

Who are the loneliest Americans?

Working paper

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2020-09-13

Abstract

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Background

Time spent alone has been increasing among Americans. This can have numerous health effects (x,y,z) and it may be impacting subpopulations differently. Data from the American Time Use Survey shows the mean amount of time spent on non-work activities with no other person present has steadily increased from ~295min per day to ~330min per day.

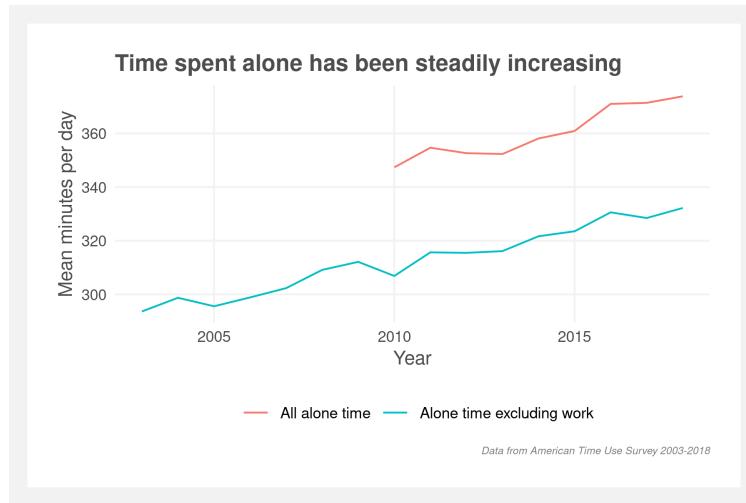


Figure 1: Mean alone time 2003-2018

It's intuitive that this increase may not be evenly distributed across the population. Rather than subdividing the population by demographics, the population can be divided using sequence analysis and unsupervised learning techniques to find clusters of similar time-use patterns. These in turn may represent distinct demographic groups (e.g. a cluster with large amounts of time spent on education consists mostly of sub 25 year olds) but are not direct measurements of demographics. The clustering methodology allows demarcation of groups based on their activity and may capture groups such as students, workers, and the elderly.

Research question

Are increases in time spent alone equally affecting different subpopulations of Americans?

Alone time definition

The American Time Use Survey tracks alone time via a computation of other collected variables. For each activity — except those noted below — the BLS tracks the number of participants present during the activity. Alone time is tallied only during activities for which only the primary respondent is present.

Activities that are excluded from the tally include:

- Working
- Sleeping
- Washing, dressing, or grooming

- Personal/private activities
- Any time in which the respondent refused to provide activity detail

The BLS also includes another variable, TRTALONE_WK which is similar to TRTALONE but includes alone time during work activities. This is excluded for the analysis as it is only available 2010-2018.

Literature review

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Methodology

Clustering methods will be used to determine similar sequences of how individuals spend their day. Primary techniques will be using string editing techniques ([Abbot](#)) and secondary techniques include model based clustering...

String editing techniques will start by aggregating the different types of activities from 465 specific activities into 15 activities based on their hierarchical definitions provided by the BLS. These 15 activities will then be recoded as single character strings representing how an individual spends each 30 minute period of their day. Their full day's activity is represented by the resulting 48 character string.

Data detail

Data comes from The American Time Use which surveys how Americans spend their time. The diary (atusact file) and CPS (atuscps_0318 file) data will be used from the 2003-2018 Multi-Year Interview dataset.

2003-2018 data TULINENO == 1 weekdays only The ATUS Activity file was used atusact_0318 data is collected at the minute level started at 4am-4am To reduce computation load, each respondents' day was summarized into 48 thirty-minute windows representing the model activity during the window.

Activities are

Distance measures

String editing techniques will start by aggregating the different types of activities from 465 specific activities into 15 activities based on their hierarchical definitions provided by the BLS. These 15 activities will then be recoded as single character strings representing how an individual spends each 30 minute period of their day. Their full day's activity is represented by the resulting 48 character string.

The distance between the respondents string sequences can be calculated using a number of different string distance measures:

- Levenshtein distance: insertions, deletions or substitutions
- Restricted Damerau-Levenshtein distance (OSA): insertions, deletions or substitutions of a single character, or transposition of two adjacent characters
- Hamming distance: substitutions only
- Longest common subsequence: insertions and deletions only

Each of these have advantages and disadvantages that will be explored along with their impact on the final clustering.

Clustering

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Efficacy of cross-sectional clustering

The data consists of cross-sectional observations of individual's time use. The clusters are computed across years. Therefore, no single respondent represents more than one year but individual clusters consists of multiple years.

