



Research report

Food neophobia, nanotechnology and satisfaction with life [☆]

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ABSTRACT

This study investigates the relationship between food neophobia, satisfaction with life and food-related life, and acceptance of the use of nanotechnology in food production. Questionnaire data was collected from a sample of 400 supermarket shoppers in southern Chile. The questionnaire measured knowledge of nanotechnology and willingness to purchase food products involving nanotechnology, and included the SWLS (Satisfaction with Life Scale), SWFL (Satisfaction with Food-related Life) and FNS (Food Neophobia Scale) scales. Using cluster analysis, four consumer types were distinguished with significant differences in their scores on the SWLS, SWFL and FNS. The types differed in their knowledge of nanotechnology, willingness to purchase foods involving nanotechnology, age, socioeconomic level and lifestyle. The least food-neophobic type had the highest levels of satisfaction with life and with food-related life and also had the highest acceptance of packaging and foods produced with nanotechnology. The results suggest that the degree of food neophobia is associated with satisfaction with life and with food-related life, as well as with the acceptance of products with nanotechnological applications.

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Introduction

Food neophobia is the reluctance to try new foods, and people differ in their degree of food neophobia (Pliner & Hobden, 1992), with some individuals showing great pleasure in eating new foods and others showing a strong aversion to them (Ritchey, Frank, Hurstic, & Tuorila, 2003). Food neophobia is generally characterized as a personality trait, a continuum along which people can be placed in terms of their tendency to accept or avoid new foods. At the same time, food neophobia has been discussed as a form of behavior, involving the avoidance of novel foods in a particular situation (Pliner & Salvy, 2006). According to Rozin and Fallon (1980) and Rozin, Haidt, and McCauley (1993) there are three main reasons for food rejection by humans: (a) aversion, (b) danger and (c) disgust.

Research in food neophobia was aided by the development of the Food Neophobia Scale or FNS (Pliner & Hobden, 1992) which provided a standardized measure of food neophobia. The FNS consists of 10 questions, each measured on a 7-point agree–disagree

scale. More recently, Ritchey et al. (2003) recommended eliminating several scale items. In addition, researchers have used varying numbers of items in questionnaires to measure neophobia. Some research has retained the original 7-point scale and others use shorter scales (Meiselman, King, & Gillette, 2010). Some examples are the investigations undertaken by Henriques, King, and Meiselman (2009), Meiselman et al. (2010), Camarena, Sanjuán, and Philippidis (2011) and D'Antuono and Bignami (2012). Numerous studies have shown that the FNS accurately predicts responses to novel or unfamiliar food (Ritchey et al., 2003; Tuorila, Lähteenmäki, Pohjalainen, & Lotti, 2001), but it is less suitable for assessing receptivity to foods produced by new technologies (Backstrom, Pirttila-Backman, & Tuorila, 2004; Cox & Evans, 2008; Grunert, Breddahl, & Scholderer, 2003; Lähteenmäki et al., 2002; Siegrist, 2008). Nevertheless, it must be pointed out that all these studies were conducted in developed countries.

Using the FNS several recent studies have shown that food neophobia is related to the extent in which consumers accept new and/or unusual foods (Barrena & Sánchez, 2013; Camarena et al., 2011; Chung et al., 2012; D'Antuono and Bignami, 2012; Hoek, Choe & Cho, 2011; Hoek, Luning, Weijzen, Engels, Kok, & de Graaf, 2011; Hersleth, Lengard, Verbeke, Guerrero, & Næs, 2011; Sanjuán-López, Philippidis, & Resano-Ezcaray, 2011; Henriques et al., 2009; Jaeger et al., 2011; King, Meiselman, & Henriques, 2008; Olabi,

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Najm, Baghdadi, & Morton, 2009; Ritchey et al., 2003; Tuorila, Lähteenmäki, Pohjalainen, & Lotti, 2001). Some studies show different levels of food neophobia among consumers from different countries. Ritchey et al. (2003) found that people from Sweden are generally more willing to try novel foods as compared to people from the US and Finland. Chung et al. (2012) found that Koreans showed significantly higher food neophobic tendencies than US subjects. To our knowledge, still there is no information on food neophobia in South America. Differences in the level of neophobia have also been detected according to gender (Camarena et al., 2011; Sanjuán-López et al., 2011; Tuorila et al., 2001), age (Camarena et al., 2011; D'Antuono and Bignami, 2012; Frank, 2009; Meiselman et al., 2010; Ritchey et al., 2003; Sanjuán-López et al., 2011; Tuorila et al., 2001), occupation (Sanjuán-López et al., 2011), level of education (D'Antuono and Bignami, 2012; Frank, 2009; Meiselman et al., 2010; Sanjuán-López et al., 2011; Schickenberg, van Assema, Burg, & de Vries, 2006; Tuorila et al., 2001), income level (Camarena et al., 2011; Frank, 2009; Meiselman et al., 2010; Sanjuán-López et al., 2011) and expenses per month (Choe & Cho, 2011).

