, this motor development being highly conditioned by the food choices made by parents.

At the opposite of the life span, old age also corresponds to a crucial period of development of the individual with significant physiological changes in the sensory, oral and digestive functions (Mak & Caldeira, 2014). These are due to normal ageing of the individual but also to the accumulation of numerous life events happening during this period, i.e. retirement, sickness, widowhood etc. These changes are accompanied by a significant modification in food choices and habits (Popper & Kroll, 2003) leading frequently to undernutrition with a strong impact on the health of the elderly and in turn their autonomy (Mak & Caldeira, 2014). In this last case, as for infants, decisions about food products are often taken by caregivers.

These two populations, infants and elderly, represent for our society a real demographic challenge for the coming years, particularly in the area of food supply. Indeed, in 2015 there were > 5 million European births and > 800,000 in France (INED, 2016). Even with a slowdown in the birth rate and according to the projections, population of EU-28 is expected to peak at 525.5 million by 2050. This increase in population, however, will be accompanied by a large ageing population, people 65 yo and more representing 28.7% of the population of the EU-28 in 2080, against 18.5% in 2014. As a result of these changes among age groups, the dependency ratio of the elderly in the EU-28 will be almost doubled from 28.1% in 2014 to 51.0% in 2080. The total rate of age-related dependency is expected to increase from 51.8% in 2014 to 77.9% in 2080 (Eurostat, 2016). In France, the number of people aged over 75 years were 5.7 million in 2012, they will be 12 million in 2060 (French-government, 2015).

In this context, developing age-friendly products and services specifics to these target groups is a real challenge for our society and our economy. In particular, the question of the needs of infants and elderly people in term of food products with optimized nutritional and sensory values is of crucial importance. Addressing this challenge implies to

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conduct now thorough research aiming at identifying relevant determinants of food choice and behavior in these specific populations. This will permit to ensure sufficient food supply combining sensory and nutritional constraints.

The aim of the current review is to present, through selected examples, scientific approaches and recent works and results with a focus on sensory sensitivity and reactivity to tastes, odors and texture, oral physiology and food acceptance in infants and elderly. The question of acceptance and oral management of food texture in these two populations is particularly emphasized.

2. Food choice and acceptance during infancy

After a period of exclusive milk feeding (breast or formula milk), infants are introduced with complementary foods when milk is no longer sufficient. This constitutes a very specific transition towards the consumption of food that are nutritionally balanced but also culturally appropriate. The concept of the first “1000 days” and the developmental origins of health and disease (DOHaD) underpins how early nutrition can impact later health (Simeoni et al., 2016). Parents, as the first providers of food, will determine the nutritional adequacy of their infant diet but they will also shape their infant eating behavior. Yet, the development of food preferences and eating habits are strongly influenced by early experiences and are persistent until adulthood (Nicklaus, 2017; Nicklaus & Remy, 2013). Therefore it is very important to understand how to foster the most favorable and healthiest eating habits before the age of two, that is before the emergence of neophobic behaviours (i.e. linked to the fear of eating unfamiliar foods) (Dovey, Staples, Gibson, & Halford, 2008; Lafraire, Rioux, Giboreau, & Picard, 2016).

At the start of complementary feeding, food acceptance is fairly high with 90% of new foods reported to be accepted (Lange et al., 2013). Complementary feeding is in this sense a window of opportunity to introduce a wide range of food into the infant diet. Vegetables, as nutrient-dense foods, are acknowledged to be the core of a healthy diet. In their discourse, mothers recognize the importance of introducing vegetables in their infant diet, would it be for nutritional purpose or -for French mothers- as a mean to “educate the palate” (Caton, Ahern, & Hetherington, 2011; Schwartz et al., 2013). However, despite their reputed benefits, mothers believed that vegetables could be harder to like than other food (Schwartz et al., 2013). Indeed, acceptance of vegetables is lower than for other food groups; not forgetting the categories of “meat, fish, and eggs” and fruits also often reported as refused (Lange et al., 2013; Le Heuzey & Turberg-Romain, 2015). The lower acceptance of vegetables can be explained by their specific flavor (i.e. the presence of sulfurous notes, bitterness, sourness) and/or texture (hard, fibrous, …), and their lower caloric content (Mennella, Reiter, & Daniels, 2016; Nicklaus, 2011). However, some strategies (repeated exposure and variety) can help developing food acceptance (among which vegetable acceptance) and in turn healthy eating habits. In this section, we will focus first on the role of primary tastes, odors, fat taste (based on the data of the Observatory of Food Preferences in Infants and Children (OPALINE) cohort data) and texture on acceptance and eating behaviours in infants. Secondly, we will report recent evidence regarding complementary feeding strategies fostering food acceptance. Finally, we will discuss to what extent recent guidelines targeted to both practitioners and parents fit recent scientific evidence.

