Nudging People Towards More Sustainable Residential Choice Decisions: An Intervention Based on Focalism and Visualization

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ABSTRACT

There have been numerous behavior change studies focused on sustainable travel mode choices. In this study we focused on the residential choices that in turn influence travel habits. We designed and implemented two interventions, which we term the "focalism" and "visualization" interventions, based on literature in psychological economics. The focalism intervention was motivated by literature that suggests people make suboptimal choices when looking for a new home. While focus is given to immediately tangible features like the quality of the house, important but less tangible factors like access to transportation are relatively overlooked. The visualization intervention was based on literature showing that providing information at decision points when long-ingrained habits are vulnerable to change, such as at the time of a residential move, can be influential on choices. We designed both interventions to be interactive so that the intervention was "discovered" by respondents rather than presented directly as information. With the focalism intervention, we pointed out differences in how respondents ranked their search priorities for new housing and neighborhoods, versus how they ranked what they reported makes them happy. With the visualization intervention, we explained to respondents that moving is an opportunity to make changes in one's life, and we prompted them to think through what they desired to change. We evaluated the influence of these interventions on residential housing decisions by surveying respondents about their priorities in residential search before and after the interventions, and by collecting information about their housing, neighborhoods, travel patterns, and reported well-being. The surveys were web-based, with one survey conducted before respondents moved and a second survey conducted afterward. Participants were randomly assigned to a focalism treatment group, a visualization treatment group, or a control group. 380 respondents answered the pre-move survey, and 184 of these answered the post-move survey. In the pre-move survey, we found that both the focalism and visualization interventions resulted in a significant increase in the fraction of people who planned to travel more sustainably relative to the control group. More importantly, we found that after the post-move survey, respondents in the focalism group, but not the visualization group, significantly reduced their travel time to work and increased their cycling, walking, carpooling, carsharing and transit use in comparison to the control group. Meanwhile, those in the visualization treatment group had significantly higher reported well-being after the move; those in the focalism treatment group also improved their stated well-being, though less significantly; and there was no change in the control group. These results suggest that it might be relatively easy to nudge residential choices towards both more sustainable travel and greater well-being.

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1. Introduction

A wide array of sticks and carrots has been implemented to encourage reduced automobile use. The use of pricing disincentives, though demonstrably effective, has historically been a political hard sell. Incentives such as lotteries or gift cards are easier to implement, if more costly; these have been employed recently to reward individuals for changing travel modes or avoiding the rush hour (Ben-Elia and Ettem, 2009; Merugu et al., 2009). Others have tried informational campaigns (Brög et al., 2002; Verplanken and Wood, 2006; Rodriguez and Rogers, 2014) and travel feedback programs (Rose and Ampt, 2001; Taniguchi et al., 2003; Fujii and Taniguchi, 2006; Jariyasunant et al., 2011). These interventions have been primarily focused on travel mode choices. While they may have succeeded in changing behavior in the short term, once the incentive is withdrawn the socially desirable behavior may tend to disappear as well (Ben-Elia and Ettema, 2009; Merugu et al., 2009).

While it is possible to promote more sustainable travel behavior by working to break one's regular day-to-day travel habits, residential location decisions likely have long-term impacts on travel patterns. A number of studies have shown links between the built environment, residential location decisions, and travel patterns, and physical activity (e.g., Ewing and Cervero, 2010; Berke et al., 2007; Cao et al., 2009; Chatman, 2008; Chatman, 2009). Handy et al. (2005) argue that a causal relationship between the built environment and travel behavior is highly probable, and that changing residential locations is therefore likely to result in a change in travel patterns. Although made relatively infrequently, a household's decision about where to live has a potentially profound impact on the availability of alternative travel modes and the time and money costs of daily travel, particularly driving (Chatman, 2008). While there are several studies that focus on intervening on travel choices immediately after one has moved (Brög et al., 2002; Bamberg, 2006; Bamberg, 2007), Rodriguez and Rogers (2014) is the only study we are aware of that focuses on intervening in the residential location decision itself in an effort to prompt more sustainable travel patterns. Their study sampled 292 incoming university students and, before they moved to the area, provided a subset of the subjects with information on a map showing the location of transit routes, apartment complexes, shopping centers, and campus destinations. The subset of subjects receiving information traveled between 50 and 68 percent less by automobile and stated that they preferred to live closer to the university and in areas with more transit stops

In this study, rather than to provide information, our objective was to execute interventions intended to improve the rationality of decision making about residential choices, in order to influence sustainable travel behavior and respondent well-being. Based on literature from psychology and transportation, we designed two different interventions occurring prior to residential choice. Our primary question was: can these interventions trigger residential choices that result in more sustainable travel patterns and higher well-being? Our experiment consisted of a two-stage, web-based survey, conducted before and after subjects moved homes.

2. Interventions

We designed our interventions based on literature in both psychology (Verplanken and Wood, 2006; Gilbert and Wilson, 2000; Mitchell et al., 1997) and transportation (Brög et al., 2002; Bamberg, 2006; Verplanken and Wood, 2006; Rodriguez et al., 2006; Fujii and Taniguchi, 2006; Bamberg, 2007; Comerford, 2011; Chatman, 2014). Information campaigns have often been used by researchers, government agencies, and cities to encourage people to make more sustainable travel choices (Verplanken and Wood, 2006). While informational campaigns have sometimes been shown to be effective, research also suggests that long term attitude changes are more likely when people process information in an interactive fashion, applying their own knowledge to the given information (Albarracín et al., 2005; Derzon and Lipsey, 2002; Verplanken and Wood, 2006; Ramachandran and Canny, 2008). In order to change travel behavior, Verplanken and Wood (2006) argued that persuasive communication may not be enough to trigger new habits since people with strong habit-based expectations are less likely to pay attention to new, counter-habitual information. It has been argued that information campaigns and behavior plans often provide poor results and fail to change behavior (Derzon and Lipsey, 2002), and that interactive dialogues are more persuasive than simple information (Ramachandran and Canny, 2008). Therefore, we

designed interactive interventions intended to increase respondents' awareness of transportation and location characteristics as they came up with a solution themselves when choosing a new place to live.

