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BRINGING NATURE INTO PRIVATE URBAN HOUSING: ENVIRONMENTAL, SOCIAL AND FOOD CONNECTIONS FOR URBAN RESILIENCE

Gervaise Debucquet[a*], Allan Maignant[b], Anne-Laure Laroche[b], Caroline Widehem[c] and Philippe Morel[d]

[a]*AUDENCIA Business School, 8 Route de la Jonelière, 44312 Nantes - France*

[b]*ASTREDHOR, 42 rue Georges Morel, 49071 Beaucouzé - France*

[c]*AGROCAMPUS-Ouest, 2 Rue André le Notre, 49000 Angers - France*

[d]*INRAE Pays de la Loire, 42 Rue Georges Morel, 49070 Beaucouzé – France*

[*] *Corresponding author*

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Abstract

Ongoing confinement for millions of urban citizens due to the Covid-19 pandemic has raised ecological consciousness, changed food habits and questioned the relationship urban dwellers have with nature. There is more interest in bringing plants into urban homes and in sustainable food sources, but no research have studied the relationships between food behaviours and plant-care activities. To address this gap and explore urban citizens' nature relatedness through the greening of private areas, we conducted a national survey of French, young urban citizens (n = 1,000), who are more committed to 'edible' cities than older generations but have the lowest rate of plant purchasers. A quantitative approach reveals the prevalence of aesthetic/hedonistic expectations for plants in private housing but also demonstrates contrasting perceptions of tasks for plant maintening and unequal valuation of social issues around plants. We discuss continuities between environmental awareness, commitment to sustainable food and natural/social uses of plants and argue that urban planning processes should address potential synergies for more integrative resilience. Community building around green areas, urban agriculture or collective gardens, in cities, can have ripple effects towards the greening of private housing. Lastly, the multi-disciplinary approach bridging psychosociology and urban studies can inspire multi-scalar urban planning.

Keywords

Urban housing, private gardening, environmental awareness, sustainable food, multi-scalar urban planning

Introduction

The lockdowns imposed by governments in response to the spread of Covid-19 have brought about unprecedented experiences, especially for urban citizens whose living space has been mostly limited to a matter of square meters inside buildings. During these periods, a need for a 'dose de nature' (Jiang et al., 2014), has been observed, with growing interest in home gardening in small gardens, on balconies or simply in containers (Sunga and Advincula, 2021). While some citizens have started growing food at home on a small scale (Mullins et al., 2021), others are simply taking care of green plants or flowers. Caring for nature often correlates with caring for people strongly disadvantaged in the Covid-19 context (Stok et al., 2021), thus illustrating two interlinked fronts of motivation, as advocated by Ling Wong (2020). Either way, those changes to confined people's everyday lives were perceived as a way of reconnecting with nature and as a psychological experience (Sunga and Advincula, 2021).

In fact, this crisis has revealed the importance of connections with nature for *Homo urbanus* (Bourdeau-Lepage, 2017), exposed to an overload of auditory, visual and technological stimuli in urban areas. Several studies over the last decade have confirmed the benefits of exposure to natural sounds on well-being, notably stress reduction (Alvarsson et al., 2010; Chalmin-Pui et al., 2021), and of gardening on healthy ageing (Hawkins et al., 2013; Soga et al., 2017; Wang and MacMillan, 2013). Alongside the activities of individuals, social innovations like garden collectives or urban agriculture (Aubry et al., 2014), illustrate the increasing activity around plants and food production in the heart of cities. At the same time, stakeholders in the urban planning field have been imagining new ways to introduce nature in urban areas throughout the world, allowing citizens to experience urban green spaces (Skandrani and Prévot, 2015). Moreover, in areas strongly modified by human activities, 'reconciliation' (Rosenzweig, 2003)

between biodiversity and socio-economic life could be of benefit to both nature and human beings.

However, with the growing urban resilience agenda, scholarly attention has been drawn mainly to the environmental externalities produced through home gardening, the aim being to push citizens towards more sustainable garden practices (Coisnon et al., 2019). At the European level, private gardens might actively contribute to ecological transition and reduction of greenhouse gas emissions (Cleveland et al., 2017) by becoming a 'resource by small gardening actions' pointing to the positive cumulative outcome of individual, pro-environmental gardening practices (Dewaelheyns et al., 2016). However, comparison between rural and urban areas shows lower biodiversity knowledge and less sensibility to sustainable practices among urban citizens (Coisnon et al., 2019).[1] While it has been suggested that providing more trustworthy information on biodiversity could go some way to reducing the gap, there is clearly a paradox around the increasing concern in big cities for organic food,[2] permaculture or chemical-free food production in the interstices of the building (Aubry et al., 2014). While abundant nature inside cities can respond to the deep need to feel an affinity with the natural world, also called 'biophilia' (Kellert and Wilson, 1993), one can ask more specifically whether the development of 'edible cities' (Sartison and Artmann, 2020) will influence the greening of private housing and plant care practices.

At industry level, the horticulture sector is increasingly developing sustainability-related labelling[3] and technical innovations (ecofriendly products, renewable containers,

[1] 47% of urban gardeners declared being 'rather interested' in environmental labelling while only 28% were 'very interested' (French national survey, Val'hor, TNS Sofres, 2014).

[2] According to French Agence Bio survey (BioEdition 2020), market penetration of organic produce is highest in Paris and surrounding suburbs, with 55% of consumers eating organic food at least once a week. More broadly, the increase in consumption of organic produce is highest in cities with 2,000 to 20,000 people and cities of more than 100,000 people (+2% between 2018 and 2019)

[3] For instance, in France, the Plante bleue certification recognises environmentally friendly production methods.

etc.) to address ecological challenges and push the purchase of plants by urban dwellers (Yue et al., 2016). Overall, those consumers are less likely to buy organic plants and fertilisers than organic food; the willingness to pay for eco-friendly attributes is rather low and only a small portion of consumers have an interest in locally grown plants and biodegradable/compostable containers (Yue et al., 2016; French Agence Bio survey, 2018). Little is known about the views of the rising urban population regarding plants in urban housing, and there has not been any research so far that bridges concerns for food and plants. While that point is of interest for all generations, it is more acute for young urban citizens, firstly due to their environmental awareness and increasing commitment to sustainable food in cities (Sessego and Hebel, 2019; Salladarré et al., 2018; Aertsens et al., 2009) and, secondly, because the young generation have the lowest rates of plant purchasers.[4] Moreover, little is known about how these interelations can be used in a multi-scalar approach of urban resilience (Flax et al., 2020). Following recommendations of Zhang and Tu (2021) for a multidisciplinary approach, we bridge psychosociology and urban studies to try to fill these gaps. Using a national quantitative survey (n = 1,000), we explore French young urban citizens' perceptions of caring for plants while relating them to their food behaviours, the social aspects of bringing nature into the domestic sphere and lastly, the triggers at the city level.