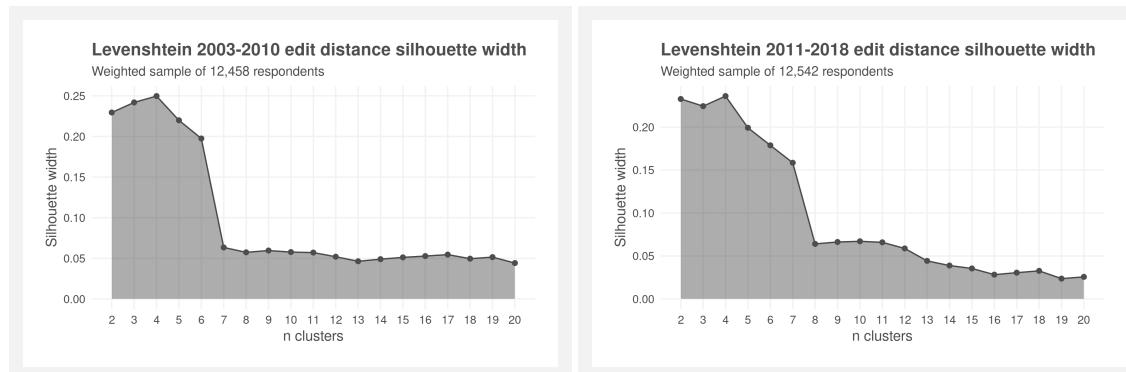


Figure 2: Silhouette comparison

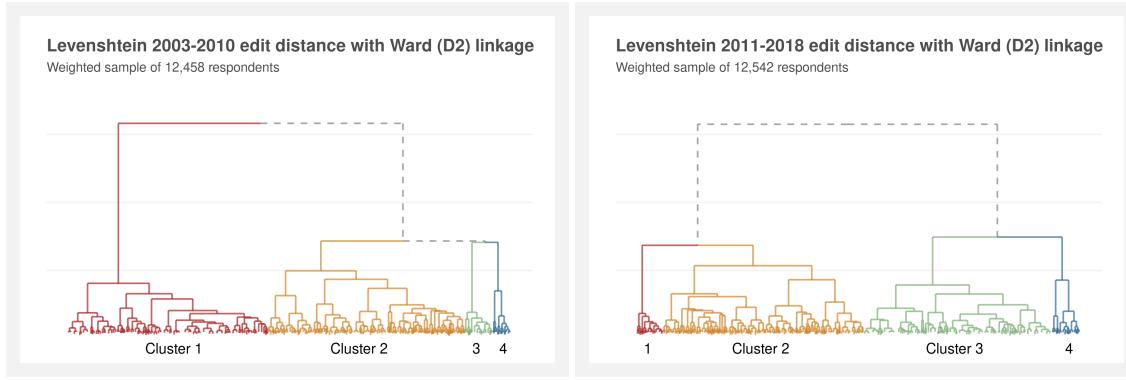


Figure 3: Dendrogram comparison

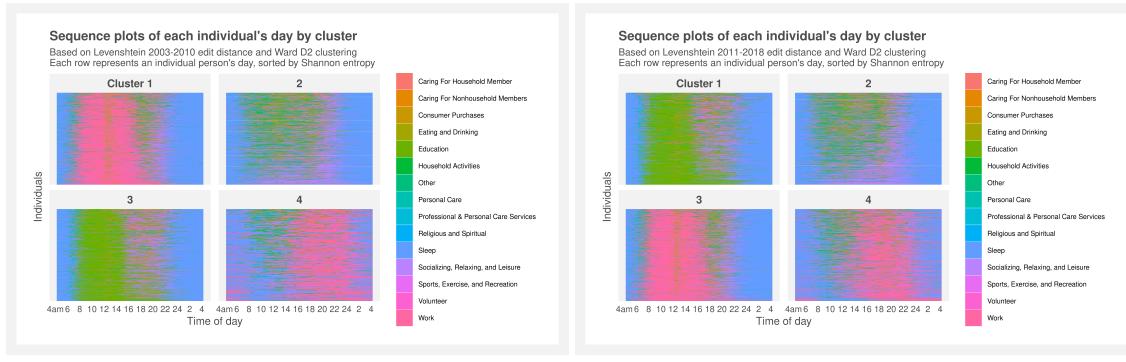


Figure 4: Sequence plots comparison

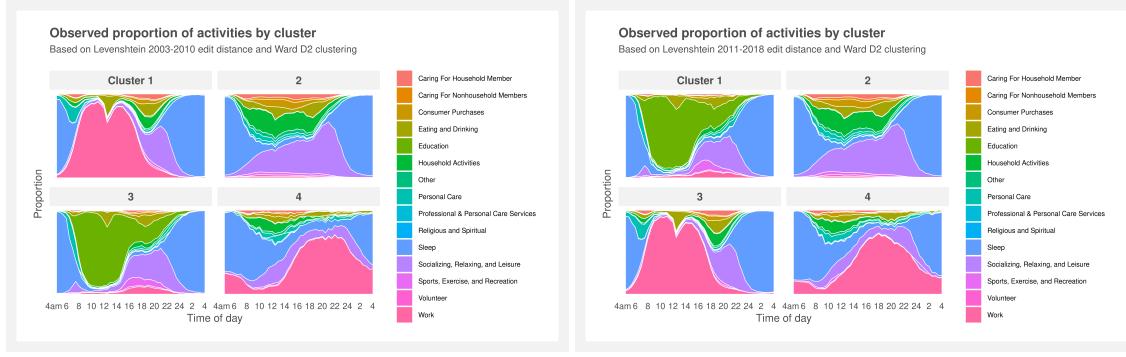


Figure 5: Proportion plots comparison

Final clusters

The final clusters were created using a weighted sample of 25,000 respondents from the 2003-2018 surveys.
Discuss silhouettes and dendrogram

