DEPARTMENT OF TRANSPORTATION

Advancing Equity in Accessibility and Travel Experiences: The Role of Gender and Identity

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16. Abstract (Limit: 250 words)

Gender can have a significant influence on people's behaviors and experiences. Hence, excluding gender diversity in transportation research and practices can result in biased or incomplete understandings of issues and perceptions about transportation and quality of life.

This study examined whether and how gender, in a broader sense, can result in distinctly different activity-travel patterns and subjective well-being (SWB) outcomes using survey data. The study reviewed existing literature and found that gender was not binary meaning that some gender identities were not solely female or male. The literature also indicated a person's gender typically intersected with their other social identities such as race and family type and created unique needs and experiences.

To address the complex nature of gender, the team collected new data using the Daynamica smartphone application and included specific questions concerning (1) participants' gender identities and attitudes toward gender roles, (2) their share of household-supporting tasks in 14-day travel diaries, and (3) their emotions during trips and activity participation. The team used 2021 Daynamica survey data and 2019 Travel Behavior Inventory data from the Metropolitan Council to extract activity-travel patterns before and after COVID-19. The team associated these patterns with participants' gender and other identities and SWB outcomes through visual explorations and statistical analysis. The findings suggested the importance of capturing the complex, intersectional nature of gender, confirmed the persistent existence of gender differences in transportation needs, experiences, and SWB outcomes in Minnesota, and supported continuous efforts and investments to advance gender equity in transportation.

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ADVANCING EQUITY IN ACCESSIBILITY AND TRAVEL EXPERIENCES: THE ROLE OF GENDER AND IDENTITY

FINAL REPORT

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance (statistical testing of differences)
CHAID	Chi-square Automatic Interaction Detection
F-Test	Test whether statistic has an F-distribution under the null hypothesis
HH Task	Household-Supporting Task
SAM	Sequence Alignment Method
SWB	Subjective Well-being
TBI	Travel Behavior Inventory
WFH	Work from Home

EXECUTIVE SUMMARY

Gender, as part of a person's social identity, can have a significant influence on people's behaviors and experiences. Excluding gender diversity in transportation research and practices could result in biased or incomplete understanding of issues and perceptions about transportation and quality of life. Moreover, transportation studies have often classified people's gender as male or female. This ignores that gender is a term much broader than the male-female binary and could lead to marginalized populations whose needs and experiences are overlooked or misunderstood.

This study examined whether and how socially constructed gender can result in distinctly different activity-travel patterns and subjective well-being (SWB) using survey data collected at the personal level. The project aimed to address (1) the gender identity that is a person's inner feeling of their gender, (2) the gender role that reflects the expected attitudes and behaviors a society associates with a gender, and (3) the impact of a person's gender identity, gender role, and other social identities on their activity-travel patterns and SWB outcomes.

To understand the complex nature of gender, the team reviewed existing literature on gender and travel in transportation and social science. The review of the definitions of gender suggested that gender is not exclusive to only women and men; therefore, using this binary perspective to define gender excludes and marginalizes people who identify as neither a woman nor a man. The review revealed the intersectional nature of gender as a social construct, that is, a person's gender always intersects with their social identities (e.g., employment, family type, life stage, and race) and creates unique needs and experiences.

The review of methods and findings regarding gender-typical behaviors in transportation showed that there is rich evidence of distinctly different transportation needs and experiences among different genders. The review also revealed that existing methods have not adequately addressed the non-binary and intersectional nature of gender, which is partially due to the lack of relevant information in the existing survey data.

To address the complex nature of gender identity and gender roles, the team collected new survey data using Qualtrics and the Daynamica smartphone application. First, the Qualtrics intake survey collected participants' basic demographic and travel preferences and included questions for participants' gender identity and attitudes toward gender roles. Second, the Daynamica in-app survey recorded participants' diaries for 14 days and included questions regarding gender roles such as whether a trip or an activity involved the household-supporting tasks and time allocated to household chores per day. At the completion of the 14-day diary entry, participants could provide feedback regarding their participation experiences using the opt-in exit survey via Daynamica app.