There follows: (1) a literature review on the nature relatedness of citizens living in cities and the recent shift, due to the Covid-19 crisis, in their motivations for caring for plants at home and finally, background literature on young urban citizens' overall attitudes towards sustainable food; (2) our research questions and methodological

[4] Data from the French National Kantar Survey for Val'hor/FranceAgriMer on plant, tree and flower purchasing behaviour (April 2021). People aged 15 to 44 represent 43% of the population and 28% of the buyers, with those aged over 44 representing 57% of the population and 72% of the buyers. https://www.valhor.fr/fileadmin/A-Valhor/Valhor_PDF/Etudes_BilanAchatsFrancaisVegetauxDonnees2020Complet_Kantar.pdf

choices; (3) findings from spontaneous evocations around caring for plants and from an analysis of the relationships between environmental concern, commitment to sustainable food and valuation of technical/social uses of plant care activities; (4) a discussion about the enhancement of nature relatedness through synergies between food habits and plants care activities in the context of the rise of green and 'edible' cities; and (5) a conclusion with reflections on ways for better addressing continuities between public green spaces and the greening of private housing in urban planning processes.

Literature review

Nature relatedness of urban citizens: a shift in post-Covid-19 cities

The Covid-19 crisis and long-term lockdowns have surfaced reflections on the reconnection of urban dwellers with nature, or what Nisbet et al. (2009) called 'nature relatedness'. This wider construct encompasses the connectedness and relationship with nature and allows to explain effective engagement – or not – in sustainable behaviour. It also allows us to capture individual differences in making sense of the diversity of forms of nature observable in big cities.

That diversity has been described by philosophers in the light of nature–culture dualism and expressed through a degree of human control over nature and/or proximity (Hiernaux and Timmermans, 2018; Larrère and Larrère, 2018; Fleury and Prévot, 2017). Their analyses provide an interesting frame in which to capture the cognitive and symbolic dimensions that citizens associate with diverse forms of urban nature. Research on the rural-urban fringe and gentrification shows that symbolic constructions of nature highly prefigure attitudes towards green areas and their wildness (Phillips, 2008). Following the Hiernaux and Timmermans (2018) typology of nature, urban citizens in modern cities can in their everyday lives be in touch with *wild* nature (e.g. plant species

that appear spontaneously, without human intervention, in brownfield areas) (Mathey et al., 2018), with *cultivated* nature (e.g. permaculture set up by citizens who want to restore natural balance in agriculture by limiting human intervention) (Copeman, 2012), with *domesticated* nature (e.g. areas with plants specifically selected by humans) (Kareiva et al., 2007), with *urbanised* nature (e.g. plants in areas with high constraints on growth, such as rare water, unfit soil, etc.; plants supported by high technology, like zero-acreage farming on rooftops) (Thomaier et al., 2015) or with *human-made* nature (e.g. potted plants inside the home, produced only for aesthetic purpose) (Risi et al., 2016). Moreover, urban citizens can search for *fantasy* nature (Jo, 2008), as observed through increased web searches on this topic, social networks dedicated to green art, and the success of special art exhibitions around plants and flowers (e.g. the Floralies" in France or the Keukenhof in the Netherlands). Lastly, cultural differences exist in the attachment to certain forms of nature, from heritage conceptions of gardens to the classical organisation of French gardens (echoing *domesticated* and *human-made* nature) or to the *wildness* of British gardens (Weiss, 1995; Phillips, 2021). So far, little is known about cultural differences when it comes to potted plants, potted flowers or small vegetable gardens in urban housing.

For their part, anthropologists (Escobar, 1996) are increasingly trying to withdraw from nature–culture dualism, especially in occidental countries, to highlight the need for a paradigm shift to address ecological challenges[5]; and also to enhance urban resilience while nature-based solutions and ecoservices are still embedded in anthropocentric urban planning processes and actually don't give voice to non-human elements (Bush and Doyon, 2019). Inspired by non-occidental countries, they claim for the removal of the concept of nature in order to consider non-human and human beings as a whole (Latour,

[5] The philosopher Michael Marder also suggests adopting a 'phytocentric' paradigm (see Marder, in Hiernaux and Timmermans (eds), 2018: 115–132).

2012). In line with that view, the emerging concept of 'biophilic cities' (Beatley, 2017; Beatley and Newman, 2013) goes beyond the urban/nature dichotomy and emphasises the embeddedness of cities within complex and interconnected ecosystems. So far, the concept of nature is still used widely[6] and this can influence the attitudes of citizens, especially when it comes to sustainable gardening practices. Clayton (2007) has questioned the extent to which the home landscape is considered part of nature or part of home, noting that in advertising, the front yard is presented as an extension of the home and lawns are sometimes described as being 'carpet-like'. But what about weeds and undesirable plants? When control over nature is expected, weeds or unusual flowers found in wild spaces can be not 'tolerated' in domestic spaces because they are not 'desired'. This highlights the ambiguity in the opposition between wild and domestic nature (Clayton, 2007). In turn, natural mechanisms associated with caring for plants (e.g. the presence of insects; the development of weeds, including in pots) may or may not be perceived as constraints to gardening, depending on how urban citizens make sense of the opposition between wildness and domestic planting. A current growing trend for rewilding private gardens has been observed and recent research has been aimed at understanding the motivational and behavioural factors (Webb and Moxon, 2021).

If we consider density of vegetation in urban homes (including indoor and/or outdoor spaces like balconies or rooftops), this depends on external factors, such as lot sizes, socio-economic inequity and leisure time, but also on psychological factors like nature relatedness. The more urban citizens feel related to nature through their yards or visits of public green spaces, the more vegetation they will have in their private spaces, influencing in turn the benefits they will get from gardening, as suggested by Lin et al. (2017). When only a window view of green spaces is possible, the effect on the greening of private

[6] Notably, in the advertising and messages dispatched by the horticultural sector (e.g. the event 'Flower week for bees' by Val'hor, French umbrella association of plants companies.

apartments remains unknown. In the same way, little is yet known about the influence of urban Green Infrastructure (GI), increasingly developed to address sustainability challenges (van der Jagt et al., 2019), on the motivation for having indoor plants. Lastly, in post-pandemic cities, there is an increasing need to put the contribution of indoor greening alongside public green spaces on the agenda for reconnecting humans with the more-than-human world (Kaplan, 2001; Qin et al., 2021; Zhang and Tu, 2021; Dobson, 2021).

Psychological and relationship benefits from caring for plants: a renewed interest for confined dwellers

The diversity of gardens and of plants-related practices in urban homes expresses various relationships with non-human beings and suggests different interests in natural/social uses (Coisnon et al., 2019). Gardening activities can contribute to food production, sustainable development, enhanced well-being and development of social relationships, or even feelings of community belonging as studied in community gardens and collaborative urban agriculture. Thus, ways of gardening can reflect personal values, but also depend on societal norms and pressures to adopt sustainable practices (Kiesling and Manning, 2010). Little is known about normative forces that influence the greening of private urban housing, where the range of expectations of bringing nature in can be wider (visual satisfaction, hygiene, well-being, small food production, etc.).

Especially during the Covid-19 lockdowns, the presence of plant at home or the ability to view them from a window were associated with higher well-being and lower negative psychological health outcomes such as anxiety, irritability and sleep disturbance (Spano et al., 2021). Inhabitants confined to small homes with lower natural light and few or no plants had more negative emotional well-being (Pérez et al., 2021). In professional

contexts, both green indoor and outdoor environments improved mental health, emotional well-being and loyalty of consumers and employees (Han and Hyun, 2019). The presence of indoor natural plants in restaurants increased experiential value and customer satisfaction (Apaolaza et al., 2020). Thus, as observed in residents of green buildings (Zhang and Tu, 2021), mere exposure to indoor plants can have positive effects on consumers, even in non-lockdown contexts.