Some studies have focused on relating food neophobia not only to the acceptance of novel food products, but also to the acceptance of new technologies used in food production and processing (Backstrom et al., 2004; Grunert et al., 2003; Lähteenmäki et al., 2002). It is necessary to distinguish between acceptance of new food and acceptance of food produced by new technologies, because technologies may be rejected outright, without regard to the product in which they are embodied. Examples of technologies that have been subject to outright consumer rejection, no matter which type of food they were used for, include genetic modification (e.g., Grunert et al., 2003) and irradiation (see Frewer et al., 2011, for this and other examples).

The last two decades have seen considerable research and development dedicated to new food technologies. One of the reasons for such interest in new food technologies is the anticipated range of benefits they can bring to the consumer and the food sector (Rollin, Kennedy, & Wills, 2011). While technology has emerged in response to problems identified by scientists and consumers alike, it is well documented that consumers are increasingly wary of new technologies because of the perceived risks and a perceived lack of consumer benefits (Cox, Evans, & Lease, 2007; Frewer et al., 2011; Rollin et al., 2011). Nowadays consumers are exposed to several applications of emerging technologies including genetic modification technology, food irradiation technology and nanotechnology (Rollin et al., 2011; Siegrist, 2008). Indeed, foods and food packaging involving nanotechnology are already being commercialized, though the number of products is still low. In the near future, nanotechnology may become increasingly important in the food sector, with governmental agencies and industry investing considerable resources in its development and implementation (Frewer et al., 2011). This is true not least in South America, where governments also are pushing the development of this new technology (Kay & Shapira, 2009). While some studies on consumer acceptance of nanotechnology have been carried out in Europe and North America (see Frewer et al., 2011; Rollin et al., 2011; Siegrist, 2008, for an overview), no such research has been carried out in South America. Recent studies conducted in European countries indicate that consumers are still sceptical about buying foods produced using nanotechnology (Bieberstein, Roosen, Murette, Blanchemanche, & Vandermoere, 2013; Siegrist, Cousin, Kastenholz, & Wiek, 2007; Siegrist, Stampfli, Kastenholz, & Keller, 2008; Stampfli, Siegrist, & Kastenholz, 2010), although there is evidence to suggest that acceptance of nanotechnological applications differs from country to country (Bieberstein et al., 2013).

Past research has focused on the neophobic's reluctance to try new foods (Pliner & Salvy, 2006), but the behavior of the neophobic

might differ in many other ways (King et al., 2008). Present day society is characterized by a growing awareness of the role played by food in improving consumers' well-being (Chern & Rickertsen, 2003). The subjective well-being (SWB) construct is commonly viewed as a tripartite phenomenon, which includes emotional responses (i.e. positive affect (e.g. joy, optimism) and negative affect (e.g. sadness, anger), domain satisfactions and global judgments of life satisfaction (Diener, Suh, Lucas, & Smith, 1999). The concept of satisfaction with life has been defined as a positive evaluation which a person makes of his life in general, or of particular aspects (family, studies, work, health, friends, free time) (Diener et al., 1999). The best known measure of the cognitive component of subjective well-being is the Satisfaction with Life Scale (SWLS), developed by Diener, Emmons, Larsen, and Griffin (1985). In general, positive evaluations of life satisfaction are linked with happiness and the achievement of the 'good life', whereas negative evaluations of life satisfaction are associated with depression and unhappiness (Proctor, Linley, & Maltby, 2009). Recent studies conclude that food is among the important domains of life which affect the subjective well-being of individuals (Grunert, Dean, Raats, Nielsen, & Lumbers, 2007; Schnettler, Miranda, Sepúlveda, Denegri, Mora, & Lobos, 2012a; Schnettler et al., 2013), although the mechanisms by which food affects subjective well-being are not spelled out in detail. Grunert et al. (2007) developed and tested the Satisfaction with Food-related Life scale (SWFL) in three studies in eight European countries, showing adequate levels of internal consistency (Cronbach's α varying between 0.81 and 0.85). These authors determined relationships between SWFL and other quality of life indicators, including satisfaction with life. Schnettler et al. (2012a) found a positive relation between people's food-related satisfaction and their satisfaction with life. Also, Schnettler et al. (2012a) and Schnettler, Miranda, Sepúlveda, and Denegri (2011a) reported the existence of a relation between satisfaction with life and preferences for certain foods. It has also been reported that there is a relation between satisfaction with food-related life and preferences for different foods (Schnettler et al., 2010, 2011b). Schnettler et al. (2013) evaluated the psychometric properties of the SWFL and its relation to the Satisfaction with Life Scale (SWLS) using a confirmatory factor analysis. The results obtained showed an adequate level of internal consistency and a good fit to the SWFL data. The evaluation of a causal covariance structure analysis model composed of the SWFL as the antecedent construct and the SWLS as the consequent construct indicates a medium level of relationship between the two constructs.

In this study, we will distinguish types of consumers that differ according to their satisfaction with life, satisfaction with their food-related life and food neophobia, and characterize these types with regard to their acceptance of foods and packages produced with nanotechnology, as well as some other demographic and psychographic criteria.