The visualization intervention uses a concept from Verplanken and Wood (2006), who divided behavioral interventions into three types: "downstream," "upstream," and "downstream plus context." Downstream interventions occur after the habit is already formed, whereas upstream interventions are designed to prevent undesired outcomes prior to habit formation. "Downstream plus context" interventions are downstream interventions paired with a major change that disrupts existing habits, providing new information at a moment when people are undergoing shifts in their environment – such as a residential move. The concept has been used in new resident marketing programs by several US transit systems (Brög et al., 2002; Bamberg, 2006), in which new residents are given temporary free transit passes to encourage new travel habits. Several researchers have tested the efficiency of such interventions to create more sustainable travel behaviors. For example, Bamberg (2007) tested the effects of a free public transit ticket and personalized transit schedule information on travel patterns after a recent move, showing that the intervention significantly influenced public transit use.

In our protocol we also took advantage of the environmental disruption experienced by movers – but by affecting the process of making the residential choice itself. Our intervention occurred *before* respondents moved, asking them to envision opportunities for change that they would experience at that future time. Then we asked them to think about what they wanted to do, using the concept of the personal behavior plan (Fujii and Taniguchi, 2006). We asked respondents to think about the changes they wanted to see in their lives, and how they could make a residential choice to help achieve those changes. We call this a "visualization" intervention, because it prompts respondents to imagine potential changes in their lives that may occur as a result of the move. This intervention is meant to help respondents select a location that is consistent with their personal behavior plans.

The second intervention was based on the psychological concept of "focalism," a term coined by Wilson et al. (2000) to refer to a tendency to over-focus on an immediate choice or on the most salient or observable aspect of a choice. Focalism is one example of a broader concept sometimes called "miswanting," in which people do not like or dislike an event (or future state of affairs) as much as they predicted they would (Gilbert and Wilson, 2000; Mitchell et al., 1997). Gilbert and Wilson (2000) find different sources of miswanting. For example, sometimes people don't truly understand what the future event will be and mispredict its repercussion. On the contrary, sometimes people know exactly what the event will be but are still bad at predicting its durable affective impacts. Sometimes, when focusing on a choice people overestimate the impact of that choice on their happiness, because they fail to think of a number of other things that may occur in the future, either along with that choice or coincident with that choice. For example, assistant professors overestimate the effect that being granted or denied tenure will have on their happiness, probably because their happiness also depends on factors such as faculty meetings, responsibilities at home, etc. – any number of other important influences on well-being in addition to job security (Wilson et al., 2000). As far as residential choices are concerned, people may make suboptimal decisions because of this tendency to focus on factors that are observable, tangible, or most salient because they obviously distinguish choices. For example, Chatman (2014) suggests that during housing search, people may tend to make suboptimal choices because they overvalue salient goods like physical size of the house and underestimate other less easily noticed factors like safety of the neighborhood and disutility of travel.

For our focalism intervention we designed a dialog for people to reflect on their true preferences. After asking respondents to prioritize factors that they thought were important when choosing a new home, we asked them to account for how they spent their time. Then we asked them to again prioritize the same factors, but in terms of how they thought each would affect their well-being and happiness. We then identified for the respondents any discrepancies between their initial and subsequent prioritization of factors.

3. Survey Instrument and Data Collection

Data collection began with recruitment and screening, followed by assignment to treatment groups, a pre-move survey and finally a post-move survey (Figure 1). We recruited respondents for the online survey by posting advertisements on three rental websites (rent.com, zillow.com and Craigslist). We screened in subjects who expected to change their place of residence within the next 3 months. We randomly assigned each recruit to one of three groups: the focalism intervention, the visualization intervention, and the control group. We conducted a two-stage survey: respondents filled out one survey before relocation (pre-move) and one after relocation (post-move). In the pre-move survey, the intervention was applied to respondents in the treatment groups (as described in more detail below) and all respondents were asked about their current housing conditions, travel behavior and happiness. After three months, we sent an invitation email to respondents who completed the pre-move survey and asked them whether they had moved or not. We again surveyed those respondents who had moved, asking the same questions about housing conditions, travel behavior, and happiness. We provided respondents an incentive of $10 for filling out the first survey and $20 for the follow up survey, in the form of Amazon gift cards. The survey instrument restricted each IP address (i.e. each computer connected to the internet) to one response.

In the pre-move survey, respondents were first asked to assign a priority score (on a 5 point scale: unimportant, slightly important, important, very important, and critical) to a number of home and neighborhood characteristics, including physical characteristics of the house, multimodal transportation accessibility, proximity to social network and activities, and non-transport neighborhood amenities. Table 1 lists the characteristics that the respondents were asked to rate. The same priority questions were asked after the intervention to check the effectiveness of the intervention on people's decisions. All of the features subjects were asked to prioritize are listed in Table 1.