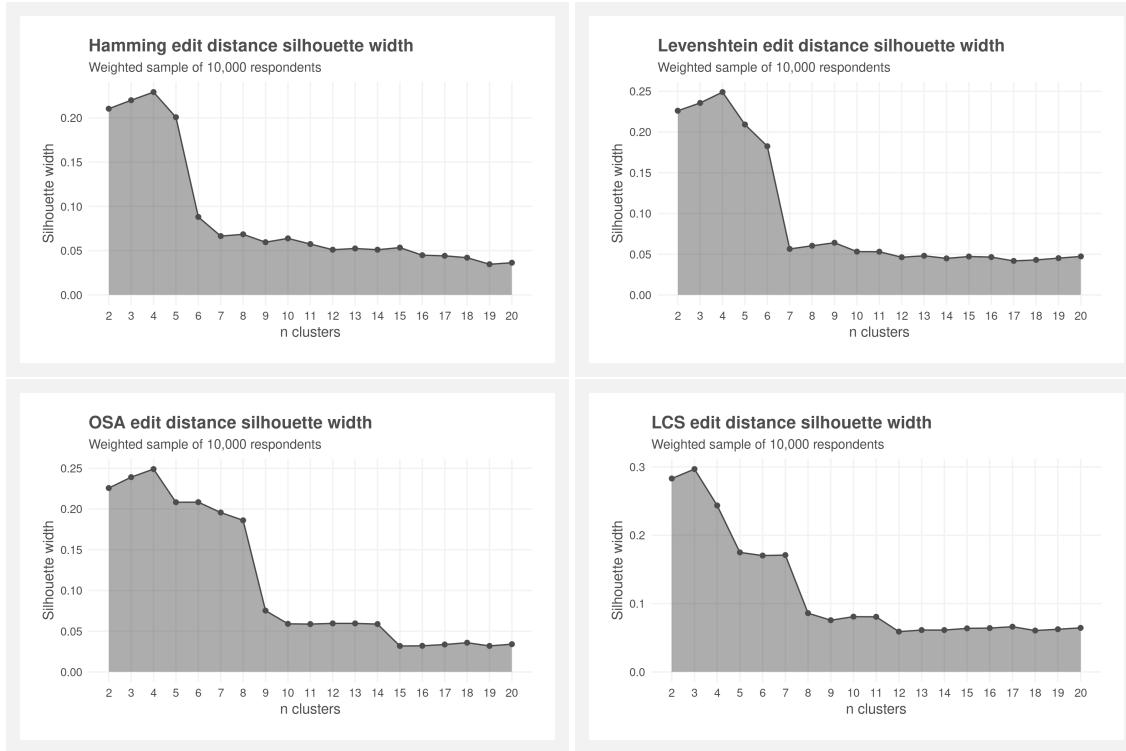


Figure 6: Silhouette distances

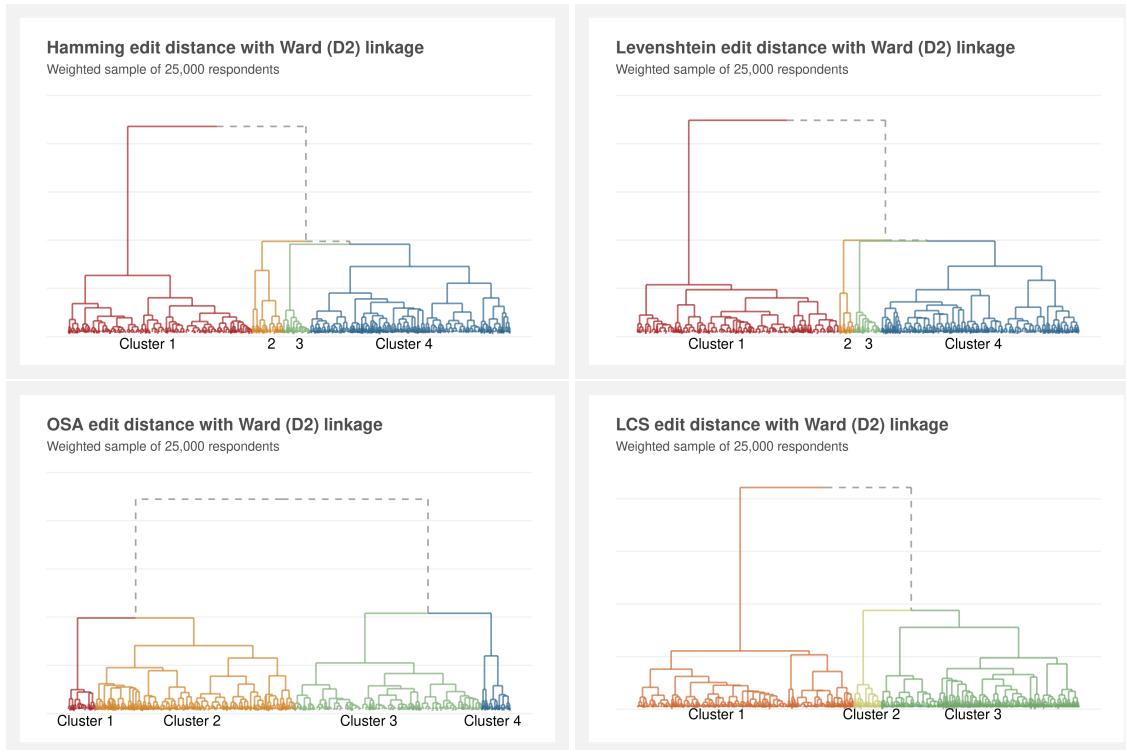


Figure 7: Dendograms

Discuss sequence plots and patterns

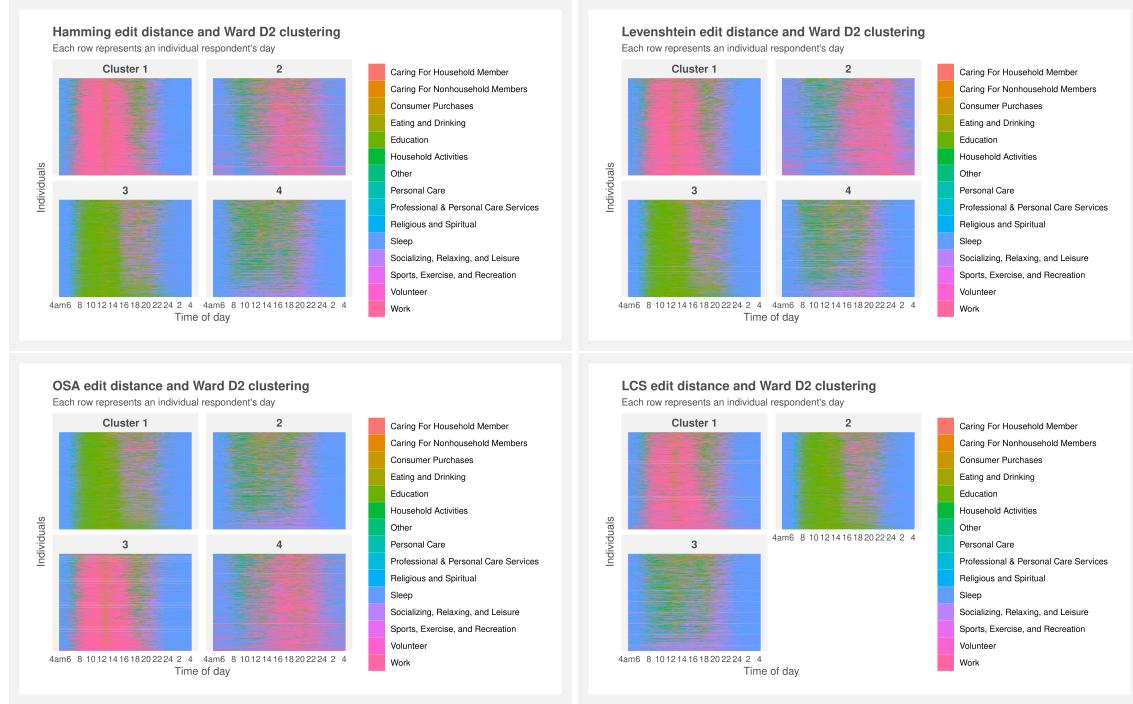


Figure 8: Sequence plots

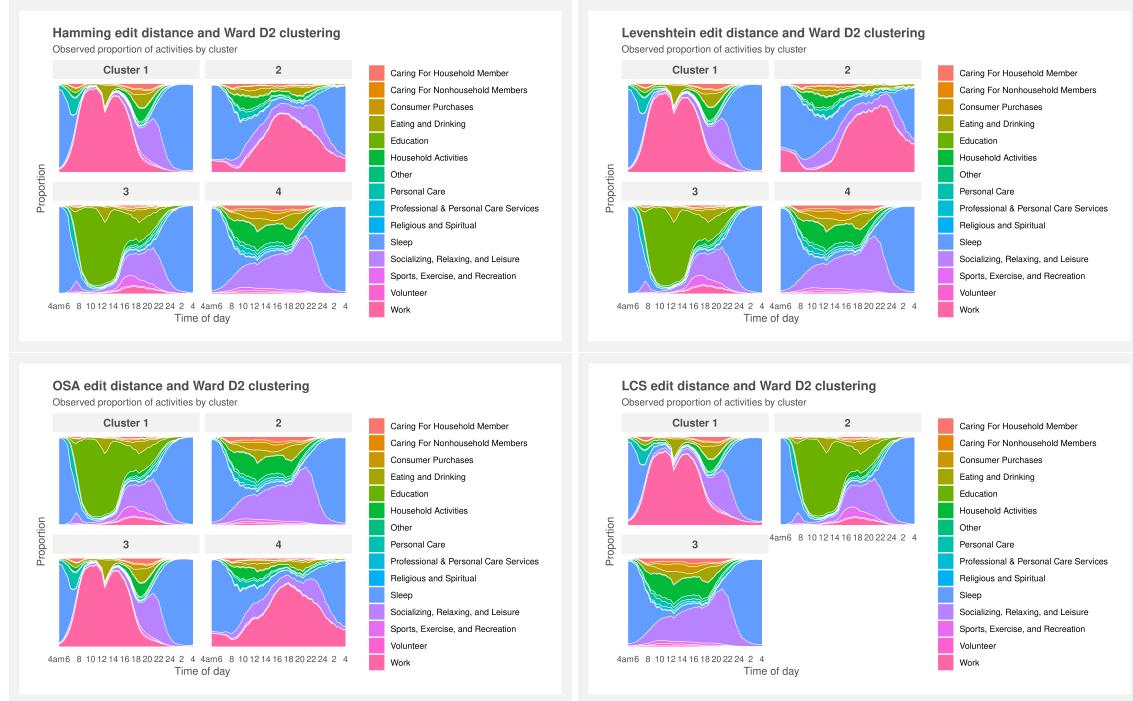


Figure 9: Proportion plots

Categorization of clusters

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Distance measure comparison

Visual inspections of the sequence and proportion plots appear to show consistency across the various edit distance measures. This is verified by examining the agreement in cluster membership. First, 90% of the respondents are clustered into the “same” cluster across methods. The remaining ~10% match to two separate clusters, and a small amount match to three. This is most likely due to the LCS method optimizing for a three cluster solution.