2.1. Role of flavor, fat taste and texture on acceptance and eating behavior

Each food has its specific sensory profile: a particular taste and aromatic profile and some particular textural cues. Yet, infant chemosensory reactivity and reactions towards specific textures may partly underpin the way infants react and accept foods. The study from Coulthard & Blissett (Coulthard & Blissett, 2009) supports this hypothesis: the more children (aged of 3.7 years old) were sensitive to taste/smell (defined via the Short Sensory Profile), the less likely they were to model their parent's consumption of fruit and vegetables. Another work showed that breastfed infants showing over tactile sensitivity (measured by questionnaire) and who started the CF process older consumed less pureed carrot at the beginning of CF (Coulthard, Harris, & Fogel, 2016). Finally, texture refusal was commonly observed among very picky eaters (van der Horst, Deming, Lesniauskas, Carr, & Reidy, 2016).

2.1.1. Role of flavor (primary taste and odors)

The role of taste and odor acceptance in shaping food preferences has been assessed experimentally within the OPALINE birth cohort run in Dijon in France. The originality of this comprehensive birth cohort lies in its main objective to describe the aetiology of food preferences and rejection over the 2 first years of life with a sensory perspective and behavioural approaches. 312 mothers (319 infants) were enrolled on a voluntary basis during their last trimester of pregnancy and followed until their child reached 2 years of age. Among other parameters, infant acceptance of primary tastes and food odors were assessed. This longitudinal study expands then the seminal work conducted by Steiner in neonates (Steiner, 1974, 1979; Steiner, 1987) with the use of sensory stimuli of moderate intensities and the follow up of a large group of infants over up to 17 months. Acceptance of food odors were assessed at 8, 12 and 22 months of age. At each age, infants were exposed to non-scented and scented bottles (with a balance of 4 a priori pleasant - apple, peach/apricot, strawberry and vanillin - and 4 a priori non pleasant food odors - dimethyl disulphide, trimethylamine, butyric acid and 2-isobutyl-3-methoxypyrazine) (Wagner et al., 2013). Results showed that unpleasantly scented bottles induced a shorter duration of mouthing than pleasantly scented bottles (as a priori defined by an adult panel) (Wagner et al., 2013). Reactions towards food odors highlighted an asymmetry in hedonic responses to pleasant/unpleasant odors: food odors considered as unpleasant by adults were fairly avoided in early infancy (Wagner et al., 2013). However, infant attraction towards pleasant food-odors seemed to be not fully shaped by these ages (Wagner et al., 2013).

When it comes to primary tastes acceptance was assessed at 3, 6, 12 and 20 months of age in the same study. At each age, infants were offered either bottles of water or bottles containing one of the five primary tastes (i.e. sweetness, saltiness, sourness, bitterness and umami taste) (Schwartz, Chabanet, Szleper, Feyen, Issanchou, & Nicklaus, 2017a; Schwartz, Chabanet, Szleper, Feyen, Issanchou, & Nicklaus, 2017b; Schwartz, Issanchou, & Nicklaus, 2009). Sweetness was on average preferred at 3 months of age over water; umami, saltiness and sweetness were on average preferred at 6 months of age over water; sweetness and saltiness were on average preferred at 12 months of age over water and all tastes except sweetness were on average rejected at 20 months of age over water. Over the first year, reactions to tastes were globally positive (or were reactions of indifference) which could help introducing a wide range of food in the infant diet. Acceptance of saltiness and umami taste was lower in girls than in boys at the age of 20 months. This gender effect was also observed at later age in another study: 7–19 years old girls liked less salty solutions than boys (Monneuse, Tanasescu, Glavce, & Roville-Sausse, 2011). The role of potential sex-based differences in feeding practices to support this clearly deserves more research.

Focussing on developmental changes, it appeared that the trajectories of acceptance were parallel for sweetness, sourness and umami tastes between 3 and 20 months of age (sweetness being the preferred taste). For saltiness, acceptance increased sharply between 3 and 12 months of age; which confirms previous reports (Beauchamp, Cowart, Mennella, & Marsh, 1994; Beauchamp, Cowart, & Moran, 1986; Schwartz et al., 2009). Between 12 and 20 months of age, the acceptance of all tastes, except bitterness, decreased. The acceptance of bitterness remained stable throughout the studied period (Schwartz et al., 2017a; Schwartz et al., 2009).

Differential reactivity scores (representing the variability of