The issue of 'know-how' is also of interest when looking at failures or successes in caring for plants or gardening. Lack of expertise is often given as explanation for a low prevalence of plants in urban housing or the reluctance to get plants (Végépolys' French survey, 2017). For the most expert gardeners, whose yards, balconies or rooftops provide a very public demonstration of know-how, psychological motives come into play (Clayton 2007). The aim of having a nice garden or balcony is sometimes to gain higher social status, increase social interactions or fuel feeling of belongingness to a local community (Clayton 2007). In this light, for some citizens, gardening is much more than a simple technical endeavor; it is also loaded with social meaning.

Environmental concern through gardening versus eating practices

Research on environmentaly responsible behaviour (ERB) has paid a lot of attention to people's connectedness with the natural world – through the concept of nature relatedness – to explain some gaps between environmental concern and behaviour (Nisbet et al., 2009). Indeed, environmental concern expresses to what extent people feel an affinity with the natural world, but it does not lead systematically to ecological practices. Food-related activities and gardening are human activities that offer ways of enhancing nature relatedness, especially for urban dwellers, but no research has yet been conducted relating to both gardening practices and food habits. Understanding consistencies and

inconsistencies between food/gardening behaviours could help us to identify drivers for or barriers to caring for plants at home or to push forward greening practices in urban housing.

Before the lockdowns, a national survey[7] found that gardening was among the favourite domestic tasks in French households, overtaking crafting and cooking (Brousse, 2015). Although some differences can be observed according age, gender and occupation, this result is worth further study given that French identity is strongly associated with cooking and gastronomy (Rozin et al., 2011).

Furthermore, concerning sustainable gardening practices, Yue et al. (2016) found that American and Canadian consumers are less enthusiastic about organic plants/fertilisers than they are about organic food. While the same results were obtained for French consumers, it is worth mentioning that organic production is very low in France and mainly dedicated to aromatic plants.[8] Above gender, age or home ownership status, income and education seem to be major drivers of engagement in practices for sustainable gardening (Coisnon et al., 2019). Moreover, due to low environmental awareness and poor knowledge of biodiversity, urban households are less likely to adopt sustainable gardening practices (Coisnon et al., 2019)[9]. However, as advocated by Dewaelheyns et al. (2016), the accumulation of small individual actions in private gardens can have sustainability benefits, and ways to promote sustainable individual behaviours have been identified, such as bottom-up or neighbourhood diffusion of good practices (Goddard and Benton, 2013). While these may improve behaviours, there is no empirical

[7] 'Time schedule and decisions in couples' (survey from Insee, the French National Institute for Statistics and Economic Research, 2009-2010).
[8] The Plante bleue label relative to sustainable production practices is used for the busines-to-business market. For the consumer market, attention is at the present time more focused on Fleurs de France (Flowers from France).
[9] See also for younger dwellers a national survey by the French ministry for ecological transition (2020): https://www.statistiques.developpement-durable.gouv.fr/les-francais-et-la-nature-frequentation-representations-et-opinions

evidence on how urban citizens actually bridge their food habits with their plant care practices or with the density of plants they have in their homes; nor do we have evidence on the degree to which their ecological sensitivity echoes their attitudes towards plants and constraints in growing practices. Those questions, addressed in this paper, are particularly of interest in relation to young people, who are more likely to be interested and involved in alternative food procurement (permaculture, urban agriculture, community-supported agriculture, etc.) in urban areas.

Relationship between commitment to sustainable food and the greening of private housing: singularities of the younger generation

An analysis of the age effect on both commitment to sustainable food and rates of plant purchasing for private housing shows that the younger generation are more motivated regarding sustainable food than for gardening. Young people have the lowest rate of plant purchasers (see Footnote 4) despite being highly committed to sustainable food. Highlighting this apparent paradox is of interest for enriching research on the various synergies that can enhance nature relatedness in cities and increase motivation for bringing more plants into private spaces.

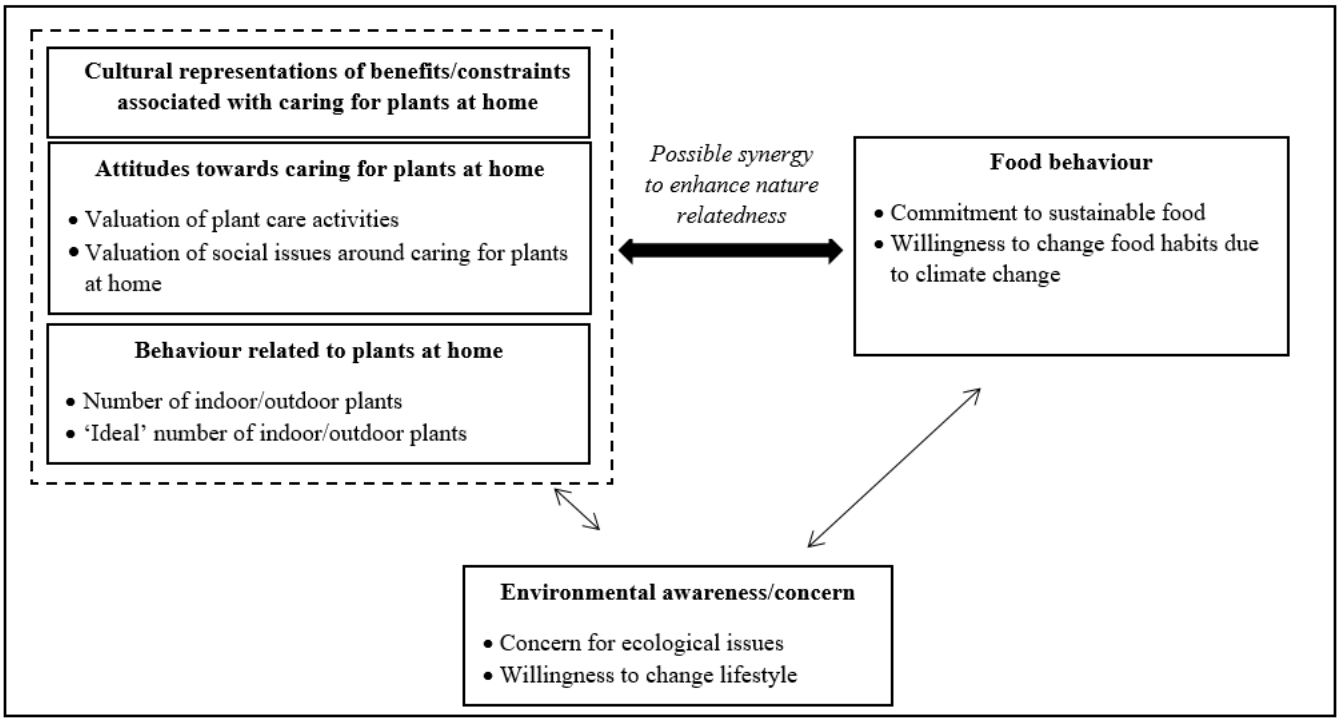
Indeed, recent surveys on attitudes towards sustainable consumption identified that people from upper classes, with high levels of education, and from the younger generation present higher interest in sustainable practices (consuming organic food, the collaborative economy, community-supported agriculture, urban agriculture, etc.) (Sessego and Hebel, 2019; Salladarré et al., 2018; Aertsens et al., 2009). Those attitudes respond to higher ecological sensitivity but also to quest for social distinction in a context where those behaviours are socially recognised.

