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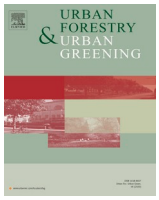

Plant your street! A research game exploring tree selection and placement in an urban neighborhood

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ABSTRACT

Tree canopy is critical to urban sustainability. At present, enhancing urban tree canopy in many cities is largely dependent upon plantings on residential and park areas. However, challenges surrounding public engagement in tree planting and stewardship remain. This project engaged visitors to public venues in the City of Los Angeles in a 'plant your street' research game. Participants (n = 184) used a gameboard depicting a neighborhood to choose from tree species grouped by a selected prominent ecosystem service - fruit bearing, flowering, climate adaptive, and carbon capture. Of particular interest were: (1) comparisons of selected tree types and species, (2) placement across neighborhood areas, and (3) the influence of messages emphasizing an ecosystem service on selections and placements. Certain tree types and species were selected overall, and, within different neighborhood areas, including one's home lot, neighboring lots and a city park; for example, the majority of trees planted on the home lot were in the relatively understudied backyard. Themes underlying these decisions were: 'perceived tree services', 'self-versus other,' and 'geography and personal connection.' Findings provide an improved understanding of urban tree planting preferences and may help inform neighborhood and residential tree planting programs.

1. Introduction

Trees are critical features of the urban environment for the survival and enrichment of ecosystems and human well-being. Benefits are wide-ranging, including the provision of shade, habitat, oxygen, food, aesthetic enjoyment and critical climate mitigative and adaptive functions (Avolio et al., 2015a; McPherson et al., 2011, 2017; Nowak et al., 2010). Shade from trees is associated with a lower average temperature, contributing to ambient cooling (McPherson et al., 2017). These services are particularly important for the estimated four million residents of Los Angeles County, who will continue to experience a hotter and often drier local climate than in past years (Hall et al., 2018). In recent years, municipal governments and nonprofits alike have prioritized planting and maintaining trees on public and private lands. Recent urban tree canopy assessments have found that the majority of plantable space exists on residential properties, often followed by park areas (Locke et al., 2021; O'Neil-Dunne, 2019). At the same time, tree canopy cover on residential properties in Los Angeles has declined (Lee et al., 2017). Adding to this concern is evidence from one study suggesting that residents intend to plant fewer trees at home in the future than they had in the past (Dilley and Wolf, 2013). Public perceptions are critical to successful urban forest management (Allendorf and Yang, 2013; Kirkpatrick et al., 2012), where public willingness to plant and care for trees and support municipally planted trees is essential (Moskell and Allred, 2013). This study engaged people in an interactive research game exploring what trees they are interested in planting around their home lot and neighborhood, and why.

1.1. Tree attributes and influences: what trees do people prefer and why?

1.1.1. Sources of influence

Decisions involving whether and what trees people might plant are influenced by various factors at different scales. Policies, such as California's greenhouse gas reduction goals, have led to the creation of programs encouraging the planting of trees high in carbon storage capacity (Forest Climate Action Team, 2018). More, to enhance urban forest resilience, many municipalities set targets for diversifying tree species composition (Sjoman et al., 2016); however, the success of plantings may be dependent on resident preferences (Shakeel and Conway, 2014). Local nonprofit and municipal urban forestry groups are

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influenced by these policies and targets, and simultaneously influence tree palettes and plantings across public and private lands. On public property, plantings may be initiated by a municipality, or at times, the request of a resident. On private property, in addition to the influence of homeowners' associations and retail nurseries, 'yard tree' programs exist in many cities, offering free or reduced-cost trees to residents (Conway et al., 2011; Nguyen et al., 2017).

Research has assessed groups that the public consults for tree planting advice and found that while many share decision criteria for tree selection, tree planting recommendations often differ (Conway and Vander Vecht, 2015). Given this variation, it is difficult to know whether the motivations of these groups align with those of individuals interested in planting trees. One study suggested that urban forestry groups tend to gravitate to messages on ecological and climate-based tree services (Silvera Seamans, 2013). Although residents also prioritize these benefits when considering both public and private urban forestry landscapes (Baur et al., 2016; Jim and Chen, 2006), aesthetic motivations tend to dominate on the home lot (Conway, 2016). Recent work in Los Angeles revealed a mix of aesthetic, public health, and economic values as perceived tree benefits (de Guzman et al., 2018).