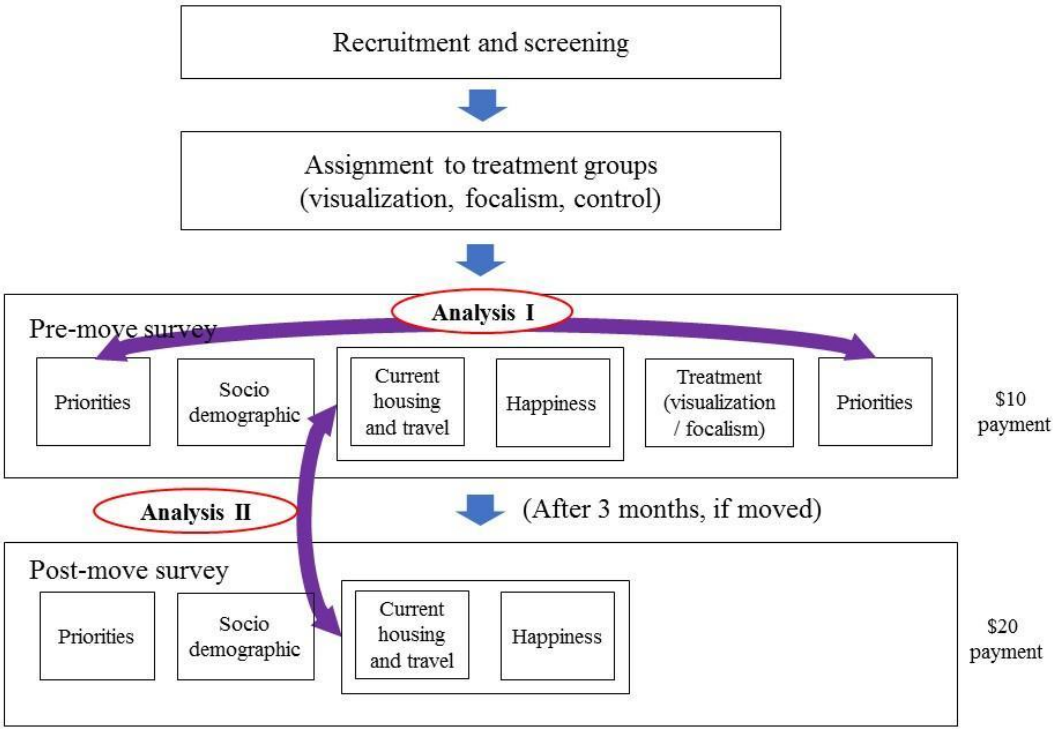

Figure 1: Data collection and analysis design.

Table1: Home/neighborhood characteristics in the survey, grouped into four aspects. Used for both priority rankings and happiness rankings. Analysis throughout is performed on the "Overall" rankings.

Aspect	Label	Metric
Physical aspects of the house	Physical	● Size of house ● Size of lot and yard ● Quality of bathrooms ● Quality of kitchen ● Number of bedrooms and bathrooms ● Quality of windows and amount of light ● Overall physical aspect
Multimodal transportation accessibility aspects	Accessibility	● Easy to park ● Easy to use transit to work, shopping or other locations ● Easy to use car-sharing to work, shopping or other locations ● Easy to walk to work, shopping or other locations ● Easy to bicycle to work, shopping or other locations ● Overall transportation aspect
Proximity to social network and activities aspects	Location	● Close to family (including partner you don't live with) ● Close to work ● Close to friends ● Close to children school ● Close to stores (including grocery) ● Close to recreational activities and other frequently visited places ● Overall location aspect
Non-transport neighborhood aspects	Neighborhood	● Low crime neighborhood ● Quiet, clean neighborhood ● Good neighborhood to raise children ● Know people in neighborhood ● People in neighborhood are like me ● Overall neighborhood aspect

The visualization intervention is illustrated in Figure 2. We first told respondents that moving can be a time to make changes in their lives, and asked them to visualize their ideal life in their new home. We encouraged them to consider how their move could enable positive changes in life, where we explicitly focusing on transportation and accessibility but also encourage broader thinking. We told them that the location of their future home would contribute to their overall quality of life. We then asked them to state what changes they would like to see in their day-to-day and weekly travel habits in five open-ended questions accompanied by detailed examples. Finally, to help the respondent make explicit links between their desired changes and their housing search, we asked them to select the top five housing or neighborhood attributes that they planned to prioritize when searching for a new home.