In another study, de Gavelle et al. (2019) examined self-declared food identities of French consumers. This confirmed findings on reduction of meat consumption observed in international surveys (Pribis et al., 2010; de Boer et al., 2017; Rothgerber, 2014): the motivations are age-dependent, with younger adults (25–34 age group) more likely to be concerned about animal welfare (especially vegetarians), environmental issues (especially pro-flexitarians – those who consume meat/fish no more than once a week) and health-related issues (especially flexitarians – those who limit meat consumption), while older participants gave mainly health-related reasons for reducing meat consumption.

Those findings illustrate a generational shift in engagement with ecological challenges. Eating natural or organic foods and swapping meat consumption for a more plant-based diet are some ways in which young people reconnect with nature. Eating and gardening are intrinsically linked in the sense that both provide, to varying degrees, a connection with nature. As little is know on the relation young urban generation have with plants at home and no research has bridged their food motivations and gardening motivations, our research aims to fill this gap. The research is aimed at addressing three specific questions: (Q1) What are young urban people' representations associated with owning plants in private housing?, (Q2) How are plant care activities valuated versus social relationships around caring for plants?, (Q3) What is the relationship between food practices – notably the commitment to sustainable food – and home plant-related practices?

Overall, our research is aimed at understanding how potential synergies between food concern and plant concern can enhance nature relatedness (Figure 1). At the city scale, our research can inform urban planning about the possible ripple effect from 'edible cities' to the greening of private housing.

Figure 1: Nature relatedness among urban dwellers: exploring the relationships between environmental concern, food behaviour and attitudes towards caring for plants



Methodology

Data collection and sample

Our research adopted a quantitative approach using a national online survey. A questionnaire was designed through Qualtrix XM survey software and made available in March 2020 (before the first lockdown in France due to the Covid-19 crisis) by Bilendi, a web-based survey institute. The research project was supported by XXX, a French transdisciplinary research group dedicated to developing the horticulture sector.[10]

In order to collect spontaneous mental representations associated with plants in urban housing, the questionnaire started with two mandatory, open questions ('*Owning plants inside/on balcony/on terrace: what are the positive/negative words that come spontaneously to your mind?*') (see questionnaire extracts in Supplementary material 1).

[10] XXX

This was followed by closed questions using multiple-choice options and Likert scales. Several topics were tackled: (1) expectations about plants (types, characteristics, level of care needed); (2) personal relationship with plants and perception of benefits of caring for plants and barriers to this activity; (3) social interactions around plants; (4) obtaining information about plant care and purchasing plants; (5) gardening practices; and (6) personal information (sociodemographic variables, food habits, awareness and sensitivity to environmental issues). The results presented in this paper come from a set of questions that we have selected to address our research questions (Appendix 1).

To answer our research questions, we chose to focus on young urban citizens aged 25 to 40 because: (1) the instability of life for people younger than 25 is not particulary favourable to caring for plants and (2) people younger that 40 (Generation Y) show the apparent paradox of higher commitment to sustainable food but lower interest in caring for plants. To select exclusively respondents from big agglomerations, the web-based survey institute has pre-selected a wider panel with people living in urban agglomerations with more than 100 000 inhabitants and in Paris conurbation. In the questionnaire, a control question was formulated for the location: '*Where do you live? In city centre / On close periphery of big towns / In rural areas'*. People who have responded 'rural areas' were excluded. Moreover, Bilendi designed a quota sampling approach based on age, gender and occupation (for a total sample size of 1,000). In terms of location, 53.7% of respondents were in inner-city areas and 46.3% were on the very close periphery of big towns. Moreover, 38.0% lived in a house while 59.9% lived in an apartment (Table 1).

Table 1. Profile of national sample (n = 1,000).

Characteristic	%	Characteristic	%
Age		Type of housing	
25–30	33.3	*House*	38.0
31–35	33.3	*Apartment*	59.9
36–40	33.4	*Student residence/other*	2.1
Gender		Small garden	
Male	49.6	*Yes*	40.3
Female	50.4	*No*	59.7
Occupation		Balcony	
Upper professional	26.8	*Yes*	44.7
Student, inactive	25.5	*No*	55.3
Worker, employee	26.9	Terrace	
Intermediate professional	20.8	*Yes*	47.1
Location		*No*	52.9
City centre	53.7	Courtyard	
On the edge of big towns	46.3	*Yes*	14.9
		No	85.1

Data analysis

Responses to open questions were analysed using the textual analysis software Iramuteq[11] (version 0.7 Alpha 2). This software allows a quantitative analysis of textual responses. It separates text segments into lexical classes according to descending hierarchical classification based on co-occurrence of words (exactly, 'reduced forms' from lemmatisation process) (Reinert, 1993; Illia et al., 2014). This classification of respondents' words is based on the idea that the words used by each person are part of different 'word contexts' or even person's 'frameworks of reference'. As data come from a sample of respondents around a monothematic, all text segments were aggregated in one single set of text segments (Reinert, 1993). It helps understanding how mental representations are embedded in social and cultural contexts (Debucquet and Cardinal, 2012); in this research, it reflects young French citizens' relationship with nature.

Lastly, for data gathered from closed questions, we performed a multiple correspondence analysis (MCA) using XLSTAT Statistics software. MCA provides a

[11] Iramuteq is free open-source software inspired by ALCESTE (analysis of co-occurrent lexemes in simple wordings of a text), using the Reinert (1993)'s method. For another illustration of textual data analysis with Iramuteq, see Idoiaga et al. (2020).

structuring framework that allows the graphical interpretation of associations between different variables of large categorical data sets, by reducing a data matrix within a few dimensions or factors (Hoffmann and Franke, 1986). Two to four principal components are usually considered. Principal components can be understood as the latent or projected axes, which are constructed in such a way that the largest data variance is explained (Le Roux and Rouanet, 2010). The MCA method was used to assess: (1) how different concerns for environmental issues and different levels of commitment to sustainable food are related to each other and (2) related to different valuations of social issues around caring for plants and of diverse plant care activities. The MCA was performed on a large set of variables including demographics, current *versus* desired number of plants owned, environmental awareness, food profiles focusing on commitment to sustainable food, concern for social issues around plants and perceptions of plant care activities. Table 2 presents the variables and modalities.

Table 2: Set of active variables used for MCA: wording of questions, answer categories and Likert scales