The pattern is clearer examined on a respondent-level basis. The right plot in Figure # shows the cluster assignment per respondent per method. Homogenous colors horizontally indicate full agreement across the edit distance measures.

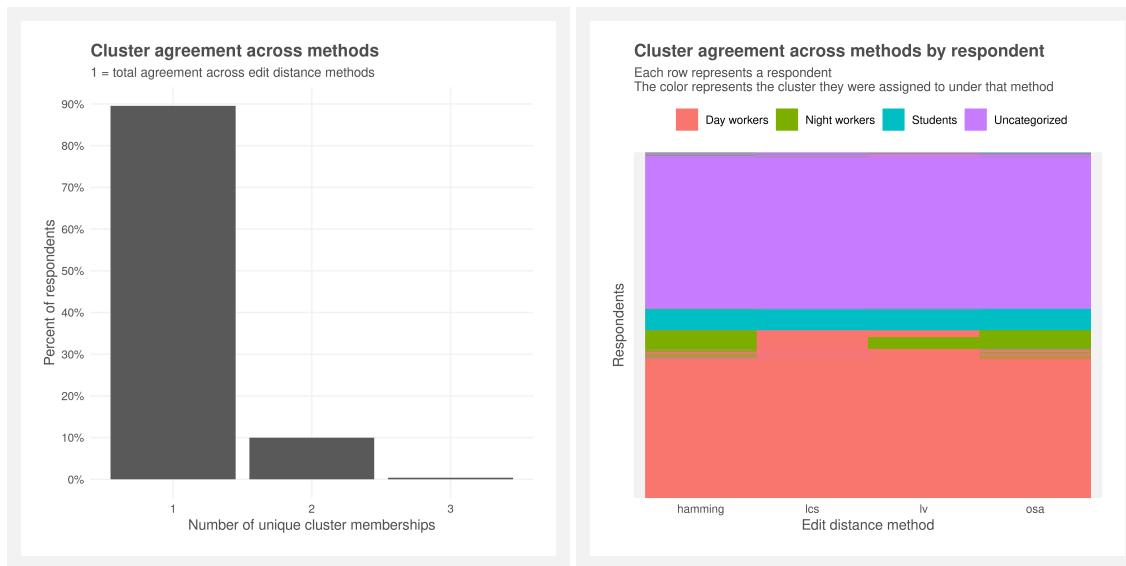


Figure 10: caption

Modeling

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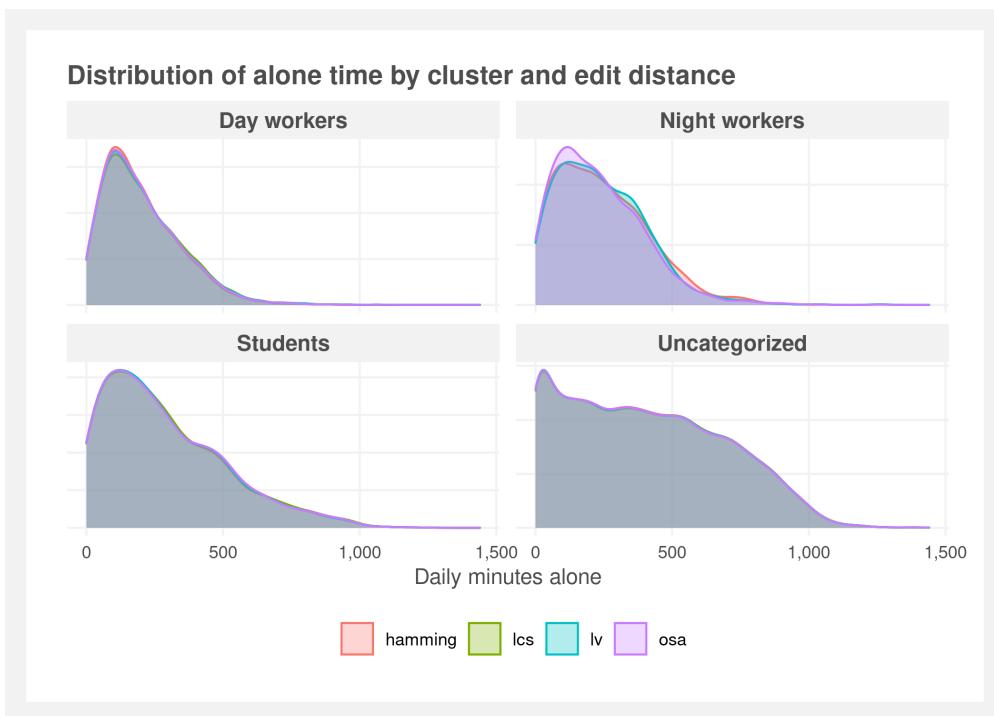


Figure 11: Densities of alone time by cluster

Over-dispersion is an issue. The mean daily alone minutes range from 202 to 400 per each cluster and the variances range from 19,724 to 81,265. This violates an assumption of Poisson models: mean equals variance. Negative binomial models do not require this assumption.