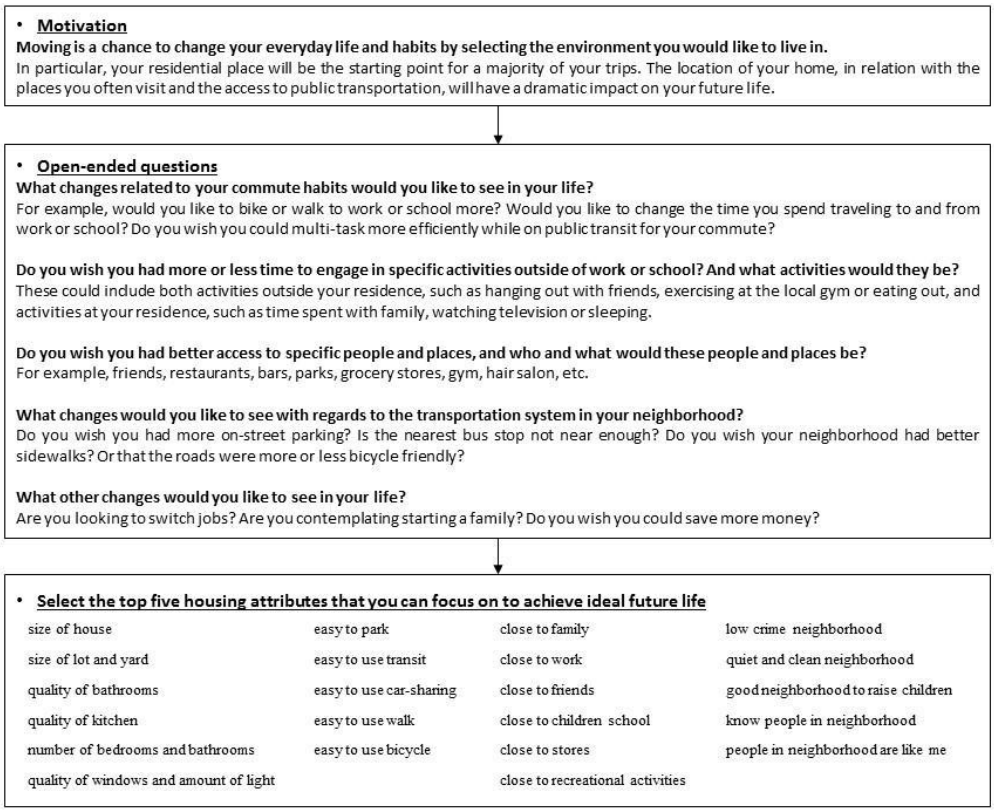

Figure 2: Flow chart of the visualization intervention.

For the focalism intervention, we first asked respondents to state the top five things they looked for while searching for new housing. Then we asked them to think of how they spent their time and which activities were important for their quality of life. We also asked them to state the amount of time they spent every day on work, school, commute, socializing, shopping, etc. The objective of this questioning was to get the subjects thinking about the details in their lives that may be impacted by residential location choices. Following this we asked them to evaluate the impact of the same list of housing and neighborhood characteristics (Table 1) on their well-being on a 6-point scale (delighted, pleased, mostly satisfied, mixed, unhappy, and terrible). We summarized the results for each respondent in the form of a ladder chart as shown in Figure 3 (shown for physical aspect rating only). A ladder chart was presented separately for each of the four aspects (physical, accessibility, location and neighborhood), the left side is the respondent's average priority score, while the right side is the respondent's average rating of the importance for their well-being. The factors that the respondent prioritized in residential search, compared to the factors that they reported were important for their own well-being, sometimes matched and sometimes did not; in either case we reported the outcome. To highlight the point, we then gave respondents a definition of focalism, stating that one's ideas about what is important in housing decisions may not always reflect what actually drives one's well-being. Finally, we included a statement suggesting that when searching for housing they should consider sometimes overlooked characteristics thought to be more closely related to well-being, such as accessibility, proximity, and social factors, instead of focusing on tangible characteristics such as physical features of a housing unit.

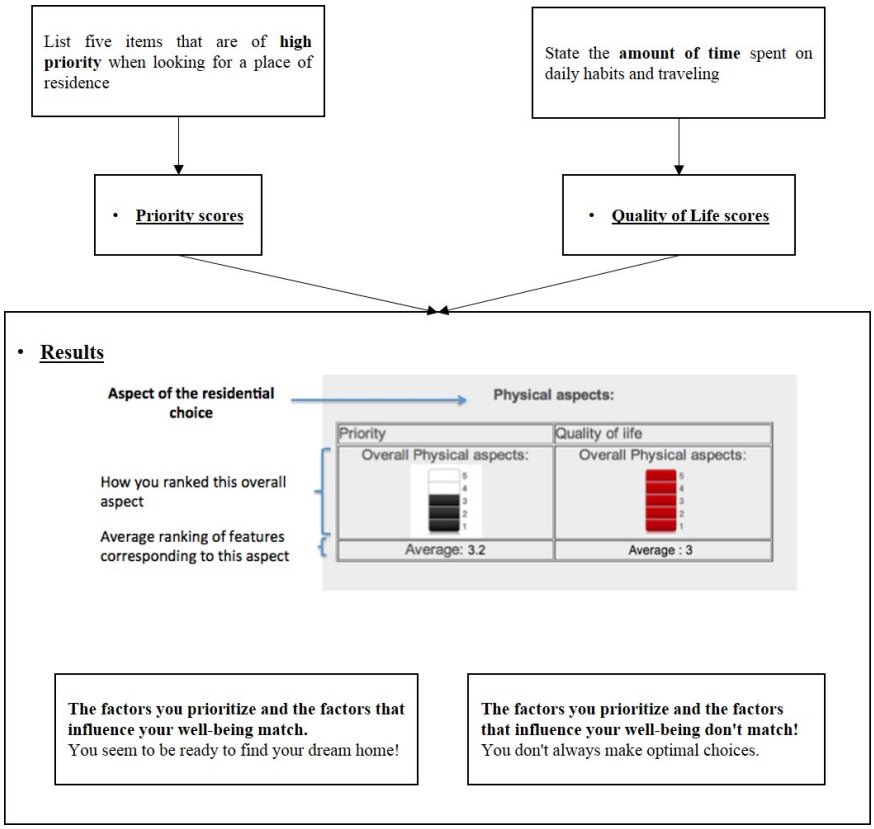

Figure 3: Flow chart of the focalism intervention.