CATEGORIES	VARIABLES	MODALITIES
Demographics		
• Age	*Age*	1 25–30; 2 31–35; 3 36–40
• Gender	*Gender*	1 Male; 2 Female
• Occupation	*Occupation*	1 Upper profession; 2 Student, inactive; 3 Worker, employee; 4 Intermediate profession
• Location	*Location*	1 City centre; 2 The outskirts of a big city
Behaviour related to plants at home		
• Plant ownership	*Plants_owned*	1 No plants; 2 A few indoor/outdoor plants; 3 Lots of indoor/outdoor plants
• Plant forecast	*Plants_desired*	1 No plants; 2 A few indoor/outdoor plants; 3 Lots of indoor/outdoor plants
Environmental awareness		
• Interest in permaculture	*Permaculture*	1 Not at all; 2 Not really; 3 Yes
• Concern for species loss	*Species loss*	1 Not at all; 2 Not really; 3 Yes
• Willingness to change lifestyle	*Change lifestyle*	1 Not at all; 2 Not really; 3 Yes, absolutely
Food profile		
• Willingness to change food habits for climate	*Change food*	1 Not at all; 2 Not really; 3 Yes, absolutely
• Flexitarian	*Flexitarian*	1 No; 2 Yes
• Purchase organic food	*Organic food*	1 Never; 2 Sometimes; 3 Regularly/Exclusively
• Purchase in short channels	*Local food*	1 Never; 2 Sometimes; 3 Regularly/Exclusively
Sociability around plants		
• Caring for other people's plants is a way of caring for those people	*Caring other*	1 Fully disagree / Disagree; 2 Agree / Fully agree.
• Talking about plants with other people gives a feeling of belonging to a community	*Belongingness*	1 Fully disagree / Disagree; 2 Agree / Fully agree.
• Giving/receiving cuttings, plants or seeds allov you to share with others	*Sharing*	1 Fully disagree / Disagree; 2 Agree / Fully agree.
• Talking about plants is a friendly moment	*Conviviality*	1 Fully disagree / Disagree; 2 Agree / Fully agree.
• Talking about plants / taking part in an online forum means being part of a community	*Chatting*	1 Fully disagree / Disagree; 2 Agree / Fully agree.
Perception of plant-care activities		
• Potting plants	*Potting*	1 A constraint; 2 A pleasure
• Watering plants	*Watering*	1 A constraint; 2 A pleasure
• Cutting plants	*Cutting*	1 A constraint; 2 A pleasure

Note on modalities grouping for MCA: Likert scales used for 'Sociability around plants': grouping of modalities 'Fully disagree / disagree' and 'Agree / fully agree'; Purchase organic food / Purchase in short channels: grouping of modalities 'Regularly/Exclusively'.

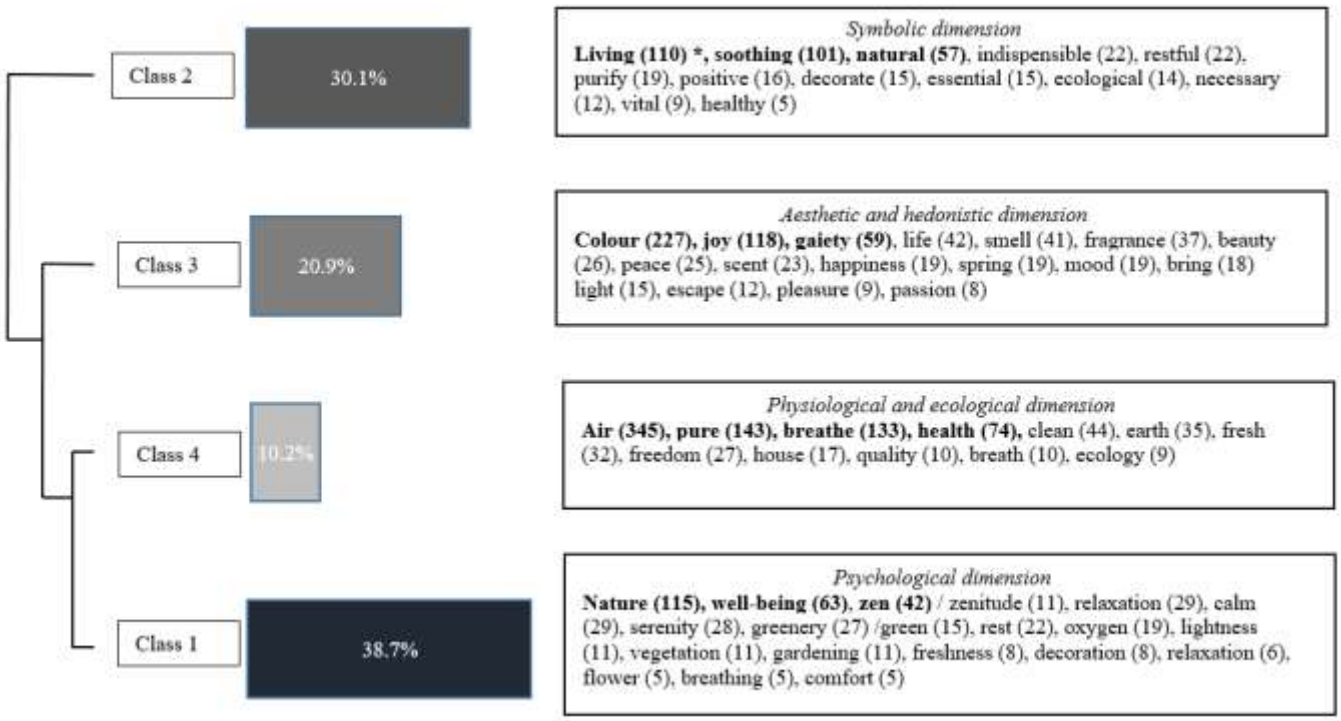
Results

Among respondents in our sample, 26.8% report having no plants (inside or outside the home), while 54.1% report having a few and 19.1%, a lot. When it comes to do-it-yourself, 9.2% very often carry out activities like seeding, potting, rooting of stem cuttings and 43.8% do so sometimes. In the following sections, we first relate results from the lexical analysis of young urban citizens' representations of benefits/constraints associated with plants in the domestic sphere. We then present the results from the MCA exploring the relationships between environmental concern, plant/food practices and valuation of technical/social issues around plants.

Lexical analysis of cultural representations of benefits/constraints associated with plants in the domestic sphere

Spontaneous representations associated with plants in urban housing were captured through open questions designed to elicit positive and negative words associated with plants kept inside the home, on balconies or on terraces. The lexical analysis of positive words covered 963 text segments (91.7% were classified), together with 672 different words/lexemes. The descendent hierarchical classification revealed four lexical classes (Figure 2).

Figure 2. 'Owning plants inside/on balcony/on terrace': Positive spontaneous representations.

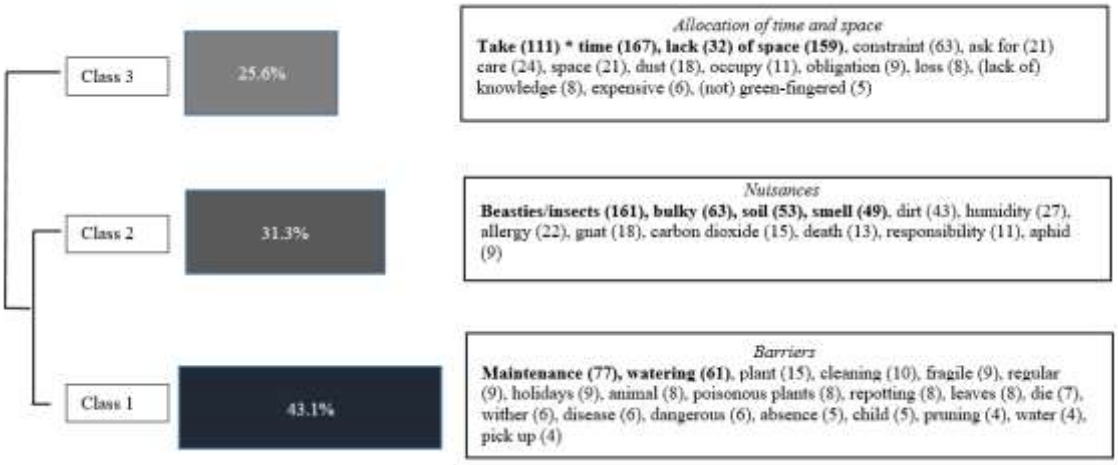


Notes: The figure shows descendent hierarchical classification and word rank in decreasing chi-square value. The chi-square values computed using Iramuteq identify associations of words with each lexical class. * Chi-square significant at $p<0.05$.