Multiple single level negative binomials

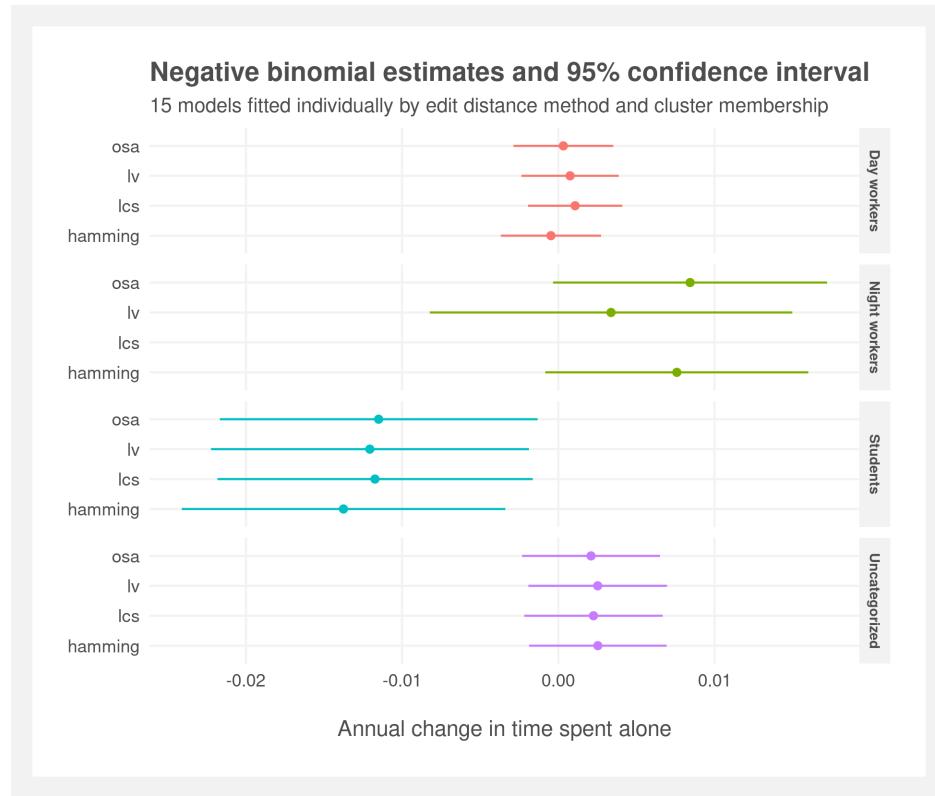


Figure 12: Negative binomial estimates

Multi-level negative binomial

Cluster as random intercept and Year as fixed and random slope

Benefit of multi-level

Model equation

The model form in R syntax:

```
Alone time ~ cluster + (cluster | year )
```

Model fit

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Table 1: Multi-level negative binomial model diagnostics

effect	group	term	estimate	std.error	statistic
fixed	NA	(Intercept)	5.619	0.1241	45.27
fixed	NA	year	-0.0002	0.0028	-0.0551
ran_pars	cluster	sd_(Intercept)	0.2465	NA	NA
ran_pars	cluster	cor_(Intercept).year	-0.0052	NA	NA
ran_pars	cluster	sd_year	0.004	NA	NA

Table 2: Multi-level negative binomial model diagnostics

sigma	logLik	AIC	BIC	deviance	df.residual
1	-166,273	332,557	332,606	29,521	24,994