Following the survey design in Chatman et al. (2013), we also asked respondents for information about their current residence, such as the number of bedrooms and the availability of amenities such as hardwood floors, new kitchens, and yards; demographic information such as income and employment status; and household information such as the number of people in the household and the amount of their rent or mortgage payment. We used standard language from the US Census American Community Survey for most of the questions in these sections. In the survey, we also asked about travel: mode and distance of the commute to work or school; the frequency and mode for other non-work trips; and cycling and walking. Question wording for these was taken from the National Household Travel Survey (NHTS). Finally, we asked the respondents about neighborhood characteristics using wording based on questions from the Los Angeles Family and Neighborhood Survey. The survey also included questions about the number of close friends and family members, and the type, frequency, and quality of social contacts with friends and family.

We also included questions that were used to gauge the impact of the residential choice on overall happiness of life. Chatman et al. (2013) used subjective well-being (SWB) survey questions largely based on pre-tested questions from other high-quality surveys, and we follow the same procedure here. The first subjective well-being (SWB) question, developed by Andrews and Withey (1976), was, "How do you feel about your life as a whole?" Responses were given on a 6-point scale where 1 is "delighted" and 6 is "terrible." The second SWB question, called the "life ladder," has been used by many surveys including the Gallup poll (Cantril, 1965). It asks, "Please imagine a ladder with steps numbered from one to nine. The top of the ladder represents the best possible life for you and the bottom of the ladder represents the worst possible life for you. On which step of the ladder would you say you personally feel you stand at this time?" We included SWB questions because while we are focused on nudging towards more sustainable and active travel, we are not interested in doing so at the expense of overall happiness. Indeed, our preference is to improve on both dimensions.

4. Analysis and Results

In this section, we first analyze the pre-move survey, in particular whether the interventions have an impact on stated priorities in house search and how the interventions impact the four aspects as collected via responses to questions as shown in Figure 2. While doing this, we also analyze how socio-demographic factors relate to the interventions and the change in stated priorities. Then we compare the pre-move survey to the post-move survey to test the results with realized changes in travel sustainability. We also test the effectiveness of the interventions in nudging people towards more sustainable and happier lives.

The 380 respondents who took the pre-move survey were randomly assigned to either the visualization treatment group, the focalism treatment group, or the control group. Of the 354 respondents who completed the first survey[1] (Table 2), the mean age was about 32 (and ranged from 18 to 61), 57% were male, 95% reported that they had a college degree, 97% had a driving license, and 52% reported they owned a home by themselves or with a partner. Based on chi-square tests and ANOVA, respondents did not differ significantly between groups with respect to mean age, number of members in household, gender, education level, marital status and home ownership. However, the fraction of respondents with children was significantly higher for respondents in the focalism treatment group (74%) and the visualization group (70%) than for the control group (56%).

Table 2: Demographic characteristics by treatment group (sample size: 354).

	Visualization (N=133)	Focalism (N=136)	Control (N=85)	*P*-value
Age mean (StdDev)	31.5 (5.4)	31.8 (6.1)	32.9 (8.3)	0.27
Household size mean (StdDev)	3.6 (1.6)	3.7 (1.3)	3.6 (2.7)	0.69
Gender (%)				0.71
Male	57	59	54	
Female	42	41	46	
Education level (%)				0.25
High school	2.3	2.9	3.5	
College	71	57	64	
Graduate	27	40	33	
Marital status (%)				0.11
Single	20	24	33	
Married	80	76	66	
Has children (%)	70	74	56	**0.02**
Owns home (%)	55	54	44	0.20

4.1 Changes in stated residential search priorities (pre-move survey)

The pre-move survey asked respondents to prioritize how important they thought different characteristics of a house and neighborhood were, on a 5-point scale, including characteristics organized into four categories: the physical characteristics of the house, transportation accessibility by different modes, proximity to social network and activities, and non-transport neighborhood aspects. We estimated the effect of the visualization and focalism interventions by comparing respondent scores before and after the interventions; that is, respondent answers within the same pre-move survey, the first answers taken at the beginning of the survey and the second set of identical questions asked again near the end of the pre-

[1] 7 (5%) out of 140 respondents in the visualization treatment group, 4 (3%) of 140 respondents in the focalism treatment group, and 4 (4%) of 89 respondents in the control group did not complete the full pre-move survey and were excluded from analysis.

move survey ("Priorities" box in Figure 1, rating on characteristics in Table 1). For the control group we asked the set of questions twice, near the beginning and end, but without an intervention treatment. We used paired t-tests to determine whether changes were significant, and the results are reported in Table 3. For the control group, there were no statistically significant differences in priority scores for residential search criteria before and after moving, as expected. For the focalism treatment group, there were significant changes in priority scores for all four aspects of home/neighborhood characteristics. For the visualization treatment group, there were significant changes in the priority scores given to transportation accessibility but not for the other three categories (housing characteristics, proximity, and neighborhood amenities). These are only stated priorities, but they suggest that the interventions, particularly the focalism treatment, may nudge respondents towards more sustainable residential location choices.

Table 3: Changes in average priority scores before and after the interventions and paired t-test for testing significant shifts (sample size: 354).

Overall aspect	Visualization		Focalism		Control	
	Trend	p-value	Trend	p-value	Trend	p-value
Physical aspects of house	-	0.80	↓	0.08	-	0.11
Multimodal transportation accessibility	↑	**0.01**	↑↑	**<0.01**	-	0.37
Proximity to social network and activities	-	0.25	↑	0.03	-	0.50
Non-transport neighborhood aspects	-	0.49	↓	0.05	-	0.21

We can dig deeper into the visualization statistics, because we asked these respondents open-ended questions to describe factors in their lives they planned to change when moving. We later coded these responses to open-ended questions, and the summary of the responses are shown in Table 4. Among 133 respondents in the visualization treatment group, only two stated that they wanted improvements in physical housing characteristics, such as a larger house; 77 said they wanted better transportation accessibility; 83 wanted to be closer to social networks and activities; and nine described wanting a better neighborhood. The fact that the accessibility and proximity responses were so common was likely because we prompted respondents specifically about accessibility and proximity. In the accessibility aspect, respondents most commonly reported that they wanted to cycle, walk and take transit more to work, and have better access to transit systems, sidewalks, bike lanes and parking spaces. In the proximity aspect, respondents most commonly reported wanting better access to friends, stores, and recreational activities.