1.1.2. Perceived tree services

Research on individual tree preferences has investigated perceived tree services and compared preference for different tree types or forms. Preferences for fruit trees have been reported (Cook et al., 2012; Jim, 1993), including a recent study where fruit trees and smaller stature trees were preferred by residents (Dilley and Wolf, 2013). Similarly, a study conducted in Southern California found a higher proportion of fruit trees on residential compared to street areas, which had more trees with low water and maintenance requirements (Avolio et al., 2015b). In a related study, shade and aesthetic tree benefits were ranked highest by Southern California residents (Avolio et al., 2015a). Aesthetic benefits rank highly in other studies as well (Lohr et al., 2004; Zhang and Zheng, 2011), followed by calming effects, improved air quality, and noise reduction (Lohr et al., 2004). There is also strong preference for trees and landscapes with flowers over those without (Akbar et al., 2003; Cook et al., 2012; Jim, 1993; Todorova et al., 2004). Whereas the majority of studies investigating tree forms or types employ more experimental designs (Hoyle et al., 2017; Lohr and Pearson-Mims, 2006; Zhao et al., 2017), studies examining *perceived* tree services tend to employ surveys (e.g. Kirkpatrick et al., 2012; Lohr et al., 2004), presenting services as abstract categories to be prioritized, removing the individual from influential personal, environmental and community contexts.

1.2. Communication

Across the multiple sectors involved in urban forestry, a wealth of public-facing information on the benefits of trees is communicated. Messaging research has been conducted in several domains including environmental disciplines and sub-disciplines (c.f. Cialdini et al., 2006; Schultz and Zelezny, 2003), but is relatively new to urban forestry (c.f. de Guzman et al., 2018). One study on green infrastructure found that residents' perspectives were 'broadened' beyond aesthetic valuation when provided with explicit ecological and climate information (Derkzen et al., 2017). Still, research in climate change communication has identified barriers to message reception such as the 'distance' of the threat and subject complexity (Lorenzoni et al., 2007). The climate related services of trees, such as carbon storage or drought tolerance, are often less 'visible' than other prominent services, such as shade provision and aesthetics. One promising avenue to barrier reduction involves engagement through climate change games (Kwok, 2019). The current study utilized a design game approach to explore how and why trees within a prominent service category, including less visible services such as climate adaptability, are selected and placed.

1.3. Neighborhood areas

Across a given neighborhood, there may be unique factors associated with different areas on a public to private spectrum, or intimacy gradient (Hall, 1966). Urban tree canopy assessments capture a snapshot of existing canopy in designated areas but are unable to explore planting motivations in these same areas. In particular, urban forestry professionals and researchers are challenged by a paucity of information surrounding residential tree selection and placement in backyards, primarily owing to access (street observations) and privacy concerns (Cook et al., 2012). Some past work suggests residents may have more actual (and sense of) control over backyards than front yards due to the influence of neighborhood institutions and societal pressures (Larsen and Harlan, 2006). Using the neighborhood as the context for the current study, participants were able to make choices across the intimacy gradient.

1.4. Current study

Given the disproportionate opportunity residential and park properties present, and concern over declining residential canopy, it is critical to investigate residents' preferences and motivations surrounding tree selection and placement. This project addressed three research questions:

1 What trees do people prefer around their homes and why? *Hypothesis:* It is expected that, consistent with past work, flowering and fruit trees will be more popular than the other trees presented.
2 Will the option of planting in different neighborhood areas influence preferences and placements? *Hypothesis*: We expect variations in tree selection and placement depending on neighborhood area (e.g. park vs. residential lots).
3 Will tree descriptions, highlighting a prominent ecosystem service, be associated with selection and placement? *Hypothesis*: Without predicting a direction, we expect selections may differ when a description of the tree highlights a service that is not visually salient - for example a tree that is high in carbon capture.

2. Method

2.1. Design and procedure

This study employed a mixed method approach resting primarily on participant observation in a design game scenario. Adult visitors to public venues in the City of Los Angeles were invited to participate in a "tree planting research game." Data were collected on weekend and weekdays between approximately 9am and 3:30pm, aiming to engage as many encountered groups as possible. To ensure maximum potential to recruit respondents, any visitor(s) passing by the research table when the game was not being administered were invited to participate if they appeared to be age 18 or older and were not involved in competing activities (e.g. cell phone conversation). The research team noted time of encounter, number of adults and children, number of participants consenting, and any reasons for refusal. Given a single gameboard and few research team members, not all visitors were approached.

