Transportation (2006) 33:447–462
DOI 10.1007/s11116-006-8075-y

RESEARCH ARTICLE

On altruists and egoists in activity participation and travel: who are they and do they live together?

Konstadinos G. Goulias · Kriste M. Henson

Abstract Formulation and specification of activity analysis models require better understanding of time allocation behavior that goes beyond the more recent within household analyses to understand selfish and altruistic behavior and how this relates to travel behavior. Using data from 1,471 persons in a recent 2-day time use/activity diary and latent class cluster analysis we identify 11 distinct daily behaviors that span from the intensely self-serving to intensely altruistic. Predicted cluster membership is then used to study within household interactions. The analysis shows strong correlation exists between social role and patterns of altruistic behavior. However, a substantial amount of heterogeneity is also found within social roles. In addition, travel behavior is also very different among altruistic and self-serving time allocation groups. At the household level, a substantial number of households contain persons with similar behavior. Another group of households contains a mix of self-serving and altruistic persons that follow specialized household roles within their households. The majority of households, however, are populated by altruistic persons. Single person households are more likely to be in the self-serving groups but not in their entirety. Altruism at home is directed most often toward the immediate family members. This is less pronounced when we examine altruistic acts outside the home.

Keywords Altruism · Social role · Time allocation · Time use · Human interaction · Travel behavior · Activity analysis

K. G. Goulias (✉)
Department of Geography, University of California at Santa Barbara (UCSB), 3611 Ellison Hall, Santa Barbara, CA 93106, USA
e-mail: Goulias@geog.ucsb.edu

K. M. Henson
Decision Applications Division, UCSB Geography & Los Alamos National Laboratory, P. O. Box 1663, MS F604, Los Alamos, NM 87545, USA

Introduction

Altruism—*the unselfish action for the welfare of others without regard for one's self*—is an equal partner characteristic of human nature with its contrasting ''egoism''—*the regard for one's own interest.* Although altruism and helping others is claimed to have its origins in the classic times (Gill et al. 1998), more recently, Wilson (1975) and Simon (1990), claimed convincingly that both altruism and egoism are equal and important considerations in determining social choice; they are inseparable when studying human behavior, and they are both consistent with natural selection. More current research in human motivations for action continues contradicting *ego* as the only fundamental tenet underlying human beliefs, attitudes, intentions, and behavior. It is worth noting here that altruism in the form of reciprocity can be divided into weak reciprocity—help given to others that in turn will become a benefit to self as a long term return and strong reciprocity that Gintis et al. (2003) defined as the ''*predisposition to cooperate with others and to punish those who violate norms of cooperation at personal cost...*''. Experimental evidence also shows these behaviors to be stable from an evolutionary viewpoint confirming claims by Simon and Wilson. A summary and synthesis supporting the co-existence of selfishness and altruism is offered from both an experimental economics and anthropology viewpoints in Henrich et al. (2004) extending the results from past experiments to a wide variety of cultural contexts.

McLean's neuroscientific concept of a triune brain claims that our brain developed in stages (see http://www.ezls.fb12.uni-siegen.de/mkroedel/paul_maclean.html—accessed July 2005). First are its proto-reptilian origins and the birth of our fundamental drive for survival offering an explanation of our biological ego. Then, a subsequent development of the paleo-mammalian complex gave origin and strength to a biological explanation of empathy in humans. Cory (1999), explains that balance between the two parts of our brain occurs in the neocortex neo-mammalian complex (frontal cortex of the brain). This ''triad'' composed of the empathetic, egoistic, and balancing functions are the foundations of a triune—consisting of or being three in one—human nature. Everyday actions are the result of an ongoing conflict between the ego and empathy in a dynamic resolution in the neocortex.

Departing from these considerations, Hayes and Lynne (2004) integrate these ideas into the hypothesis of *Ego n' Empathy*, offering important links to the philosophy of science and economics. A new analytical apparatus also emerges from these considerations to close the gap left by most micro-economic applications, which leave out of their utility-based methodology the empathetic nature of humans. Lynne (2000) moving along these lines of thought develops a parsimonious theory called *metaeconomics* that adds *the (human) will* as the integrative and balancing vehicle between egoism and altruism.

Travel behavior analysts are also starting to become aware of altruism as a potentially powerful determinant of travel behavior (Hunecke et al. 2001) and most importantly as a motivator in changing travel behavior (Seethaler and Rose 2003; Seethaler 2004; Taniguchi et al. 2004). Key in understanding the policy potential in changing travel behavior, however, is to also understand a more direct ''footprint'' of values, such as altruistic and self-serving behavior, on every day life. There are at least two sides in this potential: (a) understand altruism as a value to use in motivating people to move toward the common good such as purchasing clean fuel

cars and use environmentally friendly modes; and (b) understand altruism expressed in specific activity and travel behaviors. The latter is also particularly important when we focus on social interactions and a variety of relations including reciprocity. In fact, social interactions should be the core of activity-based approaches to travel demand forecasting.

As activity-based approaches mature, their model formulations begin to also consider interactions among persons within the generally implied but not well defined domains of social networks (Axhausen 2003). The most recent examples that include within-household interactions in activity participation can be found in Scott and Kanaroglou (2002); Gliebe and Koppelman (2002); Zhang et al. (2005); and Pribyl and Goulias (2005). These studies and their models, however, are limited to within household interactions. Presently, most operational activity-based models do not include the effects of altruistic values on within or outside the household interactions in the scheduling process. Only a handful either incorporate or are in the process of adding the capability to model intra-household scheduling, mostly in the form of ride sharing. These include Bhat et al. (2003); Salvini and Miller (2003); Pendyala et al. (2005); and Vovsha et al. (2003).