Based on previous studies (Grunert et al., 2007; Schnettler et al., 2012a), we expect to confirm the existence of a positive relation between satisfaction with life and satisfaction with food-related life. It has been reported that satisfaction with life and food-related life are associated with the preference for certain foods (Schnettler et al., 2012a, 2011a,b, 2010), i.e., people with a positive subjective well-being overall and in the domain of food have different eating habits than those who are unsatisfied with their life and their food-related life. The former, in general, is characterized as enjoying their food. One particular way in which food can be expected to contribute to overall well-being is by food-induced emotional responses, in particular negative emotions like neophobia and disgust (Raudenbush & Frank, 1999). Considering that neophobics tend to display negative attitudes and less pleasure in relation to food (Nordin, Broman, Garvill, & Nyroos, 2004; Arvola, Lähteenmäki, & Tuorila, 1999) and SWB is an evaluation which people make of

their own lives, including pleasurable emotions and the relative absence of unpleasant emotional states (Diener & Biswas-Diener, 2000), the hypothesis proposed is that there is an inverse relation between food neophobia and satisfaction with life and food-related life.

Phobia towards the introduction of unusual foods in the diet can occur for several different reasons, such as culture (Ritchey et al., 2003) and consumer characteristics, and one of the most important is uncertainty about potential health effects (Barrena & Sánchez, 2013). Food neophobia is considered a kind of defense mechanism, preventing the consumption of potentially harmful foods (Cooke, Haworth, & Wardle, 2007; Pliner & Hobden, 1992). Because the toxicological nature of hazard, the likelihood of exposure and the risk to consumers from some new food technologies are largely unknown (Chaudhry et al., 2008), we also hypothesize a lower acceptance of foods and packages produced with nanotechnology in neophobics.

The literature indicates that acceptance of new technologies applied to food production differs from country to country. European and Japanese consumers tend to accept genetic modified foods much less than US consumers (Lusk, Daniel, Mark, & Lusk, 2001; Lusk, Roosen, & Fox, 2003). Among the developing countries, there is evidence of consumer groups who have a positive attitude towards genetically modified foods, like in China (De Steur et al., 2010), Kenya (Kimenju & De Groote, 2008) or Brazil (Da Costa, Deliza, Rosenthal, Hedderley, & Frewer, 2000), but in other developing nations the perceptions are generally more negative than positive, like in Argentina (Mucci, Hough, & Ziliani, 2004) and Chile (Schnettler, Miranda, Sepúlveda & Denegri, 2012b). Therefore it is also to be expected that acceptance of foods produced using nanotechnology differs among developed and developing countries, as well as among countries from the same region, in line with what was previously reported by Bieberstein et al. (2013) in Europe. In this sense, the present study attempts to relate the level of a consumer food neophobia to the acceptance of new technologies applied to food production, taking nanotechnology as an example of the new technologies and Chile as a case study for South American countries.

Materials and methods

Sample

A personal survey was carried out on a sample of 400 supermarket shoppers, aged over 18, who were responsible for buying the food for their homes in Temuco (Araucanía Region, 38°45'S, 73°03'W), Chile. The number of people surveyed was obtained using the simple random sample formula for non-finite populations ($N > 100,000$. Temuco 245,347 inhabitants, Census 2002), considering 95% confidence and 5% estimated error with p and q 0.5 (Fernández, 2002).

Information collection instrument

The questionnaire used contained closed questions regarding knowledge of the meaning of nanotechnology, willingness to purchase a food produced with nanotechnology and willingness to purchase a food package produced with nanotechnology. Before the participants responded to the last two questions, the definition used by Siegrist et al. (2008) was read to them: "Nanotechnology is considered one of the key revolutionizing technologies of the 21st century and refers to a broad range of advanced applications that deal with particles and structures smaller than 100 nm. One nanometer is one billionth of a meter. The breadth of possible fields of application is far-reaching and includes, for example, energy and

information technologies as well as the medical and cosmetics industries. In the near future, the food industry plans to realize the potentials of nanotechnology to extend shelf life, customize flavors, or improve human health and well-being. Along with the beneficial aspects, nanotechnology also carries possible risks that we know little about. The biggest worry among experts is that nanoparticles may permeate the human body. The effects of nanoparticles on human health and the environment are still widely unknown".

The questionnaire included the FNS, SWLS and SWFL scales. Two bilingual translators translated all the original items of the FNS (Pliner & Hobden, 1992), SWLS (Diener et al., 1985) and the SWFL (Grunert et al., 2007) from English to Spanish. Subsequently a different bilingual translator translated the Spanish versions of the scales back into English. The differences found were resolved by discussion, with all the translators arriving at agreed final versions of the two scales.