Adults providing informed consent were asked to imagine the gameboard as their neighborhood, depicting six residential lots, three on one side of the street and three on the opposite, and a 'city park' at the end of the block (Fig. 1). Moving in from the street, a city easement was displayed, then a front yard and backyard. Participants were asked to engage in a 'think aloud' procedure, where they stated their thoughts, feelings or actions during the game (Lewis, 1982). They were first asked to build their neighborhood by placing a single, or multi-family dwelling on a 'home lot' of their choosing, and then dwellings on the remaining

Fig. 1. Completed research game example and tree presentation.

residential lots. To indicate non-residential lots or open space, 'X' game blocks were provided.

Then participants were invited to 'plant their street.' Eight species of trees were available, with eight of each type for equal availability. Trees were represented by moveable blocks depicting images of a fully-grown tree and selected detail, all shown against the same background (Fig. 1). Up to eight could be placed in the city park and up to three on a residential lot. On home lots, the easement, front yard or backyard were available for planting; for neighboring lots, the easement and front yard. Participants were instructed that they could plant anywhere from zero to eight trees.

Trees were selected by reviewing regional tree lists, a 'climate ready trees' assessment, species performance across attributes, and consultations with urban foresters (Forest Climate Action Team, 2018; McPherson et al., 2017). Trees were grouped into four categories or types by a single prominent ecosystem service selected by the investigators (Table 1, categories overlapped at times, e.g. fruiting trees also flower). The order of tree types was randomized across data collection days by type and within type by species to adjust for order effects.

Audio recordings were taken when permission was granted by the participant, and research staff took written notes on remarks and actions. Staff also noted participant characteristics using a pre-defined set of categories for observed age group, gender, and ethnoracial group adhering to an observational protocol for recreation settings (c.f., Cohen et al., 2007). Photographs were taken of the final design.

A quasi-experimental aspect to our study involved labels featuring implicit and explicit message conditions. The trays holding the tree blocks displayed a tree image, and an interchangeable velcro label. The implicit condition displayed the name of the tree. The explicit condition described a prominent ecosystem service, some more visible than others (e.g. fruiting versus climate adaptive). An example: "Desert Willow: A small, climate adaptive tree. This tree will perform well in Southern California under the stresses that are associated with climate change, such as drought." Implicit and explicit message conditions were randomized across locations and weekend/weekend days to distribute potential variations in participants and their responses.

Participants were debriefed following participation and provided with researcher contact information for study follow-up when requested. Procedures were reviewed by the Institutional Review Board at the University of California, Irvine.

Table 1
Species and type of trees planted in the game overall.

	Climate adaptive		Carbon capturing		Fruiting		Flowering	
Overall (n = 1423)	MM*	DW	CLO	CIP	O	A	J	WR
Number	123	141	288	152	186	146	238	149
%	8.6	9.9	20.2	10.7	13.1	10.3	16.7	10.5

* MM = Prosopis glandulosa x Maverick/Mesquite Maverick; DW = *Chilopsis linearis* 'Bubba'/Desert Willow; CLO = Quercus agrifolia/Coast Live Oak; CIP = Pinus canariensis/Canary Island Pine; O = Citrus sinesnsis/Orange; A = Persea Americana/Avocado; J = Jacaranda mimosifolia; WR = Cercis occidentalis/Western Redbud.

2.2. Participants and location

Of the 346 invited recreationists who were eligible, 200 participated, and 184 provided usable data, yielding a participation rate of 53.1%. The typical group invited to participate included two adults and no children, though each participant played the game independently. The majority of participants were female (n = 101, 54.9%; males n = 83, 45.1%) and the vast majority (91.3%) were adults, with a few seniors (6.0%) and teens (2.7%). Participants' observed ethnoracial backgrounds were white/Caucasian (54.9%), followed by Latino/Hispanic (23.4%), Black/African American (5.4%), Asian/Pacific-Islander (4.9%), or other categories (11.4%). Participants were recruited across the three data collection locations: El Pueblo Historical Monument (51.1%), Los Angeles Zoo (35.3%), and Griffith Park (13.6%).

2.3. Analysis

This mixed-method study necessitated multiple approaches. To answer what trees were selected and where they were planted in the neighborhood, independent coders assessed tree selection and placement from photographs of final designs, and discrepancies were resolved. Coded data was double entered by separate team members and conflicting entries remedied. Descriptive and comparative tests were conducted in SPSS 16. The four tree types the researchers selected are not assumed to indicate the main reason a participant selected or placed a particular tree. To answer 'why' certain trees were selected and planted, a thematic analysis was conducted on transcribed audio and observational records. Participants' remarks were read and re-read to identify relevant codes. Explicit meanings were assessed to identify

Table 2
Core themes and subthemes.