These models are still based (in explicit and implicit ways) on the single ego-motivated decision maker assumption (presumably inspired by the Bentham-Becker framework; see Pollak (1999) and Jara-Diaz (2003), and suffer from the superficial treatment/accounting of human interactions that does not address values. Although modeling these interactions explains habits and variability in activity and travel behavior in a more comprehensive way (than past utility-based models by incorporating travel with other persons), it does not explain the motivation underlying human interactions, does not describe patterns of interactions that happen outside the household, and does not contain sufficient information to explain variation in activity and travel behavior by addressing core aspects of human nature.

Goulias and Kim (in press) offered an alternate perspective about these interactions by examining the answers in a 2-day activity diary of 1,471 persons in Pennsylvania. Their data include the information *with whom* and *for whom* each activity was pursued. Answers to *for whom* an activity was pursued are used to derive altruistic behavior and perform additional analysis in this paper. It should also be noted that contrary to the majority of others datasets, our sample (named the CentreSIM sample) also includes children of all ages. In this paper *Altruism* is defined using an action-based perspective such as: *Altruistic* persons pursue activities and travel for others. *Self-serving*persons (called *selfish* for brevity herein) pursue activities and travel for themselves. It should also be mentioned this is a ''stated'' altruistic or self-serving behavior as reported by the respondents in the survey. We use the CentreSIM dataset to answer a few key questions such as:

- What are some basic types of individual activity and travel behavior when considering altruism?
- Are there clear patterns of different types of individual altruistic behaviors?
- Are there clear patterns of household orientations toward altruism and selfishness?
- Which households contain a mix of altruists and egoists?
- Are there households that are heavily altruistic or the opposite?

The next section describes the dataset used here. Then, a few patterns of behavior are derived using latent class cluster analysis and each individual is classified by her/his pattern. This is followed by a summary and description of a within household enumeration of the presence of these patterns. The paper concludes with a summary and discussion.

The data used here

The CentreSIM dataset is from a household and activity diary survey that covers all of Centre County, which had 135,940 residents in 2001. It also includes residents that work in Centre County and reside elsewhere. Each participating household provided voluntarily information about household composition and facilities available to the household members. In addition, each household member also reported personal information such as employment, driving ability, education and so forth. The survey also included a few questions about opinions and perceptions regarding the Centre County transportation system. Each person in the household provided a 2-day complete record of the activities, which included the different transportation options selected. The sampling frame is a combination of several pools. These include a database of 46,448 household addresses in Centre County purchased from a commercial mailing list vendor in early October 2002, student address lists available through Penn State University (PSU), and a list of University Park Campus employees of PSU who reside outside of Centre County. From this pool, 8,925 households were randomly selected for recruitment in the mail back household questionnaire (including a variety of demographic and social/economic questions). Of the responding households, 2,537 agreed to participate in the activity diary component.

After data cleaning and verification, 1,471 persons (from 718 households) were selected for the analysis in this paper. Table 1 shows the number of persons, households, and relevant social and demographic characteristics of the sample. A substantial amount of retired persons and school-age children are present in this sample. On one hand this is a positive fact because we can account and model the behavior of persons that are not included in other surveys. It is also a complicating factor for pattern identification due to their very diverse behavior (see the standard deviations in bottom half of Table 1). Activity types were reported using an open-ended format and details about activity classification and taxonomy can be found in Goulias and Kim (2005). As Table 1 shows travel consumes only about 6.25% of the total 48 h documented but a large part of this is for self-serving reasons. Travel for relatives takes slightly more time than travel for others. Time allocation to activities shows the lion's share dedicated to one's self; this includes sleeping time. However, time spent performing activities dedicated to others is 9.79% of the 48 h and it is larger than time dedicated to family, which is 9.17% of the 48 h. The substantial amount of time for unknown persons motivates also the inclusion of these variables in the analysis that follows.

Methods and patterns

The technique selected to identify groups of homogeneous patterns of activity and travel behavior is *latent class cluster analysis (LCCA)*. This technique is described in

Table 1 A selection of person sample characteristics

Characteristics	CentreSIM Sample (%)
Number of persons in the sample	1471
Number of households in the sample	718
Percent of males in the sample	720 (48.9)
Number of retired persons in the sample	244 (16.9%)
Number of employed (≥40 h per week) persons in the sample	575 (39.8%)
Number of employed (<40 h per week) persons in the sample	129 (8.9%)
College/university students persons in the sample	148 (10.2%)
Grades 7–12 persons in the sample	85 (5.9%)
Grades K-6 persons in the sample	84 (5.8%)
Pre-school or day care persons in the sample	32 (2.2)
Average number of trips in 2 days per person (standard deviation)	
For self	5.5 (4.2)
For relatives	2.0 (3.0)
For others	0.9 (2.1)
For unknown	0.5 (1.6)
Average number of activities (excluding trips) in 2 days per person (standard deviation)	
For self	16.5 (7.9)
For relatives	3.6 (4.9)
For others	1.8 (2.6)
For unknown	1.4 (3.9)
Average amount of time traveling in 2 days per person in hours (standard deviation)	
For self	1.7 (1.7)
For relatives	0.6 (1.3)
For others	0.5 (1.6)
For unknown	0.2 (0.6)
Average amount of time in activities (excluding travel) in 2 days per person in hours (standard deviation)	
For self	32.3 (11.5)
For relatives	4.4 (6.0)
For others	4.7 (6.5)
For unknown	3.6 (9.7)

Vermunt and Magidson (2002) and we used it in a few recent studies including Goulias and Kim (in press) and Goulias et al. (2003). In summary LCCA: (a) includes a J-category latent variable with each category representing a cluster; (b) uses many ''dependent'' or clustering variables (named *criteria* variables herein); (c) uses a mixture of multiple types of criteria variables (e.g., continuous, categorical, ordered, count); (d) uses and tests the effect of covariates of many different types; (e) is more flexible than many other clustering algorithms; (f) is a model-based clustering approach and it provides probabilistic membership of observations in clusters; and (g) provides convenient interpretable output.