In the present study the respondents had to indicate their degree of agreement with the 10 items on the FNS using a 6-level Likert scale. Given that the psychometric properties of the FNS have not previously been studied in South America, to this end an exploratory factor analysis (EFA) was used and then a confirmatory factor analysis (CFA). The EFA was implemented using SPSS 16.0 (SPSS Inc., Chicago, EUA) and the CFA using LISREL 8.8 (Scientific Software International, Inc. Chicago, 2007). The parameters in the CFA were estimated by robust maximum likelihood (Hair, Anderson, Tatham, & Black, 1999). The results of the EFA revealed only one factor that grouped six of the 10 original items (65.3% explained variance), consistent with the results obtained by Ritchey et al. (2003) with samples from the USA, Sweden and Finland. Items 2, 3, 8 and 9 were eliminated because they presented communality values below 0.4. For the six remaining items, the FNS presented a suitable level of internal consistency (Cronbach's α : 0.892). A CFA model fits reasonably well if the Chi-Square (χ^2) is not significant, if the goodness-of-fit index (GFI) and the adjusted goodness-of-fit index (AGFI) are greater than 0.90, and if the root mean square error of approximation (RMSEA) is lower than 0.08 (Hu & Bentler, 1999). The CFA performed with the six items of the FNS meant that the one-dimensional structure of the FNS could be validated with a good goodness-of-fit (Chi-Square = 7.5, P -value = 0.186, RMSEA = 0.035, GFI = 0.99, AGFI = 0.97). The standardized factor loadings for the six items were statistically significant; therefore, it may be concluded that there is convergent validity (Table 1). A food neophobia index, with a potential 6–36 range, was obtained by summing the individual item scores, after the positive items were reversed, as is usually done (D'Antuono and Big-nami, 2012; Tuorila et al., 2001). In the present study the mean FNS score of all participants was 17.5 (SD = 6.6; range = 6–36).

SWLS is a scale consisting of five items grouped into a single factor to evaluate overall cognitive judgments about a person's own life: 1. In most ways my life is close to my ideal, 2. The conditions of my life are excellent, 3. I am satisfied with my life, 4. So far I have gotten the important things I want in life, 5. If I could live my life over, I would change almost nothing. SWFL is a scale consisting

Table 1
Standardized factor loadings for FNS model.

Item	Factor loading	t -Value
I am constantly sampling new and different foods	0.72	13.79
I like foods from different cultures	0.81	18.65
Ethnic food looks too weird to eat	0.75	16.47
At dinner parties, I will try new foods	0.76	16.91
I am afraid to eat things I have never had before	0.68	14.66
I like to try new ethnic restaurants	0.83	19.24

of five items grouped in a single dimension: 1. Food and meals are positive elements, 2. I am generally pleased with my food, 3. My life in relation to food and meals is close to ideal, 4. With regard to food, the conditions of my life are excellent, 5. Food and meals give me satisfaction in daily life. In each scale the respondents were asked to indicate their degree of agreement with these statements using a 6-level Likert scale (where 1 is disagree completely and 6 is agree completely). In the present study, the SWLS and SWFL scales presented adequate levels of internal consistency (Cronbach's α : 0.879, 0.821, respectively) and the existence of a single factor for all the items (explained variance: 68.8% and 60.8%, respectively). The mean SWLS score of all participants was 23.9 (SD = 4.4). The mean SWFL score of all participants was 24.1 (SD = 3.8).

Scales with no midpoint (i.e. 6-point Likert scales) were used as previous testing of the instruments suggested a tendency by respondents to concentrate answers at the midpoint. In order to avoid the indecisive answers that tend to be concentrated at the mid-point the scales that originally contained seven (SWLS and SWFL) and five or seven levels (FNS) were changed to six levels.

Classification questions were included to establish gender, marital status, age, area of residence, family size, self-declared lifestyle, occupation and level of education of the head of the household, and ownership of 10 domestic goods. The combination of these two latter variables in a matrix allows the socio-economic level to be determined, classified as ABC1 (high and upper middle), C2 (middle-middle), C3 (lower middle), D (low) and E (very low). These variables, conceptually, are related with income, cultural level and with the stock of wealth accumulated by the family group, allowing a simple but adequate estimate to be made of the socio-economic level of Chilean households (Adimark, 2004). To obtain the self-declared lifestyle, respondents were asked what lifestyle they defined for themselves (mixed response: conservative, liberal, ecological, sporting, innovative, other; if the respondent answered "other" he/she was asked to indicate the lifestyle he would define for himself).

Procedure

The survey was applied personally by two previously trained surveyors (fifth year students in the Agronomy course, Universidad de La Frontera, Temuco, Chile), at the exit of two supermarkets in Temuco during April and July 2011. The supermarkets where the surveys were carried out are in the category of "big supermarket" in Chile (3000–6000 m², 1500–10,000 products, 20 tills on average) and attract all types of shopper. The surveyors intercepted people as they were coming out of the supermarkets, explained the objectives of the survey to them and the strictly confidential treatment of the information obtained, and then asked if they were prepared to answer the questionnaire (mall intercept type). The response rate was 68%. Prior to the application of the survey, the questionnaire was validated by a preliminary test with 10% of the survey sample. The preliminary test was done using the same method of addressing the participants as in the definitive survey. As the validation of the instrument was satisfactory, no changes were required in either the questionnaire or the interview procedure. The participants signed informed consent statements before responding. The execution of the study was approved by the Bioethics Committee of the Faculty of Farming, Livestock and Forestry Sciences at the Universidad de La Frontera.