Perceived services	Self vs. Other	Geography and personal connection
Multiple services	Sharing (or not)	Climate zone and regional issues
Comparative services	Responsibility for care	Personal history and familiarity

themes that represented patterns or meaning and flowed from the research questions (Braun and Clark, 2006). NVivo software was used to run queries to review comments made when planting a specific tree type within a certain area of the neighborhood. Individual extracts of data were coded in as many different themes as were appropriate.

3. Results

Of the maximum 1472 trees possible (eight per participant), 1423 were planted and were within the game rules (96.7% of the maximum possible). Findings are based on the planted trees that fell within the game rules and could be accurately coded for placement.

The majority of participants planted all of the trees available to them. Specifically, 87% of participants in the final analysis planted all of the eight available trees and 6% of participants planted seven out of the eight trees available.

3.1. Species of trees planted overall

The first research question addressed which trees were selected overall. Table 1 shows the frequency and proportion of trees planted by the four types of trees (categories), with two species within each. The largest number of tree types were carbon capturing (n = 440), followed by flowering (n = 387), fruiting (n = 332), and climate adaptive trees (n = 264).

To better understand the mix of tree types selected by a single participant, a 'type score' was calculated within-subjects (1=selected from one tree type to 4=selected all four tree types.) On average, 3.24 (*M, SD* = 0.794) tree types were planted. A species diversity score within subjects was also calculated, representing the number of species selected (1=planted only 1 species to 8=planted 1 of each type of tree). On average 4.88 (*M, SD* = 1.598) species of trees were planted, suggesting a tendency to use multiple tree species. While avocados tended towards a singular planting by a participant, coast live oaks, mesquite mavericks, and jacarandas averaged multiple plantings.

3.2. Why trees were selected: main themes and subthemes

Remarks provided during the think-aloud procedure revealed three core themes and associated subthemes underlying tree selection and placement (Table 2). The first core theme was 'perceived tree services,' including services such as aesthetics, cooling and shade, food provision, wildlife support, climate adaptability, and carbon storage. Two subthemes occurred herein - multiple services a single tree provides ('multiple services'), and when services were compared within or between trees ('comparative services'). As with past research, tree services rather than their disservices were mentioned far more often (Avolio et al., 2015a; Lohr et al., 2015). The second core theme was 'self-versus other,' where participants selected and placed a tree in reference to two subthemes – 'sharing (or not)' the services of that tree; and, 'responsibility' for tree care. The third core theme was 'geography and personal connection,' capturing non-service-based reasons for tree selection, such as climate zone alignment, or personal narratives (based in experiences and knowledge) with trees.

3.3. Placements across the neighborhood

The second research question addressed the influence of neighborhood area. Quantitative results are presented on an intimacy gradient from public to private areas (Table 3); qualitative results align with this gradient, where appropriate. Table 3 illuminates the demonstrated interaction between neighborhood area and tree type and species most often selected.

3.4. City park

Trees planted in the park represented 28.5% of all trees planted (Table 3), the majority of which were from the carbon capturing type (46.6%), followed by flowering (27.3%), climate adaptive (14.5%), and fruit trees (11.6%). Roughly one-fourth (26.1%) of the participants did not place any trees in the park.

3.5. Neighboring lots

Similar to the park, the neighboring lots could have consumed all of the trees planted. Neighboring lots accounted for 45.2% of all trees planted (Table 3). Of the 643 trees planted, the majority were the flowering type (32.2%), followed closely by carbon capturing (29.2%), climate adaptive (25.0%), and fruit trees (13.5%).

3.6. Home lot

Up to 552 trees (3 trees maximum among the 184 participants) could be planted on the home lot; 26.3% were planted on this lot type (n = 374; Table 3). The majority of participants (96.2%) planted at least one tree on the home lot, ranging from one (26.6%), two (32.1%) or three trees (37.5%). Over one-fourth of participants (29.9%) planted trees in the easement, accounting for one-tenth (15.2%, 57 trees) of home lot trees Over half (51.6%) planted trees in their front yards (108 trees). The

Table 3
Species and type of trees planted by neighborhood area.