Person-based analysis

In the first part of this analysis, we use the 16 variables from the bottom half of Table 1 as the criteria variables for pattern recognition. These variables are divided into two types of variables. Half are episode frequencies, which are count data (taking values 0, 1, 2, and so forth with each number representing an episode—trip or activity). The remaining eight variables, representing the amount of time to activities or travel, are continuous with large number of observations at the value of zero and thus treated as censored. Table 2 and Fig. 1 provide a summary of the

Table 2 The 11 clusters and their within cluster characteristics

		EGO medium	EGO high	EGO traveler	ALTER family	ALTER medium	ALTER low	ALTER high	ALTER other	SECretive	Very SEcretive	ALTER confused
Indicators	Cluster size	0.1597	0.1514	0.1241	0.118	0.1176	0.0874	0.0578	0.0554	0.052	0.0416	0.035
Average number	For self	21.52	21.38	18.94	13.89	15.67	17.51	13.10	14.32	8.33	0.54	12.00
of activities	For relatives	3.63	0.22	0.20	12.08	4.36	1.91	7.63	1.01	0.85	0.10	9.45
in 2 days	For others	0.52	0.07	2.88	1.00	3.79	1.58	4.77	5.91	0.86	0.64	0.57
per person	For unknown	0.03	0.07	0.05	0.06	0.02	2.07	0.53	0.14	7.50	15.54	3.51
Average amount	For self	40.75	45.90	36.24	27.15	27.80	33.63	24.42	29.14	19.70	1.22	23.15
of time in activities*	For relatives	4.41	0.15	0.23	15.46	4.39	2.53	8.94	1.33	1.69	0.10	13.45
in 2 days per	For others	0.59	0.06	8.17	2.60	12.93	4.27	9.25	10.99	2.78	2.64	0.94
person in hours	For unknown	0.11	0.16	0.13	0.13	0.11	5.00	2.17	0.32	20.94	41.66	7.59
Average number	For self	4.89	6.33	9.01	3.00	6.56	8.23	3.83	5.00	3.82	0.43	3.27
of trips	For relatives	2.83	0.10	0.02	5.50	2.13	0.89	5.22	0.43	0.70	0.23	5.88
in 2 days	For others	0.24	0.00	0.83	0.17	0.75	0.71	3.63	5.84	0.68	0.20	0.19
per person	For unknown	0.05	0.10	0.05	0.05	0.12	0.58	0.01	0.11	1.66	6.41	0.99
Average amount	For self	1.49	1.79	3.36	0.86	2.05	2.29	1.02	1.61	1.93	0.11	0.83
of time traveling	For relatives	0.82	0.02	0.00	2.22	0.62	0.36	1.57	0.17	0.15	0.04	2.26
in 2 days per	For others	0.07	0.00	0.28	0.04	0.23	0.18	1.38	5.02	0.59	0.04	0.04
person in hours	For unknown	0.02	0.01	0.01	0.02	0.04	0.18	0.00	0.04	0.77	2.15	0.24

*Excluding travel

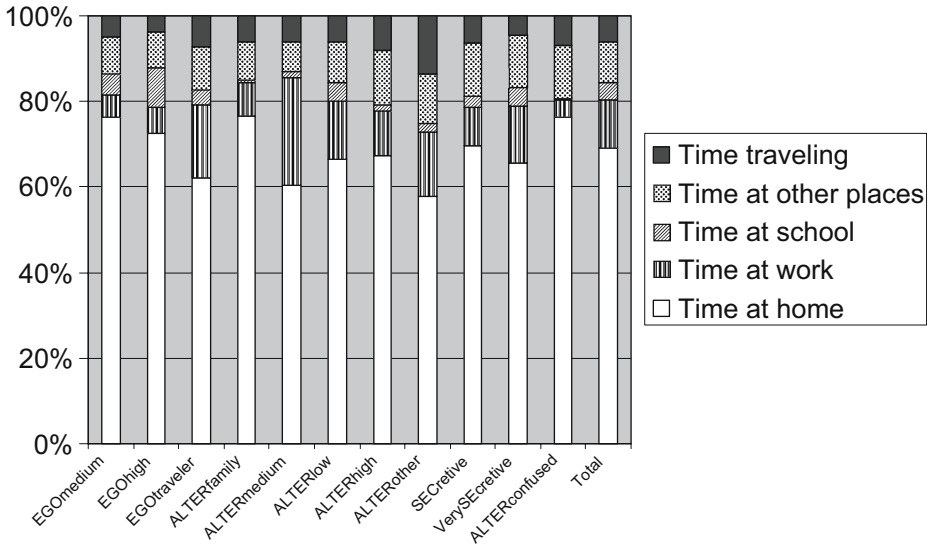

Fig. 1 Proportions of time allocated to activities and travel by each of the 11 clusters

latent class cluster analysis. There are at least 11 distinct patterns of activity and travel behavior.

In the first group of approximately 16% of the sample, cluster members allocate a moderate to low amount of time to relatives (3.6 h in 2 days) and they make more than one trip per day for relatives. We name this group *EGOmedium*. The second group of people contains a little over 15% of the sample. Its members allocate on average approximately 46 h to activities for themselves and another 1.8 h traveling for themselves leaving very little time for anybody else. We name this group *EGOhigh*. The third cluster (12.4% of the sample) allocates a very small amount of time to relatives and a little more for others. Although this group is similar to *EGOmedium* and *EGOhigh* its members travel the most for themselves in terms of time allocated to travel (3.4 h in 2 days) and frequency of trips. We name this group *EGOtraveler*.