Table 4: Number of visualization treatment group respondents who stated they were seeking changes in specific items in the open-ended questions (sample size: 133).

	No. of respondents
Physical aspects of house	
Size of house	2
Quality of bathrooms	1
Overall	2
Multimodal transportation accessibility	
Easy to park	20
Easy to use transit to work, shopping or other locations	31
Easy to use car-sharing to work, shopping or other locations	2
Easy to walk to work, shopping or other locations	34
Easy to bicycle to work, shopping or other locations	30
Overall	77
Proximity to social network and activities	
Close to family (including partner you don't live with)	7
Close to work	11
Close to friends	25
Close to children school	3
Close to stores (including grocery)	23
Close to recreational activities and other frequently visited places	55
Overall	83
Non-transport neighborhood aspects	
Low crime neighborhood	1
Quiet, clean neighborhood	4
Good neighborhood to raise children	1
Know people in neighborhood	1
Overall	9

For each of the four aspects of home/neighborhood characteristics, we separated the respondents from the visualization group into two sub-groups. One group of respondents expressed some interest in changing home/neighborhood characteristics, while the other group did not. We then used a paired t-test to determine whether the intervention had different effects on the two sub-groups (Table 5). The only significant effect was an increase in the priority ratings for accessibility—and only for those who expressed an interest in changing transport accessibility, as one would expect.

Table 5: Search criteria priority changes for visualization treatment groups, by self-reported interest in changing lifestyle (sample size: 133).

Overall aspect	Interest in changing			No interest in changing		
	N	Trend	p-value	N	Trend	p-value
Physical aspects of house	2	-	1.00	131	-	0.90
Multimodal transportation accessibility	77	↑	**0.02**	56	-	0.21
Proximity to social network and activities	83	-	0.32	50	-	0.59
Non-transport neighborhood aspects	9	-	0.19	124	-	0.80

We can also dig deeper into the focalism statistics, because some of the respondents' housing priorities matched the aspects they felt important for their well-being and some did not. Among the 136 respondents who were assigned the focalism intervention, 108 did not match. In this "non-matching" subgroup we expected search criteria priority scores to change after the intervention, if the intervention was successful. And indeed, we found that priorities for all four categories showed significant changes for the "don't match" group, whereas the "match" group did not show significant changes, as reported in Table 6. That is, respondents who felt the factors they initially prioritized when choosing a new residence did not match the factors that influenced their well-being *changed* how they reported their priorities after the focalism intervention. This suggests that the focalism intervention was successful in at least temporarily changing how respondents would search for a new place to live.

Table 6: Changes and paired t-test results for the two focalism interventions groups (sample size: 136).

Overall aspect	Don't match (N=108)		Match (N=28)	
	Trend	p-value	Trend	p-value
Physical aspects of house	↓	0.05	-	1.00
Multimodal transportation accessibility	↑	<0.01	-	0.43
Proximity to social network and activities	↑	0.10	-	0.18
Non-transport neighborhood aspects	↓	<0.01	-	0.43

We also explored how and whether the focalism and visualization treatments affected demographic groups differently. To do so we conducted multivariate analysis with the pre-move survey only (we could not do so with the post-move survey due to loss in sample size). We analyzed the influences on the interventions on how people changed their prioritization of accessibility only, since that was the only aspect significantly influenced on aggregate by both interventions. We used a multinomial logit (MNL) model, in which the dependent variable, change in prioritizing transport accessibility, was specified in three categories: negative change (decreasing), no change, and positive change (increasing). The utility functions for respondent n are expressed as follows:

$$\begin{aligned} U_n(negative\ change) &= \boldsymbol{\beta}^{-}\boldsymbol{x}_n + \varepsilon_n^{-} \\ U_n(no\ change) &= \boldsymbol{\beta}^{0}\boldsymbol{x}_n + \varepsilon_n^{0} \\ U_n(positive\ change) &= \qquad\quad + \varepsilon_n^{+} \end{aligned}$$

where $\boldsymbol{x}_n$ is a vector of explanatory variables for the respondent, $\boldsymbol{\beta}^{-}$ and $\boldsymbol{\beta}^{0}$ are the corresponding coefficients (with positive change serving as the base alternative), and ε_n^{-}, ε_n^{0}, and ε_n^{+} are the i.i.d. Extreme Value errors. The explanatory variables in the final specification are defined in Table 7 and contain two dummy variables for the two intervention types, socio-demographics and interaction between intervention types and socio-demographics. Additional variables were tested but were not significant and therefore not included in Tables 7 or 8. These include gender, having children, owning a house, level of education, and the sub-groups of the two intervention types (change, no change for visualization; and match, do not match for focalism).

Table 7: Definitions and summary statistics of variables included the model presented in Table 8 (sample size: 354).