	Climate adaptive		Carbon capturing		Fruiting		Flowering	
	MM	DW	CLO	CIP	O	A	J	WR
City Park (n = 406)								
Number	25	34	125	64	32	15	70	41
%	6.2	8.4	30.8	15.8	7.9	3.7	17.2	10.1
Neighboring Lot (n = 643)								
Number	77	84	117	71	52	35	124	83
%	12.0	13.1	18.2	11.0	8.1	5.4	19.3	12.9
Home Lot (n = 374)								
Number	21	23	46	17	102	96	44	25
%	5.6	6.1	12.3	4.5	27.3	25.7	11.8	6.7

majority of participants (76.5%) planted trees in the backyard, accounting for a majority (55.9%) of home lot trees.

In the easement, trees from the flowering tree type were most often represented (35.1%), followed by carbon capturing (33.3%), climate adaptive (22.8%), and fruit trees (8.8%). In the front yard, flowering trees were planted the most (33.3%), followed by carbon capturing (24.1%), fruit (23.1%), and climate adaptive trees (19.4%). Backyard trees were mostly fruit (80.4%), followed by carbon capturing (8.6%), flowering (6.2%), and climate adaptive trees (4.8%).

3.7. Themes across the neighborhood

3.7.1. Perceived services

Although almost all coded services were noted in each neighborhood area, services were shared to varying degrees and often alongside unique reasoning. Singular tree services were noted on their own, and in combination or comparison with another service.

Aesthetic services were noted prominently on the easement and front yards of home lots. Various trees were selected to create an attractive front yard. 1. *So I'm thinking when it comes to just the front yards in general like the floral tree pattern.* 2. *I definitely want a western redbud in my front yard… it's very pretty. I like the color.* 3. *This pretty purple one I'll put in the front because it is beautiful and purple.* This was similarly noted in the home lot's easement: *The streets I like this one because the color is nice.*

Shade provision was noted as a singular service in the city park, where larger stature trees were frequently planted: *So…in the city park… shade trees I guess… So we'd go with live oaks and mesquite maverick.*

The provision of fruit was the most prominent service noted in the backyard. 1. *I will start with some fruit trees immediately.* 2. *So I believe that you should have fruit trees in your backyard… just self-sufficiency.* 3. *I think I take the orange trees and the avocado trees because it's always nice to harvest a bit when you're in your home.* In other cases, perceived disservices drove decisions, specifically avocado trees in backyards. 4. *I think avocados need lots of water so I don't want that.*

Some services were uniquely noted in areas, such as privacy in the home lot front yard. 1. *Okay I think I would do some pines strategically placed around my home for privacy.* In the home lot backyard: play, oxygen provision, and olfactory experiences were noted. 2. *I think I got to have an oak, I'm an oak kind of guy…. I want significance… I want a tree that my kids are going to be dancing around and tying a rope from.* 3. *I feel like this (coastal oak) is going to give me more oxygen* 4. *I like the smell of pine trees so I'll probably put that in my backyard.*

3.7.2. Perceived services – multiple services

Multiple services, including another unique service – economics - were also mentioned in the backyard: 1. *You can eat oranges you can eat avocados… avocados are expensive.* 2. *I grew up and had an avocado tree in my backyard and it was wonderful and probably raised the home value… because it was big and majestic.* Multiple services of shade and aesthetics were noted with park, home lot easement and front yard plantings. 3. *let's see parks should have pretty trees as well as shade… I'm going to do a Jacaranda… the park will look pretty… purple.* 4. *It would be nice to have trees on the sidewalk because it looks nice like on a shaded street.* 5. *What would be a good front yard tree… something with a lot of shade but pretty… The oak one?*

3.7.3. Perceived services – comparative services

Aesthetic services remained a powerful influence for placement of different fruit trees 1. *Orange tree I'll put in the backyard and the avocado tree I'll put in the front yard… actually I'll switch it because orange trees are prettier.* Some negotiated between perceived services and disservices. 2. *I'm trying to choose a tree that doesn't necessarily shed so much… but that has shade.* 3. *I like oak trees too yeah but I don't know… they're not as pretty as the flower trees.*

3.7.4. Self vs. other – sharing (or not)

Whether or not participants felt compelled to share varied across neighborhood areas. Generally, sharing with others was noted more in public areas, and not sharing with others was noted more in private areas.