To recruit more women and non-binary people with diverse social identities, the team used paid services provided by Facebook and Qualtrics and reached out to community partners to boost social media posts and distribute recruitment materials. By the end of data collection, 781 participants completed the intake survey, and 278 of them completed 14-day travel diaries with good quality. Completed participants were well distributed across social groups and had spatial coverage across

Minnesota. Among the 278 participants who completed 14-day travel dairies, 36 self-identified as non-binary, which was largely attributable to the participation of research centers, non-profit organizations, and social groups for non-binary people during the recruitment process.

The team used the 2019 Travel Behavior Inventory (TBI) data from the Metropolitan Council and the new 2021 Daynamica survey data to extract distinct activity-travel patterns in Minnesota and associate these patterns with participants' gender and other social identities. While the Daynamica survey data contained richer information about gender identity and gender roles than the TBI data, the TBI data had a much larger sample size than the Daynamica data. Moreover, comparing findings from TBI data and Daynamica data provided insights into the potential influences of the COVID-19 pandemic on activity-travel patterns. To address the impacts of gender roles on activity-travel patterns, the team put travel in the context of everyday task scheduling and applied the sequence alignment method (SAM) to extract groups of participants with significantly distinct patterns. The team also adjusted parameters in the method to emphasize potential differences in household task sharing among gender groups. To address the intersectional nature of gender identity, the team used the CHAID (Chi-square automatic interaction detection) to examine interactions among various personal characters that may lead to intersectionality groups with unique activity-travel patterns.

Results from both the TBI and Daynamica data indicated that it is crucial to address the intersectionality of social identities in understanding gender differences in activity-travel patterns. For instance, females in general shared more household supporting tasks and relied more on household vehicles for travel than males. However, within the gender group of females, Black females were more likely to use public transit compared to females of other races. Another example was that females with kids were less likely to have out-of-home activities and trips than males on weekday afternoons. However, within the gender group of females, Hispanic and Black females were very likely to have late-afternoon activities.

Compared to the TBI data, the Daynamica data enabled us to better capture the shares of household tasks among gender groups. Analysis results from the Daynamica data suggested that it is crucial to account for working from home while defining employment status to gain an accurate and comprehensive view of behavior patterns. Moreover, the information about shares of household-supporting tasks can distinguish people who shared household tasks at home from those who did not.

Results from these two datasets also revealed some obvious changes in patterns after the outbreak of COVID-19. For people who stayed at home most of the time, females shared more household tasks than males even when they were employed and working from home. Females also made more trips than males and non-binary people, and they reduced their use of public transit and relied more on household vehicles for travel. Such gender differences suggested that females tended to be confronted with more challenges during the pandemic than males given the typical roles of females in the family such as caring for kids at home and shopping for groceries.

Besides changes in travel behaviors after the outbreak of COVID-19, the new data regarding travel preferences revealed gender differences in transit barriers. Females and non-binary people were much more likely to feel unsafe while using public transit and being on their way to transit stations than males. They were also more likely to find it difficult to use transit than males because they needed to make

multiple stops or travel with strollers or carts. These were consistent with findings from the existing literature that, compared to males, females are more likely to make multiple stops along the trip and travel with kids.

Based on the analysis results of travel behaviors using the Daynamica data, the team examined people's SWB outcomes concerning their activity-travel patterns. Using the Daynamica application, participants recorded their experienced emotions during each trip and activity, including happy, meaningful, and safe for positive emotions, and pain, sad, tired, and stressful for negative emotions. We also derived the net affect for SWB by subtracting the average intensity of all negative emotions from the average intensity of all positive emotions. Regarding the impact of people's gender identity on their SWB outcomes, we found that non-binary people had less positive and more negative experiences in their daily activities and trips, so their overall SWB outcomes (net affects) were the worst among all gender groups.

Regarding the impacts of gender roles on SWB outcomes, we found that living with kids and sharing household tasks at home tended to bring more intense positive emotions for males than for females. Regarding the impacts of activity-travel patterns on SWB outcomes, we found that employment status played a key role in determining behavior patterns; however, it did not have a significant direct impact on the SWB outcomes alone. Instead, it interacted with other social identities such as gender, family type, age, and student status to create distinct emotional experiences.