Model discussion

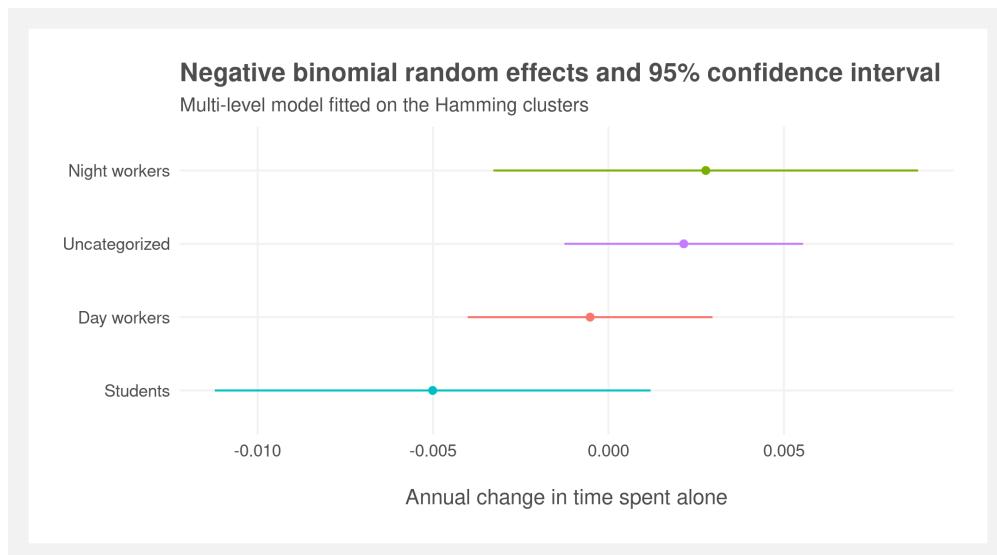


Figure 13: Hamming edit distance: Multi-level negative binomial effects

There's an issue here with singularities

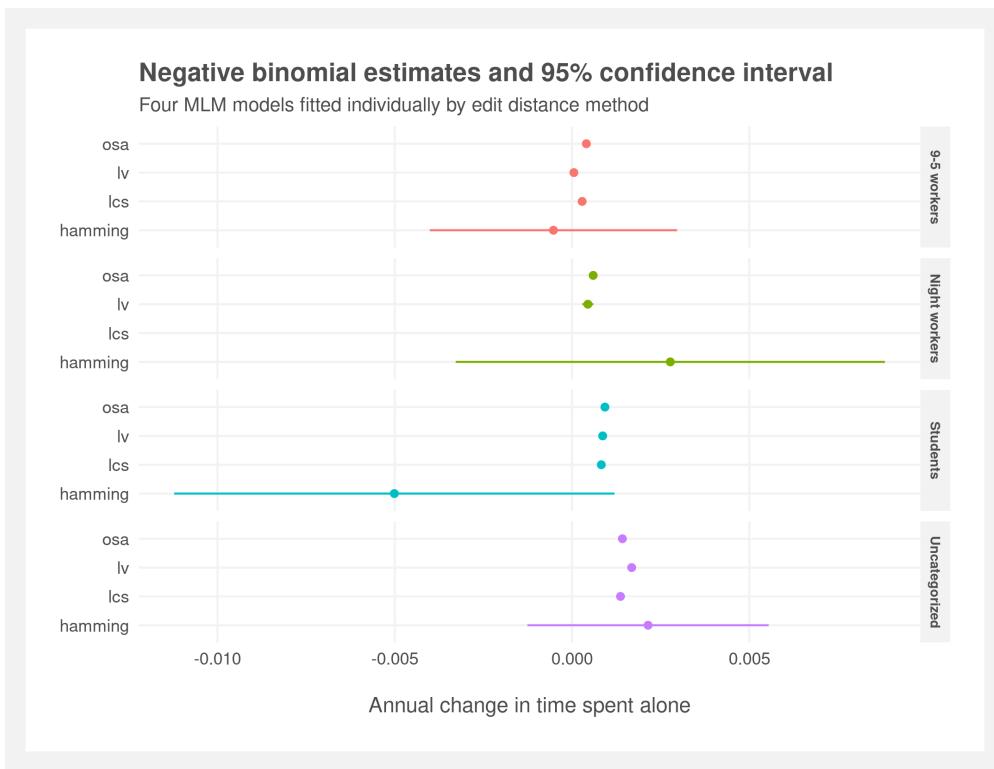


Figure 14: All edit distance measures: Multi-level negative binomial effects

Associated demographics

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explore other cluster solutions here that identify the elderly? The Hamming, Levenshtein, and OSA edit distance measures indicate that five or possibly six clusters are reasonable (Figure 6). The six-cluster solution contains clusters can be categorized as ...

The associated demographics of these clusters skew ...

Conclusion

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Appendix

Table 3: Activity aggregation mapping

Activity code	Description
t0101.*	Sleep
t010[2-9].*	Personal Care
t019.*	Personal Care
t1801.*	Personal Care
t02.*	Household Activities
t1802.*	Household Activities
t03.*	Caring For Household Member
t1803.*	Caring For Household Member
t04.*	Caring For Nonhousehold Members
t1804.*	Caring For Nonhousehold Members
t05.*	Work
t1805.*	Work
t06.*	Education
t1806.*	Education
t07.*	Consumer Purchases
t1807.*	Consumer Purchases
t08.*	Professional & Personal Care Services
t1808.*	Professional & Personal Care Services
t09.*	Other
t1809.*	Other
t10.*	Other
t1810.*	Other
t11.*	Eating and Drinking
t1811.*	Eating and Drinking
t12.*	Socializing, Relaxing, and Leisure
t1812.*	Socializing, Relaxing, and Leisure
t13.*	Sports, Exercise, and Recreation
t1813.*	Sports, Exercise, and Recreation
t14.*	Religious and Spiritual
t1814.*	Religious and Spiritual
t15.*	Volunteer
t1815.*	Volunteer
t16.*	Other
t1816.*	Other
t1818.*	Other
t1819.*	Other
t189.*	Other
t50.*	Other