The major category, Class 1 (38.7% of all text segments categorised), expresses the psychological impact of owning plants in urban housing. The contact with '*nature*' provides a feeling of '*well-being*' and of having a '*calm*', '*relaxing*' and '*zen*' moment. Class 2 (30.1%) focuses on the symbolic dimension of caring for plants, described as '*living*' and '*natural*'. Their presence appears '*essential*', '*indispensable*' or '*vital*' for human beings. Items in Class 3 (20.9%) characterise an esthetic and hedonistic relationship with plants, the latter bringing '*colour*', '*smell*', '*fragrance*' and '*beauty*' into urban housing and, in turn, '*pleasure*', '*happiness*' and a good '*mood*'. The smallest category, Class 4 (10.2%), reveals physiological and ecological aspects of caring for plants: plants contribute to improved '*air*' quality, that is more '*pure*' and '*fresh*', and better '*breathing*'. In sum, plants in urban housing help citizens to reconnect physically and symbolically with nature, benefitting mental and physical health. Surprisingly, there

was no reference to opportunities for gaining knowledge and understanding about plant physiology and ecology: in response to a closed question 52% said they did seek technical information before purchasing plants, whereas 48% said they did not. These findings suggest that urban dwellers relate to plants emotionally and practical concerns are of secondary importance. That might explain the negative representations of home gardening (Figure 3).

Figure 3. 'Owning plants inside/on balcony/on terrace': Negative spontaneous representations.



Notes: The figure shows descendent hierarchical classification and word rank in decreasing chi-square value. The chi-square values computed using Iramuteq identify associations of words with each lexical class. * Chi-square significant at $p<0.05$.

Lexical analysis of negative words covered 906 text segments (73.3% were classified) together with 633 different words/lexemes. The descendent hierarchical classification revealed three lexical classes (Figure 3).

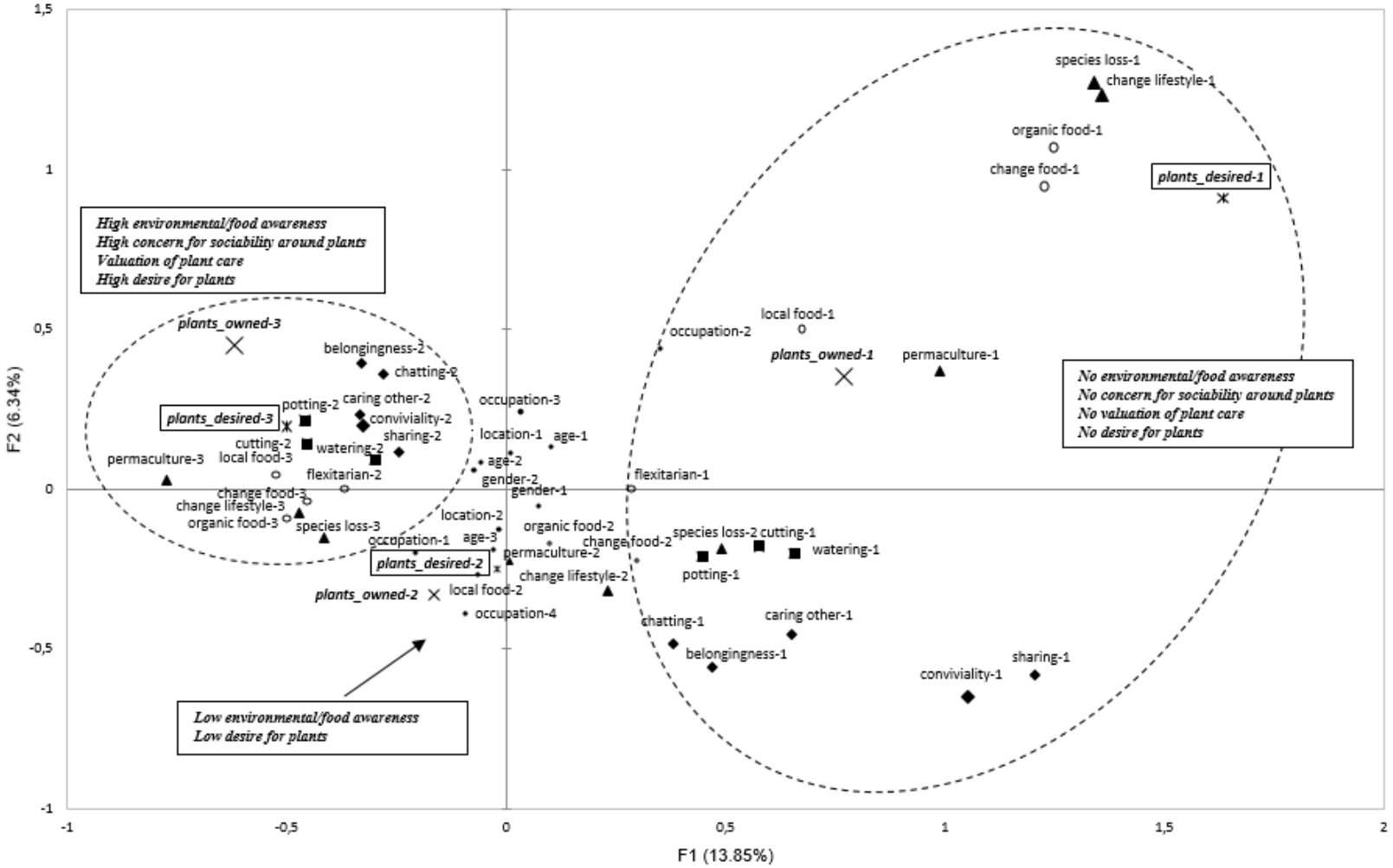
The major category, Class 1 (43.1%), identifies '*maintenance*', '*watering*', '*repotting*' and '*pruning*' as constraints to plant care/gardening. Toxicity for animals and children is also mentioned. Class 2 (31.3%) includes the nuisances associated with plants: '*insects*', '*soil*', '*smell*', '*dirt*', '*humidity*' and '*carbon dioxide*'. Thus, what is often perceived positively outside – that is, nature and its components – can be perceived negatively when bringing plants inside. Lastly, Class 3 (25.6%) covers the allocation of '*space*' and '*time*' for plant care. This class includes the failure of those who do not have a '*green thumb*'. In sum, these three classes reveal the gap between the emotional, symbolic relationship with plants and the actual requirements for plant care in urban settings. An additional closed question confirms that the 'ideal plant' is expected to be convenient: inside urban housing the main expectations were that plants are 'easy to

maintain' (62.1%), 'resistant' (37.5%) and 'creative/esthetic' (35.4%) while for outside housing, 'easy to maintain' (50.5%), 'adapted to extreme conditions (lack/excess of water, sun)' (42.6%) and 'good for the environment (birds, shadow)' (38.9%).

Multiple correspondence analysis of relationships between environmental, food and home plant issues

The MCA results reveal some relationships between environmental concern, commitment to sustainable food and social/technical valuation of home plant-care activities (Figure 4).

Figure 4: Multiple Correspondence Analysis – First and second factorial axes (n = 1,000 respondents).