Based on findings from the literature review, survey collection, and data analyses, this project identified several key action items that transportation and local agencies could take to implement in future studies and practices. First, it is important to capture the complex, intersectional nature of gender and adopt gender-inclusive language in future project design and communication. Second, findings from the study proved the persistent existence of gender differences in time allocation, transportation needs, and SWB outcomes in Minnesota. These findings support continuous efforts and investments to advance gender equity in transportation. Third, we found that non-binary people had worse SWB outcomes than males and females. More in-depth qualitative data and analyses will be needed to identify reasons for their poor emotional experiences. Last, participant recruitment outcomes suggested that by communicating with community-based organizations, we could connect with hard-to-reach populations and more effectively collect feedback from them.

CHAPTER 1: INTRODUCTION

MnDOT has been undertaking the Advancing Transportation Equity Initiative to better understand how the transportation system, services, and decision-making processes help or hinder the lives of people in underserved and underrepresented communities in Minnesota. Early transportation equity work has indicated that our research and decision-making processes do not adequately consider transportation needs by gender.

There is more information about transportation needs of women at the national and international levels. Study cases in the U.S. have revealed that, compared to men, women tend to travel for a wider variety of purposes, make more household-supporting trips, rely more on a household vehicle if they have one, and are more concerned about safety during travel. It is important to complete analyses to confirm whether these patterns apply in the Minnesota context to ensure policy decisions can meet the specific transportation needs of all genders accordingly.

Moreover, gender identity has not been incorporated into transportation planning and practices. Most studies have classified people's gender as male or female, commonly based on their biological sex. This ignores people's inner feeling of their gender, also known as their gender identity, which is not always in accord with their biological sex and may go beyond the male-female binary. So, using male and female to define people's gender can lead to the misunderstanding of transportation needs and experiences of marginalized populations in the realms of gender and gender identity. Accordingly, understanding the complex nature of gender identity beyond the male-female binary and its impact on transportation needs and experiences will help policymakers improve their decisions so that reliable, safe, and healthy transportation options are available to all genders.

To address these gaps, this project examined whether and how the socially constructed gender might result in distinct activity-travel patterns and subjective well-being outcomes using survey data collected at the individual level. The objectives of this project included:

- Advance the understanding of gender differences in transportation needs and experiences by capturing the complex nature of gender beyond the binary gender of male and female. The project considered gender identity that is interconnected with other dimensions of a person's social identity such as race and family types. The project also considered gender roles (generally desirable behaviors) that may substantially vary across cultures and regions and can significantly influence a person's transportation needs and experiences.

- Use the 2019 Travel Behavior Inventory (TBI) household survey data to identify groups of people with distinct behaviors and relate them to the social identities of each group (e.g., gender, race, ethnicity, income, and education). The findings can reveal whether and how the intersectionality of gender and other dimensions of social identity may lead to distinct travel behaviors.

- Collect new survey data to capture the intersectional nature of gender and examine its impact on travel experiences and subjective wellbeing (SWB) outcomes. The survey included questions

to address various aspects of gender such as sex at birth, gender identity, and gender roles as well as other aspects of social identity such as employment, family type, and race. The project collected participants' diaries and their SWB status during travel and activity participation to investigate how gender, in a broader sense, may affect a person's travel needs and experiences.

- Identify potential disparities of activity-travel behaviors and SWB outcomes statewide across gender and other social groups, especially marginalized groups whose needs and experiences are often misunderstood. These findings can facilitate potential action items that incorporate gender and identity into transportation planning and policymaking.

The report is organized as follows. Chapter 2 provides a systematic review of previous research and projects on gender and gender-typical travel behaviors. This includes a summary of key terms related to gender, discussions on the intersectional nature of gender, and a synthesis of findings regarding gender-typical travel behaviors and the definition of gender used in each study.