Statistical analysis

A cluster analysis (hierarchical conglomerates) was used to determine typologies of consumers according to their satisfaction with life, satisfaction with food-related life and food neophobia,

with linkage by Ward's method and the squared Euclidian distance as the measure of similarity between objects (Hair et al., 1999). The number of groups was obtained by the percentage change of the recomposed conglomeration coefficients. To describe the segments, Pearson's Chi² test was applied to the discrete variables, and analyses of variance for the continuous variables. Because the Levene's statistic indicated non-homogeneous variances in all the continuous variables analyzed, the variables for which the analysis of variance resulted in significant differences ($P < 0.001$) were subjected to Dunnett's T3 Multiple Comparisons test. The program used was SPSS 16.0 for Windows.

Results

Of the entire sample (Table 2), the largest proportion were women, married or living with a partner, between 35 and 54 years, resident in urban areas, from families with three to four members, in private employment, belonging to socioeconomic group ABC1, with a conservative lifestyle. The majority of the participants did not know the meaning of nanotechnology. Approximately 49% were willing to purchase a food produced with nanotechnology, whereas this proportion rose to approximately 69% in the case of food packages produced with this technology. The Pearson's correlation between FNS and SWLS scores was -0.272 ($P < 0.01$) and between FNS and SWFL was -0.391 ($P < 0.01$). The correlation between SWLS and SWFL was 0.546 ($P < 0.01$).

Cluster analysis enabled four typologies of consumers to be distinguished with significant differences in the average values of the FNS, SWLS and SWFL scales ($P \leq 0.001$) (Table 3). The typologies presented significant differences according to age, socioeconomic group, self-declared lifestyle, willingness to purchase foods and packages with nanotechnological applications ($P \leq 0.001$), marital status and knowledge of the meaning of nanotechnology ($P \leq 0.05$) (Table 4). The composition of each typology is shown below.

Neophobics, satisfied with their life and their food-related life

Group 1 ($n = 167$), which represented 41.8% of the sample surveyed, presented the highest value on the FNS scale, significantly higher than Groups 3 and 4. The point scores obtained on the SWLS and SWFL were similar to Group 4 and significantly higher than Group 2 (Table 3). Group 1 contained a greater proportion of participants that do not know the meaning of nanotechnology, that would not be willing to purchase foods or packages produced with nanotechnology, that were aged 55 or over and that declared themselves to be conservative (Table 4).

Neophobics, dissatisfied with their life and their food-related life

Group 2, which represented 6.0% of the sample surveyed ($n = 24$), had a point score on the FNS that was statistically similar to Groups 1 and 4. This group presented lower scores on the SWLS and SWFL, significantly lower than the rest of the typologies (Table 3). This group presented a higher proportion of participants who were single, separated, divorced or widowed and belonging to socioeconomic group C3 (Table 4).

Non-neophobics, extremely satisfied with their life and their food-related life

Group 3 represented 20.8% of the sample ($n = 83$); it had the lowest score on the FNS, differing statistically from the other groups. The scores obtained on the SWLS and SWFL were significantly higher than those obtained by the other typologies (Table 3).

Table 2
Characteristics (%) of the sample of habitual supermarket shoppers in Temuco, Chile. July 2011.

Sample	Total
Gender	Female 64.5 Male 35.5
Marital status	Single, separated, divorced or widowed 35.5 Married or cohabiting 64.5
Age	<35 years 23.8 35–54 years 50.2 55 years or older 26.0
Residence	Urban 95.8 Rural 4.2
Family size	1–2 members 26.3 3–4 members 59.5 5 members or more 14.2
Occupation	Independent worker 7.2 Businessperson 11.8 Private-sector worker 51.0 Public-sector worker 17.2 Retired 12.0 Unemployed 0.3 Other 0.5
Socioeconomic status	ABC1 (high and middle-high) 41.0 C2 (middle-middle) 25.3 C3 (middle-lower) 23.5 D (lower) 10.2
Lifestyle	Conservative 56.5 Liberal 11.3 Ecological 6.0 Athletic 12.3 Innovative 13.8
Knows the meaning of nanotechnology	Yes 27.5 No 72.5
Would be willing to buy foods with nanotechnological applications	Yes 48.7 No 51.3
Would be willing to buy packaging for foods with nanotechnological applications	Yes 69.1 No 30.9

Table 3
FNS, SWLS and SWFL mean scores for the three clusters and overall, in Temuco. Chile July 2011.

Scale	Total sample (n = 400)	Group 1 (n = 167)	Group 2 (n = 24)	Group 3 (n = 81)	Group 4 (n = 126)	F	P-value
FNS	17.5	23.5 a	18.6 ab	10.7 c	13.7 b	259.557	0.000
SWLS	23.9	24.1 b	13.5 c	27.5 a	23.2 b	125.615	0.000
SWFL	24.1	23.6 b	16.3 c	28.0 a	23.7 b	124.907	0.000

Different letters in the line indicate significant differences according to Dunnett's T3 multiple comparison test ($P \leq 0.001$). "a" is significantly higher than "b". "b" is significantly higher than "c".