The next five clusters are more altruistic in allocating time for relatives or others or both. In the fourth cluster (11.8% of the sample) almost 18 h in 2 days are allocated in activities and travel for relatives. We named this cluster *ALTERfamily*. In the fifth group (also 11.8% of the sample) we find members that dedicate in 2 days an average of 13 h for non-relatives in activities but very little traveling for others. We name this group *ALTERmedium*. The next group contains 8.7% of the sample; its members dedicate a substantial amount of time for relatives and others but less than all the other altruistic groups. For this reason we give this group the name *ALTERlow*. The seventh cluster (5.8% of the sample) is populated by persons that allocated the most time to others and relatives. Therefore, they are called *ALTERhigh*. The members of cluster 8 (5.5% of the sample) allocate a substantial amount of time for others; we name this group *ALTERother*.

In the last three groups we find members that had many activities for which they did not tell us with whom each activity was pursued. We named the ninth and tenth clusters *Secretive* and *VerySecretive* because of the large amount of time for which

they could not or did not want to declare for whom they pursued activities. The last group with a substantial amount of time dedicated to activities for relatives, shows about 7.6 h for unknown and for this reason named *ALTERconfused*. Figure 1 provides a summary of the 11 cluster behaviors using the time allocated to activities and travel proportions.

The CentreSIM questionnaire includes a question about the social role of each individual respondent. Using the categories in the social role and the predicted membership in each cluster we derive the contents of Table 3. All the groups that we would expect needing attention focused on themselves exhibit a self-serving behavior in their everyday life. For example children at home show the highest proportion of membership in the *EGOhigh* and *EGOmedium* groups. Similar behavior is also found for pre-school/daycare children and children of grades K-6 (between 5 and 12 years old). Gaining freedom of movement and the need to be at different places than home and school as children grow older is also directly reflected in these patterns as children in grades 7–12 (between 12 and 18 years old) show higher proportion in the *EGOtraveler* group than their younger counterparts. University students as expected show an even higher proportion of membership in this higher mobility group but also a tendency to be even more self-serving. Part-time and full-time persons show a wide spread among all clusters. Surprisingly, full-time workers are as altruistic in their time allocation (if not even more than) part-time workers. This is verified later when we examine the household interactions. It is also interesting to note the higher proportion of persons that did not declare for whom activities and travel were performed. They are those looking for work, retired, disabled, and university students. This may be due to the presence of disenfranchised individuals but also the possible failure of our survey in establishing a relationship with these groups.

Using the Chi-Squared Automatic Interaction Detection (CHAID) and a tree based segmentation technique we identify the most significant predictors for the 11 clusters using social and demographic data in our sample. In this version of CHAID we use the algorithm by Magidson and Vermunt (2005) for multiple dependent variables. The variables used as predictors are age, gender, education, employment, marital status, annual household income, and the presence of children and adults in the household. We also used variables describing the ownership and characteristics of the person's residence. As expected the three most important variables are social role, marital status, and gender. Figure 2 shows the segmentation tree. The very young children (child at home, child at day care, and K-6) have in essence indistinguishable membership patterns of altruistic and self-serving behavior. This is an indication of similar needs and patterns in focusing to themselves and been cared for. Indistinguishable are also cluster memberships of persons looking for work, retired, and the disabled. All the other social role groups have their own distinct cluster memberships. Significant differences are found within the full-time working group between the married and unmarried individuals. From among the group looking for work, retired, and disabled we find four significantly different groups (male married, male unmarried, female married, and female unmarried).

Household-based analysis

We turn now to the household level analysis and examine within household interactions. For each person in the sample, we use the predicted cluster membership as discussed in the previous section. Then, we assemble the persons from the same

Table 3 Social role and cluster membership (cells contain counts and in parentheses are raw percentages)

Social Role	EGO medium	EGO high	EGO traveler	ALTER family	ALTER medium	ALTER low	ALTER high	ALTER other	Secretive	Very SEcretive	ALTER confused	Total
Child at home	23 (45)	18 (35)	0 (0)	3 (6)	1 (2)	2 (4)	0 (0)	0 (0)	2 (4)	0 (0)	2 (4)	51
Home duties	11 (17)	2 (3)	1 (2)	31 (47)	0 (0)	6 (9)	5 (8)	1 (2)	2 (3)	0 (0)	7 (11)	66
Look For work	4 (25)	2 (13)	3 (19)	2 (13)	0 (0)	0 (0)	0 (0)	1 (6)	2 (13)	1 (6)	1 (6)	16
Retired	55 (23)	37 (15)	19 (8)	30 (12)	13 (5)	25 (10)	12 (5)	7 (3)	20 (8)	10 (4)	16 (7)	244
Disabled	2 (13)	3 (20)	2 (13)	3 (20)	0 (0)	1 (7)	0 (0)	0 (0)	4 (27)	0 (0)	0 (0)	15
Pre-school or day care	13 (41)	8 (25)	0 (0)	5 (16)	0 (0)	2 (6)	1 (3)	1 (3)	2 (6)	0 (0)	0 (0)	32
Grades K-6	32 (38)	26 (31)	2 (2)	10 (12)	3 (4)	3 (4)	2 (2)	3 (4)	2 (2)	1 (1)	0 (0)	84
Grades 7–12	14 (16)	31 (36)	12 (14)	0 (0)	7 (8)	8 (9)	2 (2)	5 (6)	1 (1)	4 (5)	1 (1)	85
College/university	5 (3)	36 (24)	46 (31)	5 (3)	3 (2)	14 (9)	3 (2)	8 (5)	9 (6)	17 (11)	2 (1)	148
Part-time (<40 h/week)	16 (12)	16 (12)	11 (9)	23 (18)	23 (18)	13 (10)	11 (9)	5 (4)	4 (3)	2 (2)	5 (4)	129
Full-time (≤40 h/week)	54 (9)	41 (7)	87 (15)	55 (10)	126 (22)	51 (9)	48 (8)	46 (8)	28 (5)	25 (4)	14 (2)	575
Total	229 (16)	220 (15)	183 (13)	167 (12)	176 (12)	125 (9)	84 (6)	77 (5)	76 (5)	60 (4)	48 (3)	1445