Chapter 3 presents the design of the new survey and the procedure and outcomes of data collection. It starts with an explicit discussion of how the survey was designed to effectively collect information about various aspects of a person's gender and the involvement of gender roles involved in activities and trips. It then summarizes the participant recruitment outcomes with a focus on the profiles of the participants who have joined and completed the surveys.

Chapter 4 examines activity-travel patterns in Minnesota, focusing particularly on identifying gender-typical behavior patterns and relating these patterns to gender identities and gender roles. The chapter first introduces the 2019 TBI data and the new 2021 survey data collected before and after the outbreak of COVID-19, respectively. The chapter then presents visual explorations of mobility patterns and compares such patterns across intersectional social groups. The chapter continues to highlight groups with distinct patterns and relate them to the social profiles of each group, which include selecting and refining statistical methods, visualizing analysis results, and comparing results across days of the week and among social and behavior groups.

Chapter 5 investigates the SWB outcomes of everyday life in Minnesota. Based on the new 2021 survey data that collects experienced emotions during activities and trips, this chapter presents visual and statistical analyses of emotional outcomes and their associations with key socio-demographic characters that determine activity-travel patterns, including gender, employment status, student status, family type, age, race, and educational attainment.

Chapter 6 summarizes the key findings from the project and their benefits to Minnesota's transportation research, planning, and practices in the future.

CHAPTER 2: LITERATURE REVIEW

This chapter reviews existing literature on gender and travel in transportation and social science. The main purpose of the review is to explicitly describe gender-typical activity-travel behaviors. The review section contains two sub-sections: (1) definitions of gender in transportation studies and social science, and (2) findings regarding gender-typical behaviors. The review section provides the basis for the survey design, quantitative analysis, and result interpretations in later chapters and useful references for future research and practices.

2.1 DEFINE GENDER

Gender has often been viewed as a synonym for women in transportation studies. Most studies have used sex, or biological differences between females and males, to define gender and study gender differences in travel needs, behaviors, and experiences. Nevertheless, gender is a much broader term, which refers to "the associations, stereotypes, and social patterns that a culture constructs based on actual or perceived differences between men and women" (Nelson 1995). This suggests that gender is a social construction, and it is "about roles and relationships, about differentials in power and access to resources" (Fainstein and Servon 2005) in a society during a specific period. Given this dynamic nature of gender, "although differences between men and women that stem from sex do not change much", gender roles have been constantly evolving, reflecting the expected attitudes and behaviors a society associates with each sex (Lindsey 2020). This section lists key terms in gender studies and discusses the intersectional nature of gender as part of a person's social identity.

2.1.1 Gender Terms

Figure 2.1 presents the *Gender Unicorn* (TSER), which contains key glossaries to describe a person's gender identity, gender expression, sex assigned at birth, and sexual attractions both physically and emotionally. Definitions of these gender terms may vary across academic realms, government agencies, and non-profit organizations. Below are three useful resources:

- Definitions Related to Sexual Orientation and Gender Diversity in APA Documents. American Psychological Association: https://www.apa.org/pi/lgbt/resources/sexuality-definitions.pdf
- Frequently Asked Questions about Transgender People, National Center for Transgender Equality: https://transequality.org/issues/resources/frequently-asked-questions-about-transgender-people
- GLAAD Media Reference Guide, 10th Edition, GLAAD (Gay and Lesbian Alliance Against Defamation): https://www.glaad.org/reference