The strongest presence in Group 3 was people who indicated that they knew the meaning of nanotechnology, were willing to purchase foods and packages produced with nanotechnology, were under 35, and stated that they had athletic and innovative lifestyles (Table 4).

Non-neophobics, satisfied with their life and their food-related life

Group 4, which represented 31.4% of the sample ($n = 126$), had a low score on the FNS, but that did not differ significantly from Group 2. The scores for the SWLS and SWFL were similar to those obtained by Group 1 (Table 3). This group presented a larger proportion of participants who would be willing to buy foods and packages produced with nanotechnology, who were under 35 (Table 4).

Discussion

The results of the present study make it possible to confirm the existence of a positive relation between satisfaction with life and satisfaction with food-related life. The correlation between the two scales was significant and similar to that obtained in previous

studies in Chile (Schnettler et al., 2012a) and higher than that obtained in 8 European countries by Grunert et al. (2007), which was 0.36. One of the causes of this result lies in the fact that consumers in developing countries spend a much higher proportion of their income on food than consumers in developed countries (Selvanathan & Selvanathan, 2006). Food is a need common to everyone; nevertheless, if this takes up the greatest part of the household budget, it is to be expected that this will become a significant concern and have a greater impact on the satisfaction with life of these people compared to those for whom the food budget is less relevant.

Relation between food neophobia, satisfaction with life and food-related life

Although it was possible to confirm that the scores of the FNS correlated inversely and significantly with the scores from the SWLS and the SWFL, the correlation values were low. This is probably due to the FNS measuring a personality trait (Pliner & Hobden, 1992), a continuum along which people can be placed in terms of their tendency to accept or avoid new foods (Pliner & Salvy, 2006). The low correlation between the scales is reflected in the

Table 4
Characteristics with significant differences in the groups of buyers identified by cluster analysis in Temuco, Chile, July 2011.

Characteristic	Group 1 (n = 167)	Group 2 (n = 24)	Group 3 (n = 83)	Group 4 (n = 126)
Knows what nanotechnology means	<i>P</i> = 0.003			
Yes	22.2	12.5	42.0	28.6
No	77.8	87.5	58.0	71.4
Would be willing to buy foods with nanotechnological applications	<i>P</i> = 0.000			
Yes	22.2	45.8	77.8	65.9
No	77.8	54.2	22.2	34.1
Would be willing to buy packaging for foods with nanotechnological applications	<i>P</i> = 0.000			
Yes	46.7	75.0	90.1	84.1
No	53.3	25.0	9.9	15.9
Marital status	<i>P</i> = 0.041			
Single, separated, divorced or widowed	32.9	62.5	34.6	34.1
Married or cohabiting	67.1	37.5	65.4	65.9
Age	<i>P</i> = 0.000			
<35 years	12.6	12.5	15.1	32.5
35–54 years	47.9	62.5	49.4	52.4
55 or more years	39.5	25.0	14.8	15.1
Socioeconomic status	<i>P</i> = 0.001			
ABC1 (high and middle-high)	63.5	45.8	87.0	74.6
C2 (middle-middle)	30.5	41.7	12.0	23.8
C3 (middle-lower)	5.4	12.2	0.6	1.0
D (lower)	0.6	0.2	0.4	0.6
Lifestyle	<i>P</i> = 0.000			
Conservative	71.9	62.5	30.9	51.6
Liberal	6.6	8.3	14.8	15.9
Ecological	7.8	12.5	2.5	4.8
Athletic	9.0	8.3	21.0	11.9
Innovative	4.0	8.3	30.9	15.9

P value corresponds to the (bilateral) asymptotic significance obtained in Pearson's Chi squared Test.

typologies found, because the typology **“neophobics, satisfied with their life and with their food-related life”** had satisfaction with life and food-related life values which were statistically similar to the typology **“non-neophobics, satisfied with their life and their food”**. The expected relation was obtained in the typologies **“neophobics, dissatisfied with their life and moderately satisfied with their food-related life”** and **“non-neophobics, extremely satisfied with their life and their food-related life”**. The first was characterized as being neophobic and having low scores on the SWLS and SWFL, while the second was less neophobic and presented the highest scores on the SWLS and SWFL. However, it was decided not to discuss the results referring to Group 2 (*n* = 24) because it is risky to draw conclusions based on segments with such a low number of consumers (McEwan, 1997). Therefore, it is possible to suggest that both neophobics and non-neophobics can be satisfied with their life and their food-related life. Nevertheless, the significantly higher score on the SWLS and SWFL in the typology **“non-neophobics, extremely satisfied with their life and food-related life”** give account of an overall higher level of subjective well-being as well as in the domain of food in this group of participants. Both aspects are related to happiness and achieving the good life (Proctor et al., 2009), as well as to pleasurable emotions and the relative absence of unpleasant emotional states (Diener & Biswas-Diener, 2000). This suggests that less neophobic people experience pleasure in the face of the possibility of trying novel foods or innovating in their food, which may lead to them being extremely satisfied with their life and their food-related life. In the case of the typology **“neophobics, satisfied with their life and their food-related life”**, the relatively low level of subjective well-being in the domain of food may be related to the fact that consumption decisions regarding novel food products have an important emotional component that is more pronounced in neophobic subjects, suggesting that the greater the reluctance to consume the product, the more complex the underlying choice process (Barrena & Sánchez, 2013). Therefore, it can be proposed that the

greater complexity of the food selection process in neophobics translates to a lower level of satisfaction with their food-related life because neophobics tend to display negative attitudes and less pleasure in relation to food (Nordin et al., 2004; Arvola et al., 1999; Ritchey et al., 2003).