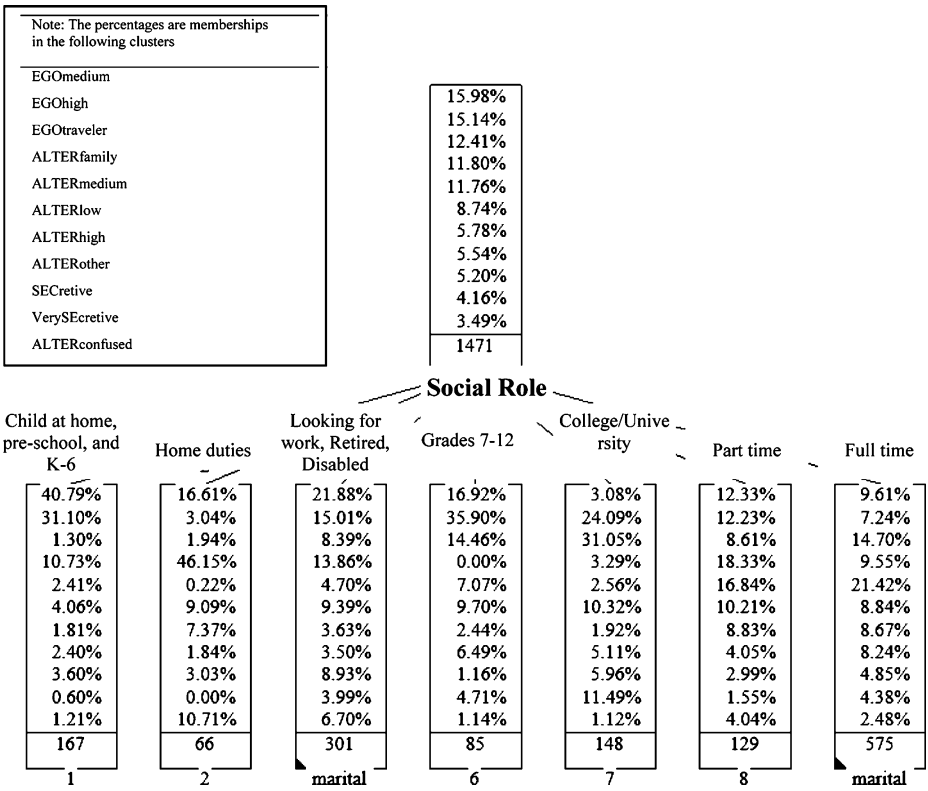

Fig. 2 Segmentation tree of the 11 clusters by social role and marital status. Note: Marital in the figure indicates that further segmentation based on marital status is warranted

household and study their interactions in terms of altruistic and self-serving behavior.

From the sample we first select households that have three or more persons. This results in a sample containing 230 households corresponding to 714 persons (from an expected 833) that gave us complete data. A CHAID segmentation analysis showed a significant difference between the 165 households that contain two married persons (e.g., husband and wife) plus other children and/or adults and the other 65 households that do not have married persons (e.g., roommates).

From within the married couple group we examine the cluster membership of the two oldest adult household members and find that in 40 households (28% of the households), both older adults are in the same cluster. Almost half of these households are in one of the three self-serving groups (*EGOmedium*, *EGOhigh*, and *EGOtraveler*) showing there are two-parent households where neither of the adult parents exhibit altruistic behavior. From within this same group, we also examined the behavior of the remaining persons (third, fourth, fifth and so forth) in the household and did not find any clear presence of altruistic behavior when at least two out of the three persons are in the self-serving clusters. However, a small number of households contain couples with opposite behavior (a mix of altruists and egoists). No gender roles are identified in this analysis reflecting the findings at the