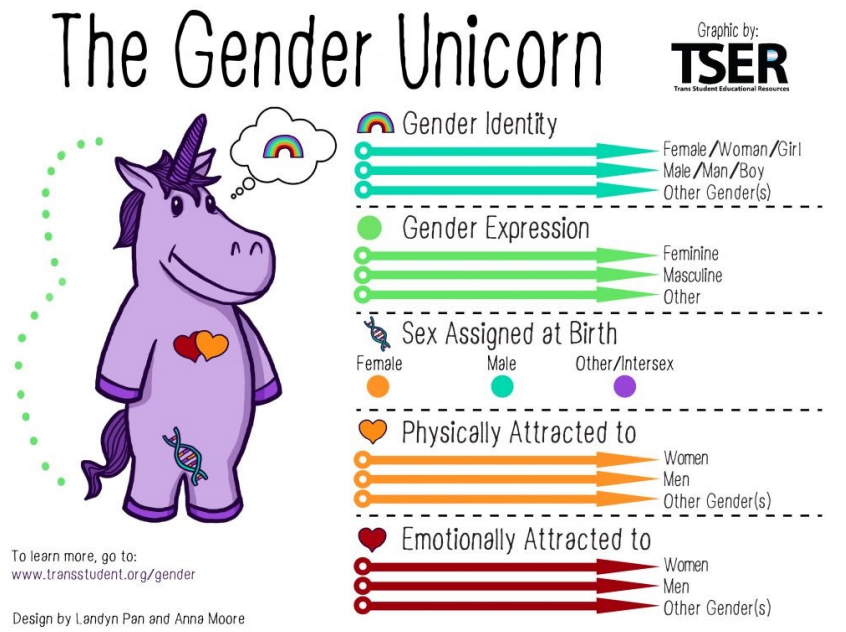


Figure 2.1 The Gender Unicorn. (source: transstudent.org)

The gender terms listed below were used to guide the survey design for data collection in our project. In addition to the terms listed below, the 2015 Transgender Survey were also used as a key reference to develop language in the survey (accessible at: https://www.ustranssurvey.org/). Note that this list does not contain all gender terms but only those closely related to this project.

- **Gender** refers to the attitudes, feelings, and behaviors that a given culture associates with a person's biological sex. Behavior that is compatible with cultural expectations is referred to as gender-normative; behaviors that are viewed as incompatible with these expectations constitute gender non-conformity (APA).
- **Gender Binary** refers to the two categories of male and female (NCTE).
- **Gender Expression** refers to an individual's presentation — including physical appearance, clothing choice, and accessories — and behavior that communicates aspects of gender or gender role. Gender expression may or may not conform to a person's gender identity (APA)
- **Gender Identity** refers to one's sense of oneself as male, female, or something else (APA). When one's gender identity and biological sex are not congruent, the individual may identify along the transgender spectrum (APA).
- **Gender Role** reflect the expected attitudes and behaviors a society associates with each sex. This definition places gender in the sociocultural context (Lindsey 2020). It is worth pointing out that when the sociocultural concept of role is combined with the biological concept of *sex*, it is difficult to determine what content is being discussed when subsumed under the label of sex role. Accordingly, gender role, rather than sex role, is standardized usage in sociology today.

- **Homosexuality** refers to sexual attraction or activity between members of the same sex. It is now commonly referred to as same-sex sexual orientation or activity. Although the term can refer to homosexual orientation in both men and women, current practice often distinguishes between gay (typically males) and lesbians (typically females) (APA).
- **LGBTQ** is the abbreviation for lesbian, gay, bisexual, transgender, and questioning or queer. It is an inclusive term used to refer to the homosexual population in all of its diverse forms, to those with both homosexual and heterosexual preferences, and to those whose gender identity differs from the culturally determined gender roles for their birth sex (APA).
- **Non-Binary Gender** is used when people who don't neatly fit into the binary gender of female and male. Most people – including most transgender people – are either male or female. But some people don't neatly fit into the categories of "man" or "woman," or "male" or "female." For example, (1) some people have a gender that blends elements of being a man or a woman, or a gender that is different than either male or female; (2) some people don't identify with any gender; and (3) some people's gender changes over time (NCTE).
- **Sex** refers to a person's biological status and is typically categorized as male, female, or intersex. There are several indicators of biological sex, including sex chromosomes, gonads, internal reproductive organs, and external genitalia (APA).
- **Transgender** is an umbrella term that incorporates differences in gender identity wherein one's assigned biological sex doesn't match their felt identity. This umbrella term includes persons who do not feel they fit into a dichotomous sex structure through which they are identified as male or female. Individuals in this category may feel as if they are in the wrong gender, but this perception may or may not correlate with a desire for surgical or hormonal reassignment (APA). It is inappropriate to use transgender as a noun (e.g., is a transgender) but instead as an adjective (e.g., is transgender) (GLAAD).