Relation between food neophobia and acceptance of foods produced with nanotechnology

In contrast to what was reported in previous studies in developed countries (Backstrom et al., 2004; Cox & Evans, 2008; Grunert et al., 2003; Lähteenmäki et al., 2002; Siegrist, 2008), in this study the level of food neophobia was related to the willingness to buy foods and packages produced with nanotechnology. The less neophobic typologies (**“non-neophobics, extremely satisfied with their life and their food-related life”** and **“non-neophobics, satisfied with their life and their food-related life”**) presented a significantly greater proportion of participants who indicated a willingness to purchase foods and packages produced with nanotechnology. By contrast, in the typology **“neophobics, satisfied with their life and their food-related life”** the proportion of participants who indicated an unwillingness to buy the products in the study was greater. This seems to confirm the claim by King et al. (2008) that neophobia has a major impact on preferences, selections and product acceptability. This result leaves room for the suggestion that the FNS may be a suitable instrument for measuring acceptance of food produced with new technologies in developing countries. However, considering that the acceptance of new technologies applied to food production differs between developing countries (Da Costa et al., 2000; De Steur et al., 2010; Kimenju & De Groote, 2008; Mucci et al., 2004; Schnettler et al., 2012b), new research in developing countries from different regions of the world will be necessary to confirm the relation found. Also, future investigations will have to compare the utility of the FNS and the Food Technology Neophobia Scale (Cox & Evans, 2008).

In the present study, most people who did not know the meaning of nanotechnology in the typology **“neophobics, satisfied with their life and with their food-related life”** and the greatest proportion of participants who knew the meaning in the typology **“non-neophobics, extremely satisfied with their life and their food-related life”** is consistent with research reports indicating that familiarity of food may be a central determinant of liking especially for food-neophobics (Backstrom, Pirttila-Backman, & Tuorila, 2004; Barrena & Sánchez, 2013; Raudenbush & Frank, 1999). In this regard, although all the survey participants received information about nanotechnology prior to answering whether they were willing to buy products with nanotechnological applications, having previous knowledge of nanotechnology or being familiar with the term is related to a greater willingness to buy nanotechnological foods and packages in the typology **“non-neophobics, extremely satisfied with their life and their food-related life”**.

Food neophobia, satisfaction with life and food-related life, and consumer characteristics

With respect to the sociodemographic composition of the typologies found, the greatest presence of people under 35 years of age in the less neophobic groups (**“non-neophobics, extremely satisfied with their life and their food-related life”** and **“non-neophobics, satisfied with their life and their food-related life”**) and the greatest proportion of participants over 55 in the typology **“neophobics, satisfied with its life and his food-related life”** is consistent with several studies that indicate major neophobia in older people (Camarena et al., 2011; D’Antuono & Bignami, 2012; Frank, 2009; Meiselman et al., 2010; Ritchey et al., 2003; Sanjuán-López et al., 2011; Tuorila et al., 2001). Likewise, the greatest presence of people at the highest socioeconomic level in the less neophobic typologies (**“non-neophobics, extremely satisfied with their life and their food-related life”** and **“non-neophobics, satisfied with their life and their food-related life”**) and the lower presence of people at this socioeconomic level in the typology **“neophobics, satisfied with their life and their food-related life”** is consistent with the lower levels of food neophobia reported in people with a higher level of education (D’Antuono & Bignami, 2012; Frank, 2009; Meiselman et al., 2010; Sanjuán-López et al., 2011; Schickenberg et al., 2006; Tuorila et al., 2001) and income (Camarena et al., 2011; Frank, 2009; Meiselman et al., 2010; Sanjuán-López et al., 2011) in studies conducted in developed countries. Therefore, these results reveal that neophobics share some demographic characteristics both in developed and developing countries.

It should be pointed out that the greatest presence of people from the highest socioeconomic level in the typology **“non-neophobics, extremely satisfied with their life and their food-related life”** tallies with studies that indicate that a greater socioeconomic status improves subjective well-being (Agrawal et al., 2011; Oshio & Kobayashi, 2011) as well as satisfaction with food-related life (Schnettler et al., 2012a). The latter may be due to the possibility of access to food of better quality and greater variety that people with a greater socioeconomic status enjoy.