Although fruit trees were not in the top two tree types planted in these areas, sharing food from fruit trees was noted in the park, home lot front yard and easement; in the easement, sharing shade was also noted for fruit trees. 1. *But avocados are kind of fun too… maybe we'll do edible landscaping over in the park so everyone can enjoy it right… make a real mess.* 2. *So I'll give the city park some orange trees and some avocado for some of the people who might be destitute and might want to eat something…* 3. *What happened is I already have fruit trees in the front of my yard so it allows for individuals just to come by and maybe pick.* 4. *I'm putting my citrus so it overhangs onto the street so that hopefully the occasional walker, if my tree gets big enough, can have some of those oranges as well.*

The following remarks reveal thoughts about access to trees and green space as a different form of sharing. 1. *…big trees for the apartments so that there will be shades for kids to play.* 2. *Going to do apartments closer to the park because apartments lack green space for the residents, and I think they should be closer to the park… because they can have access to the green space.*

Another unique form of sharing emerged surrounding trees and wildlife was noted in the park and at home, where the participant negotiated between the self and others (wildlife): 1. *the Jacaranda which I find quite attractive… for me as a birder I know these flowering trees are quite good for migrant birds.* 2. *Alright so… Do I want to shade the homes to reduce the energy for heating or do I want to maximize my usage……usage of local trees for local species? It's a tossup between the two.*

Interest in sharing a service with others was mixed in the front yard, where some participants planted for themselves, and others planted for the enjoyment of others. 1. *I'm going to put these pretty flowery trees that way I have a nice view… so I'm centering everything around my house.* 2. *Putting a flowery one in the front yard because it's pretty for people to look at.* Although neighboring lots were less a focus in qualitative results, flowering trees that were placed in these lots often came with remarks reflecting generosity such as giving a gift of flowers to a friend.

The many participants who planted fruit trees in their backyards often mentioned keeping the fruit for themselves, reflecting less sharing. 1. *So I would plant two orange trees I guess those are oranges and one avocado so I can have delicious guacamole with some giant avocados.* 2. *We're going to put that in the back that's for sure…probably away from the fence because then all the neighbors are going to run up and take the avocados.* Sometimes a single individual shared two points of view simultaneously, where one participant noted putting orange and avocado trees in the park for people who are hungry and then reported after: 3. *I'll put an orange tree in my backyard because I don't want these darn kids picking off my fruit and I'll put an avocado tree there too.*

3.7.5. Self vs. other - responsibility for care

Concerns of self vs. other surrounded perceived responsibility for care. Participants negotiated tradeoffs between a noted service and perceived upkeep, placing some flowering and fruiting trees elsewhere to shift responsibility to others. 1. *We're going to have all of these Jacarandas…they're pretty drought tolerant… they're really pretty… somebody else has to clean them up.* 2. *I'm putting the Jacarandas in the park because they're really pretty trees but they also make a big mess… so you want to have somebody who comes by and cleans it up.* 3. *also an orange tree in the park… far away from me so I don't have to deal when the fruit falls and the flies and stuff like that?*

In contrast to the home lot front yard, participants expressed confusion over stewardship of the easement: 1. *So… if you plant on the parkway are you responsible for the maintenance or is the city?* The following comment notes multiple tree services and also discusses 'responsibility for care' from a different perspective. 2. *Helping to store a lot*

of carbon dioxide, I like that… I feel like because of where we're at we need to focus a lot on trees that can help combat carbon dioxide … and just purely off of aesthetics I like, the, how the island pine looks so I'm going to choose this… And I think here on the city easement… I feel like the city should be…if the city invests in that I think that's a smart idea.

For a few participants, unique to the backyard, responsibility for care influenced the decision to fulfill stewardship responsibility, and share the fruit after: *And I would also put the avocado in the backyard… I would still make the avocados available but they can be kind of finicky so I would rather be able to take care of it and just put the food out.*

3.7.6. Geography and personal connection

3.7.6.1. Climate zone and regional issues. Regional and climate issues were considered overall, sometimes alongside other services: 1. *Another warming spell geologically speaking in California and based on the UCLA study that says that we are going to a more…we're headed to a hotter drier environment with many more hot days.* 2. *Alright I'm partial to the coast live oak… as I understand it's an adaptable tree… it's frequent across California… I think it might be native… that's two.*

The geography of two neighborhood areas led participants to consider scaling and design implications, such as matching tree size with placement. On the park: 1. *Tall better for park* 2. *Pines and parks just go hand-in-hand for me*.