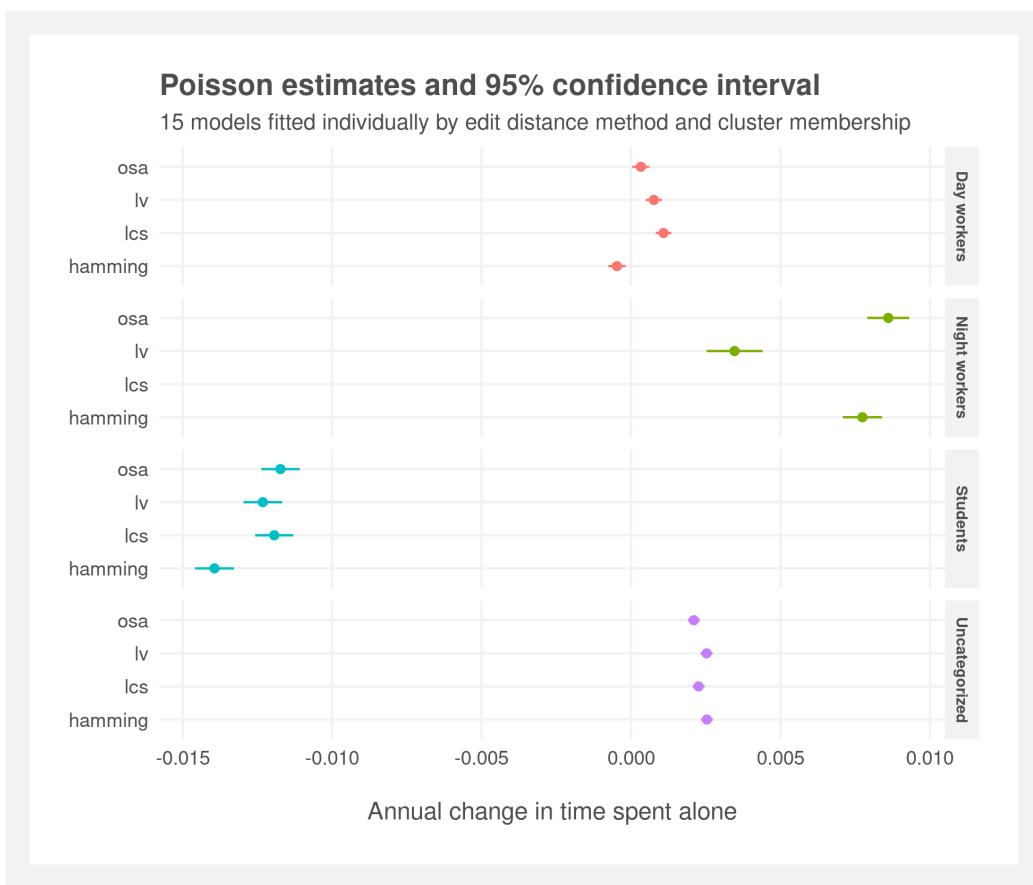


Figure 15: Poisson single-level effects

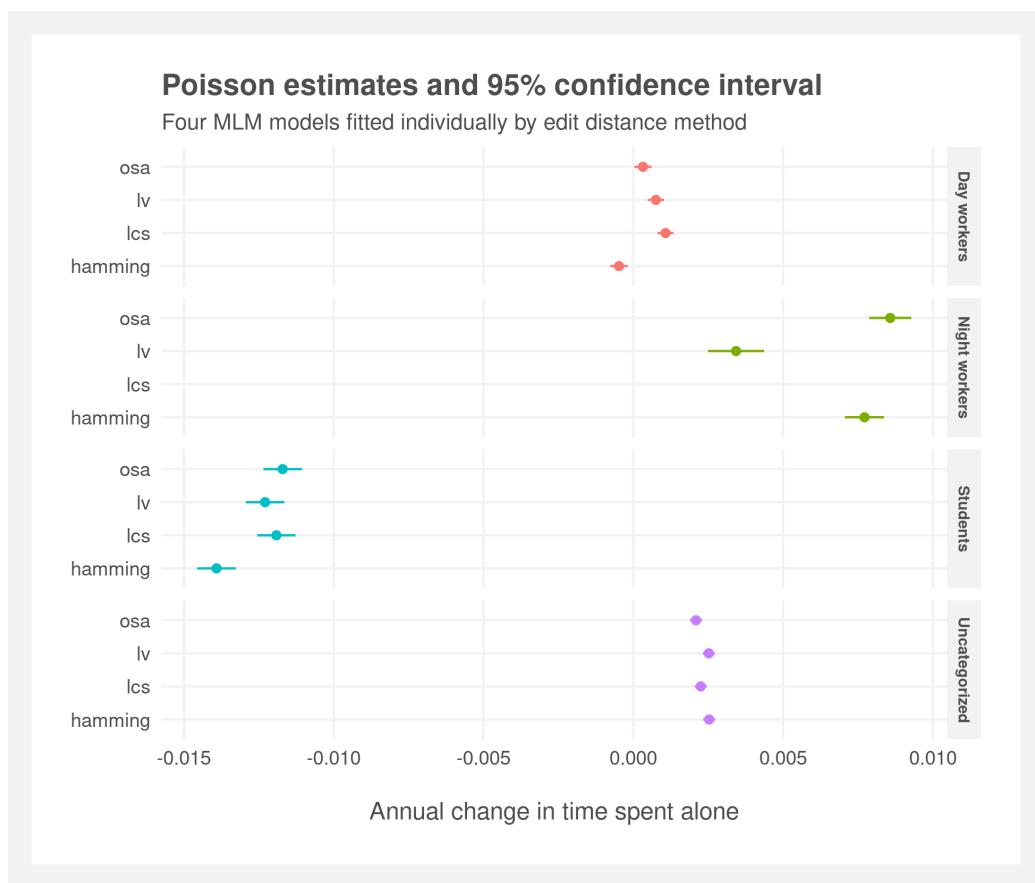


Figure 16: Poisson MLM effects