Note: Dot size is proportional to the value of cosine-square indicating the quality of the representation of a modality. Each category of variables is represented by a distinct symbol.

Figure 4 shows a good degree of scattering, which indicates that the chosen sets of variables have low similarity. The test values indicate significant spread from the centre of the plot ($p<0.05$) for all modalities of variables related to plants (except for 'low number of desired plants' on factor 1) (Supplementary material 2), of variables related to environmental awareness (except for 'low/high interest in permaculture' on factor 1/factor 2, respectively) and those related to sustainable food commitment (except for 'high willingness to food change' on factor 2 and 'flexitarian / not flexitarian' on factor 2) (Supplementary material 3). On the contrary, most modalities of the sociodemographic variables show no significant spread from the origin (Supplementary material 4), thus they appeared around the centre of the plot (Figure 4).

The first two dimensions are able to explain 20.19% of the total data variance. The contributions of variables/modalities to the construction of the principal component axes are provided in Supplementary materials 2, 3 and 4. With regard to the contributions to factor 1 and factor 2, we note that the highest contributions to both factors (Ctr from 5.71% to 11.14% to F1/F2) are from, in decreasing order of contributions, variables related to species loss concern, lifestyle changing, changing food habits, purchasing organic food and, lastly, those related to conviviality around plants, the number of plants owned and the desired number of plants. Moreover, other high contributions to a single factor come from variables related to social sharing around plants (Ctr 6.60%, F1), interest in permaculture (Ctr 10.02%, F1), feeling of belongingness through plant care activities (Ctr 10.82%, F2) and chatting about plants (Ctr 8.56%, F2). Those results show the importance of sociability around plants in the definition of factors. The lowest contributions to both axes come from sociodemographics variables (Supplementary material 4), so age, gender, location of housing and professional occupation are not key

factors explaining concerns for the environment, sustainable food and for caring for plants.

The relative positions of modalities of variables allow for the visual interpretation of degrees of association. Higher association is indicated by higher proximity, as is the case for high environmental concern, high sustainable food commiment, high valuation of sociability around plants and of plant care activities, and high number of plants owned/desired (see the left side of Figure 4). Those strong associations concerning only a part of our sample of young urban dwellers show the interrelationship between concern for environmental issues, commitment to sustainable food and positive attitudes towards caring for plants in private housing. In contrast, the right-hand side of Figure 4 shows the modalities of variables related to no environmental concern, no sustainable food awareness, no concern for sociability around plants, no valuation of plant care, no plants owned and no desire have any. The larger graphical distance between plant issues and environmental/food issues suggests that those issues are not really associated for a part of our sample of young urban dwellers, or even connected in their minds.

Finally, those results demonstrate that the more young urban citizens are engaged in sustainable food practices and have environmental concern, the more they value plant care tasks such as potting, cutting and watering and sociability around caring for plants, thus suggesting the existence of some continuities between ‘outdoors’ and ‘indoors’ or even internal consistencies in behaviours. Concerning the valuation of social exchange around plants, it is worth noting that feelings of belongingness to a community through chatting obtained the lowest rate of agreement (57.40%), meaning that when engaging with others around plants, online interaction is not as meaningful as that with friends or neighbourhood acquaintances (Supplementary material 2).

Discussion

In this section, we discuss our results regarding the relationship that young French urban citizens have with plant care and gardening; most notably the gap between ecological challenges and actual expectations/practices regarding plants at home. Then, we envision the role of social triggers, at the level of close neighborhood and of urban planning, to enhance the greening of private housing. Finally, we suggest ways to benefit from continuities - which could be spurred within edible cities - in young people's attitudes towards caring for plants and their food profiles.

Feelings and experiences with caring for plants at home: limits on and ways to enhance nature relatedness

The gap between environmental concern and actual ecological behaviour has been highlighted through the nature relatedness concept (Nisbet et al., 2009). Individual differences in nature relatedness are rather stable over time, but environmental education or positive emotions from experiences in nature can change feelings about the nature–human relationship (Pooley and O'Connor, 2000). While research on nature relatedness has concentrated mainly on the impact of outdoor activities in contact with nature (Lin et al., 2017), little is known about indoor / at home everyday experiences with plants, especially for urban dwellers. We adressed that gap by focusing on young French urban people, who are the group least likely to purchase plants.

By analysing spontaneous feelings associated with plant care at home, we avoid desirability bias about ecological practices in domestic settings (Uren et al., 2015). A lexical analysis of young urban dwellers' survey responses revealed a relationship with plant care based less on ecological benefits than on individual convenience or human-centred concerns such as psychological well-being, aesthetic benefits and the effect on

physical health of improved air quality. Moreover, all aspects of maintaining plants were described rather in negative terms, with opinion divided as to whether those tasks are a ‘constraint’ or a ‘pleasure’. As the nature relatedness concept embraces both positive and negative feelings for nature (Nisbet et al., 2009), we can ask how negative aspects of caring for plants in private urban housing can be associated with more positive emotions and, in turn, how we can help people to become more connected to nature. That could then lead urban dwellers to derive more happiness from innate biophilic tendencies (Kellert and Wilson, 1993; Zelenski et Nisbet, 2014).

Connections between ‘indoor’ and ‘outdoor’ experiences could contribute to developing an ‘intimate sensitiveness’ (Gorz, 2009) with nature which is essential in facing ecological challenges (Latour, 2012). From that perspective, ‘landsenses ecology’ (Zheng et al., 2020) has highlighted the adaption of natural environments to suit people; for example using sensory stimuli (seeing plants or water; the feel of sunlight; hearing animals) in the design of urban parks so that they appeal more to people. Green places in cities can also contribute to developing people’s latent capacity to make sense of the various functions of urban nature (benefits for non-human beings, animals, other plants, etc.) (Ng, 2020). When it comes to caring for plants at home, we can hypothesis that those initiatives would allow urban dwellers to envision differently the diverse requirements of natural beings, to position their plants in the overall urban ecosystem and to view plant-care activities as green citizenship.

Furthermore, to enhance nature relatedness and ecological practices in urban housing, emotions and experiences in urban green spaces could play more significant roles than knowledge. It has been known for some time that knowledge of environmental issues does not necessarily predict pro-environmental behaviour (Nisbet et al., 2009). Spaces for plants care are obviously less available in urban housing but surprisingly,

concern for environmental issues (protection of local species, selection of plants that are good for birds or insects, use of domestic compost, seasonality, etc.) and willingness to learn more about non-human living beings' requirements were near absent in our results. Finally, from that perspective, young urban dwellers are no different from the overall population (Beumer, 2018; Coisnon et al., 2019). To push forward the greening of urban housing and more sustainable gardening practices, we look next to social relationships around plants.

Social ties around caring for plants: A trigger for building community and green identity in urban setting

By demonstrating the link between higher environmental awareness and more positive evaluation of technical/social issues around caring for plants at home, our results reveal two different urban gardener profiles, in line with Clayton (2007): urban gardeners with an ecological ethic, caring for plants because of the benefits for nature and for social interaction and, 'utilitarian' urban gardeners who look for convenience and ease of maintenance. Marketing plants on the basis of their resilience to urban constraints is one response to the expectations of 'utilitarian' urban gardeners, but social triggers might also been considered to help them to engage with ecological arguments for keeping plants. Indeed, as Coisnon et al. (2019) wrote, 'apart from their own environmental consciousness, individuals are also known to be strongly influenced by imitation behaviours and social norms […] and more particularly in the case of outdoors spaces exposed to neighbours'. Moreover, social interactions among residents within green buildings can provide a supportive and educational environment to enhance environmental awareness and pro-environmental behaviours (Zhang and Tu, 2021).