2.1.2 Intersectionality

Intersectionality refers to the interaction between gender, race, and other categories of difference in individual lives, social practices, institutional arrangements, and cultural ideologies and the outcomes of these interactions in terms of power (Davis 2008). Kimberlé W. Crenshaw's work (1990) is one of the first studies that address the intersectional nature of gender. Crenshaw argued that studying gender independently from other identities such as race would marginalize groups such as women of color (Crenshaw 1990).

The intersectionality reflects how we respond to our social environment and consequently constitutes or changes our social identities. This suggests that (1) the gender identity, or awareness of self-regarding gender, is one of many social identities of a person, with some others being race and ethnicity, class, parenthood, and life stage; and (2) gender identities can change over time, and they are essentially self-reflection on the reality of lives given the time and location.

Intersectionality has been widely recognized as a success in feminist scholarship that can address the differences among women as well as among genders (Shields 2008). However, studies on gender and travel have not fully addressed the intersectionality issues (Rosenbloom, in preparation). For example, studies revealed that women made more mid-day trips than men, but this statement did not account for the fact that more women were employed part-time than men and travel in the middle of the day as well (CIVITAS 2020). This would indicate that, instead of gender, employment status may be the factor that leads to more mid-day trips. Another example was that women with low incomes, particularly those of color, usually traveled further than other workers, which contradicted the general conclusion that men traveled further than women in the literature (Rosenbloom et al. 2019). Therefore, it is necessary to adopt an intersectional perspective while studying gender and travel. Specifically, it is vital to better understand how gender interacts with race, employment status, income, and other social, economic, and demographic characteristics of a person to obtain a more accurate and comprehensive view of travel differences across genders as well as within various groups of women.

To emphasize the unique form of identity created out of intersections, existing studies often defined or derived a set of social characteristics to identify a group (i.e., low-income women of color) and compared their transportation needs, behaviors, and experiences. For instance, studies have examined how *race* may lead to different travel constraints, decisions, experiences, and safety concerns (Gao and Kerstetter 2016, Levis 2013, Sersi et al, 2020). Special attention has been paid to travel modes such as bicycling and public transit and identified challenges to adopting these 'green' modes for women from various backgrounds (Barajas 2016, Graglia 2015). The *cultural dimension* of social identities has been addressed in several studies to recognize the role of cultural norms in explaining unique behavior patterns for women immigrants (Bourke et al. 2019, Iqbal et al 2020, Rosenbloom and Plessis-Fraissard 2009). Some other studies investigate the intersection of gender and *family relationship* and *employment status*, especially dual-earning couples or partners (Chidambaram and Scheiner 2020, Fan 2017). Besides, a few recent studies also start to address gender beyond the binary males and females and investigate travel behaviors of gender non-conforming people (e.g., Klein and Smart 2016, Smart et al. 2017, Smart and Klein 2013). The next section provides a systematic and detailed literature review on gender and travel.

2.2 GENDER-TYPICAL BEHAVIORS

To obtain evidence on differences in travel behaviors among genders national and internationally from existing studies, we conducted the literature review on gender and travel. We searched literature on gender and travel in four academic databases (Web of Science, Science Direct, WorldCat, and Academic Search Premier) and three databases in the field of transportation (TRID, Transport Database, National Transportation Library). We used a combination of keywords related to gender and travel and searched them in titles and keywords (and in abstracts if feasible). Keywords related to gender included "gender", "gendered", "gender gap", "gender-typical", and "women", and keywords related to travel included "travel", "travel behavior", "travel pattern", "transportation", and "transport". Then, we searched literature about travel behaviors for gender non-conforming groups. Keywords related to non-binary

gender included “LGBTQ”, “non-conforming”, “same-sex”, “gay”, and “lesbian”, and keywords related to travel were the same as the previous search. Figure 2.2 illustrated the main steps.