Table 4 Pattern interaction in married couples

Pattern of one person		Pattern of the other person											
		EGO medium	EGO high	EGO traveler	ALTER family	ALTER medium	ALTER low	ALTER high	ALTER other	SECretive	Very SEcretive	ALTER confused	Total
EGO medium	Count	11	4	1	8	5	5	3	0	0	0	0	37
	% of Total	4.93	1.79	0.45	3.59	2.24	2.24	1.35	0.00	0.00	0.00	0.00	16.59
EGO high	Count	14	9	2	2	0	2	0	0	0	0	1	30
	% of Total	6.28	4.04	0.90	0.90	0.00	0.90	0.00	0.00	0.00	0.00	0.45	13.45
EGO traveler	Count	1	2	5	1	3	2	0	1	4	1	3	23
	% of Total	0.45	0.90	2.24	0.45	1.35	0.90	0.00	0.45	1.79	0.45	1.35	10.31
ALTERfamily	Count	3	0	2	9	2	0	1	1	0	1	3	22
	% of Total	1.35	0.00	0.90	4.04	0.90	0.00	0.45	0.45	0.00	0.45	1.35	9.87
ALTERmedium	Count	6	0	4	2	15	1	2	4	0	0	0	34
	% of Total	2.69	0.00	1.79	0.90	6.73	0.45	0.90	1.79	0.00	0.00	0.00	15.25
ALTERlow	Count	2	1	6	2	2	5	1	1	0	0	1	21
	% of Total	0.90	0.45	2.69	0.90	0.90	2.24	0.45	0.45	0.00	0.00	0.45	9.42
ALTERhigh	Count	0	1	0	1	1	2	1	0	0	0	1	7
	% of Total	0.00	0.45	0.00	0.45	0.45	0.90	0.45	0.00	0.00	0.00	0.45	3.14
ALTERother	Count	3	2	1	3	5	1	2	0	0	0	0	17
	% of Total	1.35	0.90	0.45	1.35	2.24	0.45	0.90	0.00	0.00	0.00	0.00	7.62
Secretive	Count	1	1	0	2	2	1	1	0	3	1	1	13
	% of Total	0.45	0.45	0.00	0.90	0.90	0.45	0.45	0.00	1.35	0.45	0.45	5.83
VerySEcretive	Count	1	1	1	0	0	0	1	1	3	4	0	12
	% of Total	0.45	0.45	0.45	0.00	0.00	0.00	0.45	0.45	1.35	1.79	0.00	5.38
ALTERconfused	Count	1	0	0	1	0	0	0	0	0	0	5	7
	% of Total	0.45	0.00	0.00	0.45	0.00	0.00	0.00	0.00	0.00	0.00	2.24	3.14
Total	Count	43	21	22	31	35	19	12	8	10	7	15	223
	% of Total	19.28	9.42	9.87	13.90	15.70	8.52	5.38	3.59	4.48	3.14	6.73	100.00

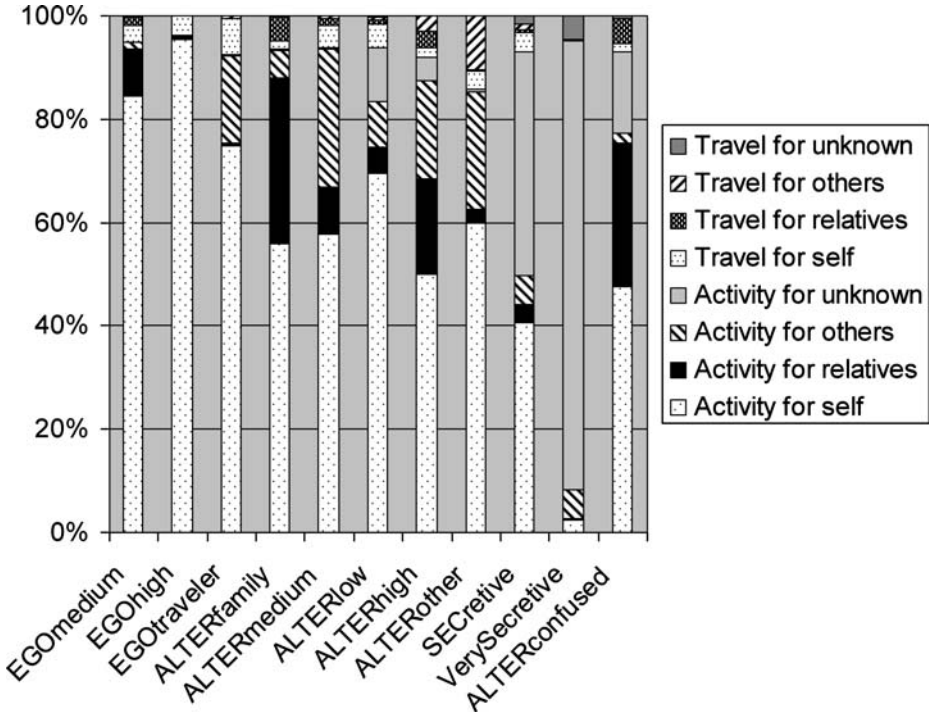

Fig. 3 Clusters and proportion of time at specific locations and travel

person level (recall gender played a role in distinguishing among clusters only among the persons looking for work, retired, and disabled).

The majority of the households (53%), however, have both parents in one of the altruistic groups supporting the hypothesis of ''balanced'' reciprocity within the household. In these households, members pursue activities and travel for the other members as well as other persons outside the household with a varying degree of altruism following the person-based patterns described in the previous section (e.g., parents tend to be more altruistic than their children).

Some similarities to the above are found when we consider only couples (two married persons and household size equal to two). Table 4 shows the cross-classification of cluster membership of the two persons in this household type. A little over 30% of the households contain persons that are both members of the same cluster indicating, for this portion of married couples, egoists live with other egoists with very similar behavior and altruists live with altruists who have very similar behavior 30% of the time (e.g., *EGOmediums* with *EGOmediums* and *ALTERhighs* with *ALTERhighs*). When we count the number of persons that are married and are egoists (the top quadrant of Table 4 corresponding to the three self-serving groups) we find 49 households (22.0% of the total married couples) have a general self-serving orientation. To the opposite end we find households with a general altruistic orientation to be 64 (28.7% of the total married couples). Presumably this indicates that only half of the married couples tend to adopt similar orientations in their altruistic orientation as expressed by activity participation and travel. It should also be noted that another 38 households comprised of married couples are not included

in this analysis because the records of one of the two persons were missing (i.e., the diary was not returned or was unusable).