Variable	Definition	N
DEPENDENT VARIABLES		
Negative change	Dummy variable that equals 1 when the priority score for overall transportation accessibility aspect decreases.	49
Positive change	Dummy variable that equals 1 when the priority score for overall transportation accessibility aspect increases.	107
No change	Dummy variable that equals 1 when the priority score for overall transportation accessibility aspect does not change.	198
EXPLANATORY VARIABLES		
i. Intervention types		
Visualization	Dummy variable that equals 1 when the respondent is from the visualization group.	133
Focalism	Dummy variable that equals 1 when the respondent is from the focalism group.	136
ii. Age		
Age<26	Dummy variable that equals 1 when the respondent is younger than 26 years old.	147
26≤Age<35	Dummy variable that equals 1 when the respondent is between 26 and 35 years old	124
Age≥35	Dummy variable that equals 1 when the respondent is more than 35 years old	83
iii. Marital status		
Single	Dummy variable that equals 1 when the respondent is single.	88
iv. Commute modes		
Drive to work	Dummy variable that equals 1 when the respondent usually drives to work.	277
Transit to work	Dummy variable that equals 1 when the respondent usually takes public transport to work.	213
Walk to work	Dummy variable that equals 1 when the respondent usually walks to work.	142

We started out testing each of these variables for analyzing the effect of our interventions on respondents' priority scores. Setting the base at positive change (when respondents increase the priority score for multimodal transportation accessibility aspect, after our intervention), we estimated the values for negative change (when respondents decrease the priority score for multimodal transportation accessibility aspect, after our intervention) and no change (when respondents did not change the priority score for multimodal transportation accessibility aspect, after our intervention. The final results of the model are presented in Table 8.

Table 8: Model results for priority changes in 'multimodal transportation accessibility' aspect (sample size: 354).

Variables	Negative change (relative to positive change)		No change (relative to positive change)	
	Estimates	P-value	Estimates	P-value
Visualization (N=133)	-0.19	0.85	**1.11**	**0.09**
Focalism (N=136)	**-2.91**	**0.03**	**1.39**	**0.10**
Control	1.23	0.22	**1.96**	**0.01**
26≤Age<35	0.34	0.68	0.06	0.91
26≤Age<35 × Visualization	-0.13	0.85	0.61	0.21
26≤Age<35 × Focalism	1.56	0.30	-0.83	0.39
Age≥35	-1.43	0.18	-0.49	0.49
Age≥35 × Visualization	**2.32**	**0.04**	0.49	0.55
Age≥35 × Focalism	**5.01**	**0.01**	1.43	0.25
Single	-1.33	0.12	-0.80	0.19
Single× Visualization	0.25	0.85	1.18	0.14
Single× Focalism	**3.30**	**0.01**	0.83	0.37
Drive to work	0.48	0.31	-0.46	0.15
Transit to work	-0.52	0.19	-0.14	0.61
Walk to work	-0.22	0.58	**-0.49**	**0.07**

We find that the no change intercepts (coefficient values of 1.11, 1.39 and 1.96) are positive and significant, which is not surprising as the most common outcome was that respondents did not change their priority ranking. For the focalism intervention, the negative change utility parameter is significant (coefficient of -2.91). This indicates the focalism was overall more effective in intervening the respondents' choices, which also matches the results of our aggregate analysis. In terms of demographic effects, we observe that older people and single people are less likely to follow our intended nudge (coefficients of 2.32, 5.01, 3.03), and in fact are nudged towards *lowering* their priority of transportation aspects. Among the three commute modes, respondents who walk to work tend to increase their priority score for transportation aspects after our intervention (coefficient of -0.49).

4.2. Changes in commute time, travel mode and well-being (post-move survey)

A total of 184 people moved after the first survey and completed the second survey. An additional 37 stated they had not moved. The remaining initial respondents did not reply to the invitation to complete the second survey. There were no statistically significant differences in responses of the 184 known movers and 37 non-movers. Of the group of non-respondents, it is unknown which fraction did not reply to the survey because they had not moved in the interim. The second survey was identical for all respondents, making no mention of the interventions that some respondents had been subject to. Of those subjects who completed the second survey, 59 had been in the visualization treatment group in the first survey, 81 in the focalism treatment group, and 44 in the control group.

Our analysis concentrates on changes in commute time and travel mode among these groups. For commute time the analysis was restricted to workers: 50 for the visualization treatment group, 70 for the focalism group and 38 for the control group. First we compared the stated weekly time spent on commuting as provided in the pre- and post-move survey. We analyzed whether the aggregate change in travel time to work varied across treatment groups using a paired t-test at 90% level of significance

(Table 9). While the classical residential location choice model would suggest that people would generally try to move closer to their workplaces, we found statistical significance of this only for our focalism group. Those in the visualization treatment group and in the control group had no significant change.

Table 9: Change in hours spent commuting (per week) before and after change in residence (limited to workers only) (sample size: 158).

Activity	Visualization (N=50)			Focalism (N=70)			Control (N=38)		
	Pre-move (hours)	Post-move (hours)	p-value	Pre-move (hours)	Post-move (hours)	p-value	Pre-move (hours)	Post-move (hours)	p-value
Commute (workers)	7.12	6.98	0.34	7.24	6.49	**0.02**	6.42	6.48	0.96

Note: P-value from paired t-tests within each group

Next we looked at changes in the travel modes that people reported taking for work; trips to restaurants, shopping and services; and trips to visit family and friends. We categorized the modes into three separate groups: a) Cycling and walking (active travel); b) Drive alone and motorcycle; and c) Carpool, car-share and public transit (sustainable motorized travel), and calculated changes using Chi-square tests (Table 10). Again, the only significant changes were among respondents in the focalism treatment group, in which there was an increase in the use of active travel and sustainable motorized travel. Since the focalism intervention pointed out the cognitive bias that people have towards certain aspects of the house, the intention was to make people realize the importance of an active lifestyle and time management with overall well-being. The results for the visualization intervention also showed a change in the direction of our expectation for all three mode groups, but not to statistically significant levels. As expected, the control group showed the least change with very low statistical significance.