On the easement, biodiversity and heterogeneity concerns were compared against design consistency. 1. *I want to organize like this so when you drive down the street, they look the same… so when you drive down the street you have this nice row.* 2. *having one type of tree does make it easier… even though it does make it a little bit worse for biodiversity.* 3. *Sorry I'm kind of a… I didn't mean to make a monoculture but I love oak trees… Okay so I'm going to opt for lots of oaks because I love oaks and they make really nice street trees.*

3.7.6.2. Personal history and familiarity. Familiarity was revealed across neighborhood areas: 1. *I see a lot of live oaks around my area… let's put one at the park…* 2. *I'll put an oak in my backyard because I kind of have oak in my backyard.* Familiarity sometimes involved autobiographical memories of fruit trees in backyards. 3. *Then for myself I like oranges a lot and I grew up with like an orange tree in my backyard and an avocado tree in my backyard… And that's what I would want to plant in my own back yard.*

3.8. Effects associated with implicit and explicit conditions

The final research question posited that descriptions in the 'explicit condition' might make climate adaptive and carbon capturing features more salient, resulting in a possible effect on tree selection. Independent samples *t*-test showed no significant difference in the number of each tree type selected by message framing condition for climate adaptive trees: $t(182) = -0.85$, $p = .39$ and for carbon capturing trees $t(182) = -.36$, $p = .72$.

4. Discussion

Using a research game, this study examined what trees people prefer on and around their home lot, where the majority of plantable space remains in cities, with the goal of aiding urban residential tree planting programs. Implications for tree palette options are discussed as well as nuanced communication approaches, particularly as inadequate information about trees during selection and planting can be associated with later likelihood of removal (Conway, 2016).

4.1. Trees planted overall

Most participants opted to plant all of the trees available, with a large majority planting at least one tree on their home lot. Consistent with our hypotheses, selections varied by type. We found that flowering trees were a popular choice, however the larger stature trees – within the carbon capturing tree type were most frequently selected. These were planted mostly in the city park and second-most popular in other areas. This is partially a reflection of the proportion of trees that could be allocated to the city park and neighboring lots. Most tree types and species were represented relatively well, including the carbon capture and climate adaptive types; a promising result, regardless of whether participants based their selections on a given tree's climate mitigative features. For residential property, where individual control is most realistic, these results suggests that retail garden centers, who primarily serve a demand for smaller ornamental trees rather than large shade trees, might consider expanding tree palette options for residents (Conway and Vander Vecht, 2015).

Past work indicated that potential homeowners were tolerant of no more than six tree species in a neighborhood (Plant and Kendall, 2018). Results in this study revealed that participants planted multiple tree types and species across the neighborhood, looking beyond the 'streetscape' where the majority of work in this area is focused (Weber et al., 2008). This result holds promise for municipalities aiming to increase tree species diversity, particularly in southern California, whose urban forests are known for their many different species (Avolio et al., 2015b; streets.lacity.org/urban-forestry-division).

4.2. Patterns: what trees were planted where?

The option of planting trees in different neighborhood areas revealed nuances in selections, sometimes across the intimacy gradient from public to private spaces, from the visible front yard to the understudied backyard (Cook et al., 2012).

In the park, carbon capture type trees followed by flowering type trees were most popular. In the home lot easement and front yard, the reverse was true. In the home lot easement, climate adaptive type trees were infrequently selected, indicating that the public and municipalities may need better alignment. Past work assessing street tree canopy in Southern California recorded primarily trees with lower water and maintenance requirements (perhaps reflecting the choices of managers) (Avolio et al., 2015a). Finally, a majority of trees on the home lot were planted in the most private area, the backyard. Building on past work reporting a higher proportion of fruit trees on residential property (Avolio et al., 2015b), we found the backyard in particular was favored for fruit trees.

4.3. Why? Perceived 'known' services

Shade provision was prominently noted, often alongside aesthetic services in parks and easements. This is partially consistent with past work that has found that flowers (and fruit provision) were highly valued park amenities (Jim and Liu, 2001). More, a higher proportion of shade trees are found on streetscapes (Avolio et al., 2015b) and shade provision is often noted as a key roadside amenity (Jim and Liu, 2001). Data were collected during summer when extended daylight hours and ambient temperatures may have influenced characteristics of trees that participants remarked upon, such as shade or cooling.

In the front yard, a desire to display beauty and color was prominent, as was shade provision. In the backyard, as a reflection of that more intimate space, personal and protective themes arose – concern for the self (one's own fruit tree), and unique multiple services such as economic and olfactory benefits, play, as well as personal connections to tree(s). These results provide a clearer picture of prominent perceived services for different yard areas; building on past work suggesting front yards tend to reflect status and norms and backyards, values and lifestyle choices (Larsen and Harlan, 2006).