An examination of households containing two persons that are not married (70 households) showed that 21.4% of the households contain persons with the same cluster membership and 22.9% are in a self-serving group (both members adopting a self-serving pattern). As in the married couples there are 11 households with the records of one of the 2 persons missing for this analysis. Overall in all the groups examined here and as the segmentation analysis showed marital status is a strong predictor of the cluster membership. It is not, however, a predictor of altruism. For example, married persons are not uniformly altruistic; they exhibit different combination patterns of altruistic and self-serving behaviors than their unmarried counterparts.

The 157 single persons exhibit a remarkably different behavior. The majority of these individuals are in the self-serving groups (62.8% are in the *EGOgroups* and another 10.8% are in the *ALTERlow*, which is very close to a self-serving group). Their composition is also very different than the other groups (23.7% are retired, 26.3% are college students, and 37.2% are full-time workers). These full-time workers are also substantially different than the full-time workers in a couple or in a household with children.

Location and altruism

The sample analyzed in this paper spends approximately 69% of its time at home, 11% at work, and 3.9% at school. For the remaining 15.7% of time, activities are spent elsewhere (9.5%) and for traveling, which takes approximately 6% of the time. These proportions differ considerably, however, when we consider the 11 self-serving and altruistic clusters derived here. Figure 3 provides a summary. As expected, members of the EGO groups, which are dominated by children, along with their parents in the *ALTERfamily* group spent a substantial amount of time at home (caring for relatives and being cared for by relatives). The *EGOtraveler*, *ALTERmedium*, and *ALTERother* spend the most time outside their homes. It is also important to note that these latter two groups that allocate more time for others also show a need to travel to other places (in addition to work and school) in their pursuit of altruistic acts. A similar behavior is also exhibited by the *ALTERhigh* group. All clusters, however, show a substantial amount of time at places that are not home, work, or school locations. This includes the children dominated clusters as well as clusters populated by retirees and disabled. The large amount of time at work of the *ALTERmedium* group confirms our previous finding that full-time workers in families with children are also allocating time caring for relatives and others.

When we examine the number of activity episodes we find that 44.8% take place outside the home. When we also look at the person for whom these activities are pursued these patterns are different depending on the recipient. For example, for the activities at home, 86.6% are for ones self, approximately 10.7% are performed for the immediate family (husband, wife, daughter, son, brother, sister, mother, and father), and finally small percentages of activities are completed for a variety of others groups such as other relatives, friends, co-workers, and so forth. When we turn to activities performed outside the home, 69% are for self, 16.7% are for the immediate family members, and those performed for co-workers becomes a sizable 7.25%. Meanwhile, activities for friends take only 1.5% of time. Interestingly 0.5%

of the activities at home are for pets and outside the home this becomes 0.7% of the activities.

Summary and conclusions

In this paper, using data from 1,471 residents of Centre County Pennsylvania, we examine time allocation to stated altruistic and self-serving behavior. Some of the findings here repeat findings in past analyses. The latent class cluster analysis reveals that a large amount of time in a day is dedicated to activities and travel for reasons/purposes that are self-serving. For example, on average people in this sample spend 2/3 of their time for themselves. This happens even when we consider that a considerable portion of the 48 h is dedicated to sleep and rest. However, significant heterogeneity is observed within the sample leading to three main groups: self-serving, altruistic, and the confused/secretive. The last group, the smallest of the three, has a substantial amount of missing information possibly due to participants unwilling to provide the necessary data. Within the self-serving and the altruistic groups, we also find substantial heterogeneity in time allocation behavior. The self-serving clusters are dominated by the presence of children of all ages and college students. The altruistic groups are dominated by workers (part- and full-time).

The household analysis focusing on spouses shows that we have one group where the household members follow very similar daily behavioral patterns (e.g., both adults in the household are in the same cluster). A second group of households has one person in a self-serving cluster while the other person is in an altruistic cluster. The largest group of households, however, contains persons that are both altruistic possibly indicating a substantial amount of reciprocal behavior and altruism towards others in the social group.

Although the finding of a generally diffused altruistic behavior (with self-serving mostly emerging from the need for children and young adults to grow and mature) in this study is a positive and a welcome finding, it raises concerns about transportation policies that do not account for this within inter- and intra- household relationships. As we observed, altruists in this study need to be in different places and travel to these places. Pursuing activities for other persons may function as a constraint for the use of alternative modes to the private automobile. In addition, the strong correlation between location and altruism points to another direction that travel behavior research needs to explore. For example, a cursory analysis of the activities pursued at home shows that 81.3% of the activities at home are for one's self. This proportion drops to 65.7% when we examine activities pursued outside the home. When we design applications that also aim at predicting the locations and duration of activities at specific locations, the relationship between altruism, activity type, and location becomes of paramount importance and requires further scrutiny. For example, home as we see in this analysis is the location of an inward orientation (self and immediate family). There may be other locations that have predominantly an outward orientation for human sociality and these places may not be work and school. The overall finding of substantial heterogeneity in altruistic and self-serving behavior challenges the simplifications we see in current activity-based approaches, proposes a different way of modeling and simulation that reaches back to human values, reintroduces a forgotten explanatory variable that is marital status, and demonstrates the value of considering all the children in the household.

Acknowledgements We are grateful to Tae-Gyu Kim who worked on earlier data analysis in CentreSIM. The data used here were part of a project funded by the Pennsylvania Department of Transportation and the Mid-Atlantic Universities Transportation Center, a US DOT regional transportation center. Part of this material was produced under U.S. Government contract W-7405-ENG-36 for Los Alamos National Laboratory, which is operated by the University of California for the U.S. Department of Energy. It has been approved for unlimited public release (LA-UR-05-5234). The contents of the paper reflect the authors' viewpoints and they do not constitute a policy or official position of any State and/or Federal public agency.