In addition to changes in healthy and sustainable travel, we are also interested in the effect of the interventions on well-being. In both the pre- and post-move surveys, respondents rated their level of happiness on a 6-point scale from delighted (6) to terrible (1). For analysis of these responses, paired t-tests were done within each treatment group to test within-individual changes for statistical significance. In addition, we conducted two-sample t-tests to test whether average changes in well-being in the treatment groups were statistically distinguishable from changes in well-being in the control group (Table 11).

We found that the visualization treatment group had a statistically significant increase in reported well-being (at the 90% confidence level), while the focalism and control groups had no statistically significant change. (The positive shift in well-being among visualization treatment group respondents was also statistically significantly larger than the small change in the other two groups (at p-value<0.01), while the change in well-being in the focalism treatment group and the control group were not significantly different from each other (p-value=0.19).) The success of the visualization treatment in increasing well-being could be attributed to the fact that the visualization intervention was kept more open-ended than the focalism intervention. This may have given more room to respondents to introspect relevant aspects of their lifestyles before moving.

Table 10: Change in number of people taking different modes for various daily activities (sample size: 184).

VISUALIZATION (N=59)									
	Bike, Walk, Bike-share			Drive Alone, Motorcycle			Carpool, Car-share, Public transit		
	Pre-move	Post-move	p-value	Pre-move	Post-move	p-value	Pre-move	Post-move	p-value
Work commute (limited to workers, N=50)	19	24	0.31	31	27	0.42	18	22	0.41
Visit to shopping, services, restaurants	19	23	0.45	31	27	0.46	45	40	0.49
Trips to visit family, friends etc.	24	26	0.71	26	23	0.57	37	31	0.40
FOCALISM (N=81)									
	Bike, Walk, Bike-share			Drive Alone, Motorcycle			Carpool, Car-share, Public transit		
	Pre-move	Post-move	p-value	Pre-move	Post-move	p-value	Pre-move	Post-move	p-value
Work commute (limited to workers, N=70)	27	39	**0.04**	44	36	0.17	23	32	**0.10**
Visit to shopping, services, restaurants	21	31	**0.09**	49	37	**0.06**	28	35	0.25
Trips to visit family, friends etc.	38	52	**0.04**	42	28	**0.03**	17	26	**0.10**
CONTROL (N=44)									
	Bike, Walk, Bike-share			Drive Alone, Motorcycle			Carpool, Car-share, Public transit		
	Pre-move	Post-move	p-value	Pre-move	Post-move	p-value	Pre-move	Post-move	p-value
Work commute (limited to workers, N=38)	21	22	0.82	16	17	0.81	11	12	0.80
Visit to shopping, services, restaurants	19	20	0.83	21	20	0.83	9	8	0.79
Trips to visit family, friends etc.	18	19	0.83	16	16	1.00	10	10	1.00

Table 11: Change in level of happiness in pre-move and post-move surveys. Happiness is coded from 6 (delighted) to 1 (terrible) (sample size: 184).

Level (score)	Visualization (N=59)			Focalism (N=81)			Control (N=44)		
	Pre-move	Post-move	p-value	Pre-move	Post-move	p-value	Pre-move	Post-move	p-value
Delighted (6)	7%	21%	**0.01**	10%	14%	0.18	8%	7%	0.98
Pleased (5)	29%	38%		20%	24%		20%	18%	
Mostly Satisfied (4)	27%	29%		31%	12%		22%	23%	
Mixed (3)	13%	10%		19%	38%		24%	27%	
Unhappy (2)	12%	1%		12%	9%		19%	18%	
Terrible (1)	12%	1%		8%	3%		5%	7%	
Average score	3.69	4.63		3.68	3.79		3.57	3.57	

5. Conclusions

This study validates the potential of the focalism and visualization interventions in nudging people towards residential choices that are not only sustainable but also make them happier. The interventions had statistically significant impacts on both stated residential location criteria prior to moving, and upon the post-move outcomes, relative to our control group.

While the individuals assigned to the focalism intervention were more likely to reduce their commute time and use more active and sustainable modes than those assigned to the visualization intervention, the visualization group had a statistically significant increase in stated well-being compared to the focalism group. The control group showed no statistically significant change on these measures. The focalism intervention was designed to override people's cognitive bias towards the immediate physical features of a residence. Respondents assigned to the focalism intervention were apparently nudged towards locations that reduced their commute times and increased their use of active and sustainable modes. The visualization intervention was designed in a way to give the respondents an opportunity to reflect on what they felt was missing from their home and neighborhood. While the changes in travel times were not found to be significant for the people assigned to the visualization intervention, it does appear to have nudged them to move to places that increased their happiness.

The results from this study may have broad reach since the interventions are inexpensive relative to other methods used to change people's travel or residential behavior, such as transit subsidies. It is worth considering how such a method could be adopted by planning organizations to inform household residential choices. This research approach could further be expanded to a mobile app-based study in which respondent travel patterns are mapped using GPS data to more accurately observe changes in travel behavior. The study also provides additional evidence of the benefits of incorporating ideas from the psychological literature to nudge transport and land use decisions towards more sustainable, active, and happier lives.

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