These results suggest that considering all residential property as a homogenous category misses important nuances about tree choices and plantings across neighborhood areas and the home lot. Additionally,

while tree services are often presented in singular lists, results demonstrate that participants considered perceived services singularly, in multiples, or in comparison to one another, within and across trees and areas, as they negotiated tree selections and placements.

4.4. Why? Insights into public reasoning

In addition to enhancing dialogue surrounding tree services across different areas, research game engagement allowed for unexpected or non-service-based influences to emerge: namely, thoughts around the self and others in regard to willingness to share varied by neighborhood area. This highlights how tree choices and plantings are different even across one's home lot, suggesting that messaging to tree adopters about their 'yard' may miss important nuances key to unlocking their interests. Messaging aligned with values is ultimately more effective (Schultz and Zelezny, 2003). Together results suggest that effective messaging might include discussing the shared experience of beauty and shade in more public areas, aesthetics in front yards, and in the backyard, more personal and private services or narratives, emphasizing a greater sense of ownership.

Highlighting thought processes around sharing vs. not may be a new avenue for urban forestry groups to consider; such conversations might not only involve what tree services the 'adopter' may enjoy, but how neighbors, or, extending contexts for sharing further, wildlife, may benefit. This could be tailored, where the 'adopter' may focus on either enhanced personal ownership in more private areas, or a shared responsibility with their community over tree stewardship in public ones.

However, in some cases, nuances emerged from a 'planting mindset,' where participant's choices were actually envisioned. This sometimes led to caution around willingness to care for different trees, despite noting a preferred service from the same tree. For instance, the flowering Jacaranda was often noted simultaneously for its beauty and mess, the latter being why many chose to place it in the park.

Many yard tree programs integrate information on tree care at adoption events or online. These results suggest that engaging in an open dialogue, where tree services and care can be discussed, including personal experience with trees, may be a promising avenue to pursue. Indeed, the sub-theme of personal connection (Larsen et al., 2009) and species familiarity was also influential in this study. Though beyond the scope of this paper, the personal experience of stewarding a tree provides an opportunity to shape environmental values, informing policy support that aids urban resilience (Dearborn and Kark, 2009).

4.5. Climate implications and limitations

A sub-goal of this study was to investigate how the public perceives climate adaptive and mitigative trees by allowing for the selection of trees that were carbon capturing and/or climate adaptive, when paired with the quasi-experimental messaging. Aligning the goals and priorities of residents, urban forestry groups and powerful macro forces, such as climate trends and goals, is critical for urban resilience. However, explicit messaging about climate related services did not significantly influence selections and placements. This may have been due to the greater impact of the tree image over tree descriptions, or participants' lack of familiarity with these species (see McPherson et al., 2017 regarding regional availability). Although qualitative results suggest some avenues for messaging, further quasi- or full experimental work is needed to compare messaging strategies.

Pairing the design game process with a pre-post survey would be of considerable help in understanding sociodemographic variations, personal experiences with trees, and residential characteristics (rent vs. own). A future computerized study might enable the integration of all of these factors as well as more systematically compare various tree services and tree forms and/or sizes. Additionally, participant recruitment might focus on increasing diversity of participants to better mirror the regional population. Further, regionally appropriate trees, and variations in species selected, would represent added value in studies expanding on these findings.

5. Conclusion

This study revealed that a game-based research approach, can not only answer core questions of tree preferences and placement, but uncover reasons why decisions are made. Tree preferences were evident for different neighborhood areas, especially across home lot areas, highlighting the need for practitioners to consider nuanced communication strategies. A call for expanding dialogues surrounding tree services, often discussed in singular terms, seems warranted as these services appear to be more complex in the eyes of potential adopters – in coordination and/or contrast to each other. Our qualitative, game-based approach provided the platform for uncovering these nuances. Promising new avenues for communication discovered include: the desire to share services with others or not, ownership or deference of responsibility, and one's personal histories with trees. These strategies may aid in the success of urban forestry programs, whose impact is critical for long-term urban resilience.

Author statement

Nora Davis: Conceptualization, Investigation, Writing- Original draft preparation, Writing- Reviewing and Editing; Formal Analysis; **Patricia L. Winter:** Conceptualization, Formal Analysis, Methodology, Investigation, Writing-Reviewing and Editing, Supervision.

Declaration of Competing Interest

The authors report no declarations of interest.

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