We suggest that social influences in the context of urban housing and/or green places in city centers can help to drive the greening of private urban housing. Following

Zhang and Tu (2021), urban planners could assess more formally the overall psychosocial benefits of green buidings. Moreover, local authorities and private entrepreneurs (e.g. in urban agriculture) can participate actively to enhance social interaction around plants in cities. In turn, those social interactions contribute to building community around shared values and to the enhancement of 'green identity' (Bell, 2012) or 'ecological identity'; the latter having direct and indirect influences on various environmental behaviours through social values and world views (Conn, 1998; Walton and Jones, 2018). Ultimately, this could encourage the presence of plants in private housing, though further longitudinal studies are needed to evaluate the actual porosity between public spaces and private settings.

Sustainable food choices and greening of individual urban housing: expanded scope of edible cities

With increasing concern in all occidental countries for sustainable food sources, our study explored the relationship between food profiles (willingness to change food habits due to climate change, flexitarian profile, purchasing organic foods, purchase via short channels) and attitudes towards caring for plants. The population of young French urban dwellers was of interest because they are more committed to sustainable food than older generations, but they have the lowest rate of plant purchasers. However, we found that the more young urban citizens are engaged in food transition and sustainable food, the more they value plant care tasks and the social aspects of gardening. The reverse was also observed. These continuities between commitment to sustainable food habits and attaching value to caring for plants at home have not been demonstrated previously. Recent research on the motivations of commitment to urban short channels, notably community-supported agriculture, shows that consumers look for fresh and local products

but also for reconnection with nature (Salladarré et al., 2018). Moreover, sense of belongingness is highly developed through social exchanges during the picking of vegetable baskets and around food preparation (Debucquet et al., 2020). Based on our results, young urban dwellers committed to more sustainable food sources seem to be predisposed to bringing more plants into their homes, to valuing social ties around plant care and to cultivating a sense of belongingness. The greening of their living environment is actually a logical continuation of their food habits. Synergic effects could ultimately enhance nature relatedness, especially when alternative, local ways of food purchase are offered to urban dwellers, helping them to engage concretely with nature and to make sense of plants' and other non-human beings' specific requirements. Further research could explore those synergic effects in more depth and examine how they can contribute to strengthening both food identity and green identity. As Walton and Jones (2018) mentioned, one aspect of ecological identity deals with beliefs about shared-group membership with nature and the direct individual experiences one has with it. In 'edible cities', ecological identity forged around food communities could stimulate community building around plant care in private housing.

Conclusion

Through a national survey with young urban dwellers in France, our quantitative study explored attitudes and practices towards plant care in private housing (in apartments, on balconies, in small yards). As this specific gardening context has not been explored to date, we provide useful insights not only for the horticultural sector but also for the local governance of cities, as reflecting upon the porosity between public and private spaces can lead to higher inclusion of natural elements and to open new ways to support them in urban planning processes.

While better alignment of plant selection (ease of maintenance, resistance, adaptation to urban constraints, aesthetic criteria, etc.) could meet the expectations of 'utilitarian' or aesthetic- and hedonistic-oriented urban citizens, other triggers for bringing more plants into private housing are worth considering. For instance, in line with the emergent concept of 'edible cities' (Sartison and Artmann, 2020), making food production closer to urban dwellers may be one way forward. Also, recognising the importance of nature-based solutions for food security and urban resilience to climate change, bringing more urban gardens or entrepreneurial urban agriculture into the heart of cities might help young urban dwellers to reconnect with nature and food production. That can also promote inclusivity (Cobbinah et al., 2021) and community building, especially through volunteer engagement in agricultural tasks (Sartison and Artmann, 2020; Hou, 2020); similar effects were observed through the greening of schoolyards around a community participatory approach (Flax et al., 2020). For urban planning to effectively address potential continuities between dwellers' attitudes towards public green areas and caring of plants in private housing, there is a need to consider the entanglement of ecological and social uses of nature. We advocate that favouring social ties around food production or public green areas, leading to more civic commitment in urban projets (Brazeau-Béliveau and Cloutier, 2021) and helping non-expert citizens to gain knowledge about plants and their benefits for the ecosystem, can push forward the greening of private housing. Greening the city could have a ripple effect on the greening of private housing, thus enhancing nature relatedness. In that perspective, indoor plants in individual dwellings might be considered 'proxies' for nature. It echoes with the multi-scalar approach of urban planning, spatial (from city to close neigbourhood), temporal (from young to elder people) and social (from family to local community), as suggested by Flax et al. (2020) to build more integrative resilience.

Data collection was carried out just before periods of lockdown in France due to the Covid-19 pandemic. Longitudinal research could help capture ongoing changes in attitudes. In addition, ethnographic methods could help to reflect on some new forms of urban governance addressing the continuities between public green areas and private housing. This could serve an expanded conception of ecology as explained by urban planner Felix Guattari (1989), who stated that ecology has three dimensions: environmental ecology (human–nature connections), social ecology (direct human relationships) and mental ecology (new way of thinking, desiring and dreaming).

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Appendix 1. Categories assessed and formulation of the questions

Category	Formulation of the questions
Representations of benefits/constraints associated with owning plants	• 'Owning plants inside / on balcony / on terrace': what are the positive/negative words that come spontaneously to your mind? *Please give three to five words for positive/negative aspects. (OQ)*
Behaviour related to plants at home	• Which statement applies to you? *I have a lot of indoor/outdoor plants. I have few indoor/outdoor plants. I have no plants / only artificial plants. (UC)* • Ideally, how many plants would you like at home? *A lot of indoor/outdoor plants. A few indoor/outdoor plants. No plants / only artificial plants. (UC)*
Valuation of plant care activities	• What is your perception of these tasks? *For you, potting plants is rather a constraint/pleasure. (UC)* *For you, watering is rather a constraint/pleasure. (UC)* *For you, cutting is rather a constraint/pleasure. (UC)*
Valuation of social aspects around caring for plants at home	• Having plants at home can lead to exchanges with others. To what extend do you agree with following statements? *Caring for other people's plants is a way of caring for those people. (L4)* *Talking about plants with other people gives a feeling of belonging to a community. (L4)* *Giving/receiving cuttings, plants or seeds allows you to share with others. (L4)* *Talking about plants is a friendly moment. (L4)* *Talking about plants / taking part in an online forum means being part of a community. (L4)*
Environmental concern	• Are you interested in permaculture? *Not at all / Not really / Yes (UC)* • Do you feel concerned about species loss? (Be honest!) *Not at all / Not really / Yes (UC)* • Are you willing to change your lifestyle, notably your travel habits? (Be honest!) *Not at all / Not really / Yes, absolutely (UC)*
Food profile	• Are you willing to change your food habits due to climate change? *Not at all / Not really / Yes, absolutely (UC)* • Are you flexitarian? *No/Yes (UC)* • Do you purchase organic food? *Never/Sometimes/Regularly/Exclusively (UC)* • Do you purchase some food in short channels? *Never/Sometimes/Regularly/Exclusively (UC)*

Note: OQ = Open question; L4 = Likert scale with four points; UC = Unique choice