In relation to lifestyle, the greatest presence of people who identified themselves as conservatives in the typology **“neophobics, satisfied with their life and with their food-related life”** is in line with results from previous studies focusing on the acceptance of genetically modified foods (GMF) in the United States and South Korea (Nayga, Fisher, & Onyango, 2006) and Chile (Schnettler et al., 2012b). In both studies a greater rejection of GMF was observed in people in a conservative lifestyle. At the same time, the greatest presence of people who identified themselves as innovators in the typology **“non-neophobics, extremely satisfied with**

their life and their food-related life”, confirms the negative relation between innovativeness and food neophobia reported by Backstrom et al. (2004). These results demonstrate that self-declared lifestyle is related to the acceptance of foods produced with new technologies and food neophobia.

Food neophobia, satisfaction with life and food-related life, and a person’s stage in life

What has been set out in the preceding paragraphs makes it possible to suggest that the person’s stage of life plays an important role in subjective well-being and their level of neophobia. Some authors indicate that the relation between satisfaction with life and age is U-shaped, i.e., younger and older people have the highest levels of life satisfaction, whereas middle-aged people have less satisfaction with life (Blanchflower & Oswald, 2008). This would explain that the typology **“neophobics, satisfied with their life and their food-related life”** (greater proportion of people 55 years of age and over), and the typology **“non-neophobics, satisfied with their life and their food-related life”** (greater presence of people under 35) have high and similar levels of subjective well-being both overall and in the domain of food. Satisfaction with life, besides being age-sensitive, varies in its meaning with the passing of the years (Clench-Aas, Bang, Dalgard, & Aarø, 2011). While young people give greater emphasis to the experiences of pleasure, older people give greater importance to avoiding negative experiences (McMahan & Estes, 2012). This is likely related to the lower level of neophobia among the younger typologies (**“non-neophobics, extremely satisfied with their life and their food-related life”** and **“non-neophobics, satisfied with their life and their food-related life”**) because they may be more open to experiencing and expecting pleasure from eating new foods (Ritchey et al., 2003). At the same time, the fact that older people tend to avoid negative experiences (McMahan & Estes, 2012) is consistent with the greater degree of neophobia in the oldest typology (**“neophobics, satisfied with their life and their food-related life”**). Another aspect related to the person’s stage of life is the relation between age and lifestyle because older people are generally more conservative in their eating habits (Verbeke & Ward, 2006), which is consistent with the greatest proportion of people who define themselves as conservative in the oldest typology. Therefore, just as life satisfaction is associated with a person’s age or stage of life, the results of this study suggest that food neophobia also is associated with these variables. This means that a person can be expected to be less neophobic when they are young and more neophobic as they age. Nevertheless, given that Pliner and Hobden (1992) present food neophobia as a personality trait, an enduring part of personality, and something which is not expected to vary over time, the hypothesis just raised will have to be dealt with in new investigations that study the issue with a longitudinal design.

Implications and limitations of the study

Although in this investigation it was determined that neophobics and non-neophobics alike can have a positive level of subjective well-being overall and in the domain of food, the greatest level of satisfaction with life and food-related life is noted in the least neophobic people and that they are willing to buy foods and packages using nanotechnology. This has some important implications. From the point of view of society, we can expect that the people more willing to try new foods enjoy a greater satisfaction with life, their food and a better quality of life generally. From the point of view of the research related to food acceptance, it may be suggested that aspects related to subjective well-being can be useful in explaining or associating preferences for different foods.

Likewise, results from this investigation make it possible to suggest that feasibility of a successful introduction of nanotechnology applications in the Chilean food industry would increase if the marketing strategy includes as its target market young people who are interested in new food production technologies, who have an innovative lifestyle and who, at the same time, are non-neophobics. In the area of the product, it is considered advisable to begin introducing food packages with nanotechnology applications, and secondly to introduce foods produced with nanotechnology. This is because this is what has been observed in studies conducted in developing countries (Siegrist et al., 2007, 2008; Stampfli et al., 2010); in this investigation it was ascertained that the application of nanotechnology in packages was more accepted than those that involve the use of nanotechnology in food. In the area of promotion, consumers must be informed of the risks and benefits associated with nanotechnology, as the public appreciates receiving information that can facilitate the decision to buy traditionally produced foods or foods produced with new technologies (Napier, Tucker, Henry, & Whaley, 2004). Therefore, the norms for food labeling would need to contemplate the inclusion of information on the form of production, clearly indicating whether the food was produced with nanotechnology. At the same time, the competent authorities of the Chilean government (Ministry of Health, Ministry of Agriculture) would have to provide consumers with truthful and reliable information regarding the risks and benefits associated with nanotechnologically produced food to make the trade in these products transparent.

One of the limitations of this study is that it was conducted in the context of only one country, Chile. However, it can be considered as a starting point in the study of food neophobia in Latin America, as well as in the study of the relation between food neophobia and subjective well-being overall and the domain of food. Another limitation of the study is that the sample is not representative of the country's population distribution. However, the consumer distribution in this survey was similar to the sample obtained by Schnettler, Miranda, Lobos, Sepúlveda and Denegri (2011c) in a supermarket consumer study. Therefore, although the results and conclusions in this study may not be applicable to the whole population, they might be valid for those consumers that normally purchase foods in supermarkets. At the same time, the higher proportion of women surveyed clearly reflects that in Chile women are more likely to do the shopping in the supermarket than are men, just as in developed countries.

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