References

Axhausen, K.: Social networks and travel: some hypotheses. http://e-collection.ethbib.ethz.ch/ecol-pool/incoll/incoll_964.pdf - accessed July 2005 (2003)

Bhat, C.R, Guo, J., Srinivasan, S., Sivakumar, A.: Activity-based Travel Demand Modeling for Metropolitan Areas in Texas: Software-related Processes and Mechanisms for the Activity-travel Pattern Generation Microsimulator. Research Report 4080-5, Center for Transportation Research, Austin, Texas (2003)

Cory, G.A.: The Reciprocal Modular Brain in Economics and Politics. Kluwer (1999)

Gill, C., Postlethwaite, N., Seaford, R.: Reciprocity in Ancient Greece, Clarendon Press (1998)

Gintis, H., Bowles, S., Boyd, R., Fehr E.: Explaining altruistic behavior in humans. Evol. Human Behav. **24**, 153–172 (2003)

Gliebe, J.P., Koppelman, F.S.: A model of joint activity participation. Transp. **29**, 49–72 (2002)

Goulias, K.G., Kim T.: An analysis of activity type classification and issues related to the *with whom* and *for whom* questions of an activity diary. Chapter 14 in Progress in Activity-Based Analysis (Ed. Harry Timmermans). Elsevier, pp. 309–334, (2004)

Goulias, K.G., Kilgren, N., Kim T.: A decade of longitudinal travel behavior observation in the Puget Sound region: sample composition, summary statistics, and a selection of first order findings. Proc. 10th IATRB Conf., Lucerne, Switzerland (CD-Rom) (2003)

Hayes, W.M., Lynne, G.D.: Towards a centerpiece for ecological economics. Ecol. Econ. **49**, 287–301 (2004)

Hunecke, M., et al.: Responsibility and environment: ecological norm orientation and external factors in the domain of travel mode choice behavior. Environ Behav **33**(6), 830–852 (2001)

Henrich, J., Boyd, R., Bowles, S., Camerer, C.F., Fehr, E., Gintis, H., McElreath, R.: Overview and synthesis. In: Henrich, J., Boyd, R., Bowles, S., Camerer, C.F., Fehr, E., Gintis, H. (eds.) Foundations of Human Sociality, pp. 8–54. Oxford University Press (2004)

Jara-Diaz, S.: On the goods-activities technical relations in the time allocation theory. Transportation **30**, 245–260 (2003)

Lynne, G.D.: Socio-Economics: The third way. Presentation in the Institutional and Behavioral Economics free Session, ''Alternative Social and Behavioral Theories: Is There Common Ground?'' at the Annual Meeting of the American Association of Agricultural Economics, Tampa, Florida, July 30–August 2, 2000 (2000)

Magidson, J., Vermunt J.K.: An extension of the CHAID tree-based segmentation algorithm to multiple dependent variables. In: Weihs, G. (ed.) Classification – the Ubiquitous Challenge, pp. 176–183. Kluwer (2005)

Pollak, R.A.: Notes on time use. Mon. Labor Rev. August 1999, 7–11 (1999)

Pribyl, O., Goulias, K.G.: Simulation of daily activity patterns. Chapter 3 in Progress in Activity-Based Analysis (Ed. Harry Timmermans). Elsevier, pp. 43–65, (2004)

Salvini, P., Miller E.J.: ILUTE: An Operational Prototype of a Comprehensive Microsimulation Model of Urban Systems, paper presented at the 10th International Conference on Travel Behaviour Research, Lucerne, August 2003 (2003)

Scott, D.M., Kanaroglou, P.S.: An activity-episode generation model that captures interactions between household heads: development and empirical analysis. Transport. Res. B: Meth. **36**(10), 875–896 (2002)

Seethaler, R.K., Rose, G.: http://www.tuti.com.au/PUBLICATIONS/2003/ATRF03-RG14.pdf (2003)

Seethaler, R.: Using the six principles of persuasion to promote travel behavior change. Preliminary findings of a TravelSmart pilot test. http://www.travelsmart.vic.gov.au/doi/doielect.nsf/2a6bd98dee287482ca256915001cff0c/2e596ae6a2fa68e5ca256f9600158711/$FILE/Seethaler2004.pdf—accessed July 2005 (2004)
Simon, H.: A mechanism for social selection and successful altruism. Science **21**(12), 1665–1668 (1990)
Taniguchi, A., et al.: Psychological and Behavioral Effects of Travel Feedback Program for Travel Behavioral Modification. http://www.plan.cv.titech.ac.jp/fujiilab/pdf%20files/TRRTFP03.pdf—accessed July 2005 (2004)
Vermunt, J.K., Magidson, J.: Latent class cluster analysis. In: Hagenaars, J.A., McCutcheon, A.L. (eds.), Applied Latent Class Analysis, pp. 89–106. Cambridge University Press, Cambridge (2002)
Vovsha, P., Peterson, E., Donnelly, R.: ''Explicit Modeling of Joint Travel By Household Members: Statistical Evidence and Applied Approach''. TRB Meeting CD-ROM (2003)
Wilson, E.: Sociobiology. Harvard University Press (1975)
Zhang, J., Timmermans, H.J.P., Borgers, A.W.J.: A model of household task allocation and time use. Transp. Res. B **39**, 81–95 (2005)

About the authors

Konstadinos G. Goulias is a professor of Geography at the University of California Santa Barbara, has been a professor of Civil Engineering at the Pennsylvania State University from 1991 to 2004, and he is the founder and chair of the TRB task force on moving activity-based approaches to practice.

Kriste M. Henson is a technical staff member at Los Alamos National Laboratory in the Decision Applications Division and is currently pursing a Ph.D. in Geography at the University of California—Santa Barbara.