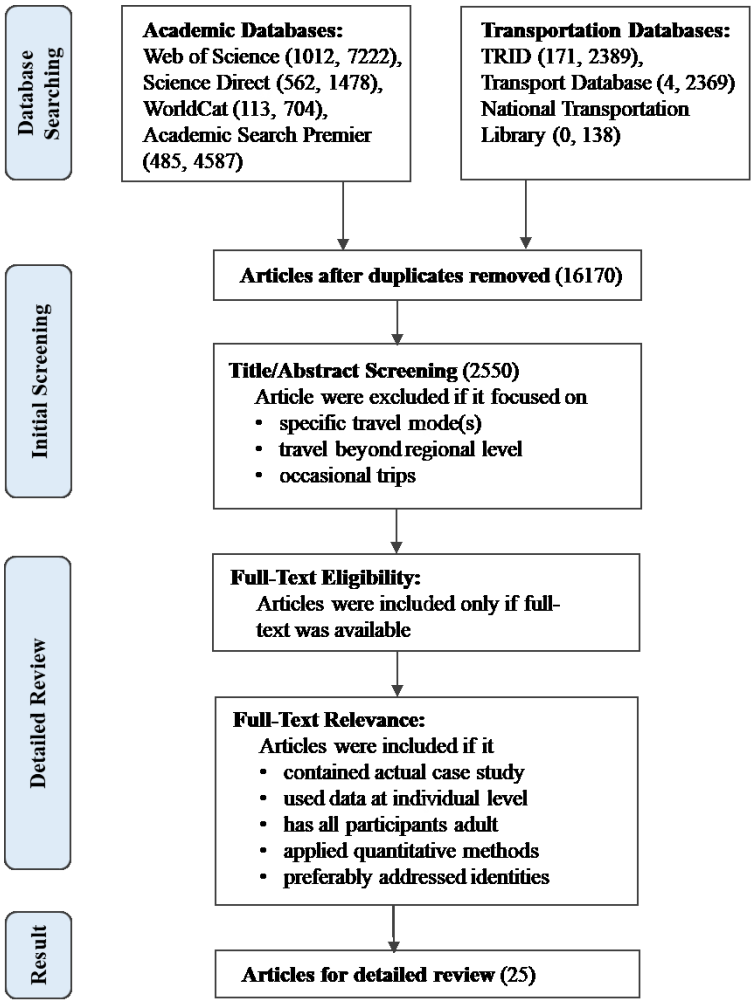


Figure 2.2 Literature search process and selection criteria.

The selection criteria included two main steps: initial screen and detailed review. For the initial screen, we selected only articles directly relevant to everyday travel behaviors at the regional level and for all travel modes. Therefore, studies that focused on specific travel modes (e.g., bicycling and public transit, carsharing), trips beyond the regional level (e.g., national and international flights), and occasional trips (e.g., tourism) were not selected. We also excluded studies that analyzed travel behaviors but only used gender as one of the many attributes instead of focusing on the impacts of gender. After the initial selection, we continued to the detailed review considering two major factors: eligibility and relevance. First, we only included studies if the full text was available. For references that only contained abstracts, it was hard to get details regarding how those studies reached conclusions and how to incorporate their methods and/or findings into our data collection and analysis. Second, we read through the articles and used a set of criteria to determine the relevance of each reference. These criteria included: (1) the study contained actual case studies, not just a literature review; (2) data used for analysis was at the individual level instead of the aggregated level; (3) participants were at least 18 years old; and (4) methods used in

the study were quantitative instead of qualitative. We also preferred studies that addressed identities other than gender binary.

We included the final selection of literature on gender and travel in Appendix A and described the data and study area, data analysis method, gender groups and intersectionality, and main findings of each study. In the list below, we summarized some key differences in travel behaviors of women, men, and non-conforming genders in the existing literature. Please note that these findings reflected common views on gender-typical behaviors, mostly in the U.S., and many findings were not grounded on the intersectionality of gender and other social identities.

- Women tend to work closer to home with *shorter commuting distances and time.*
- Women tend to travel for a *wider variety of purposes* and make *more household-supporting trips* (e.g., drop off, pick up, shop, family errands).
- Women tend to make *more multimodal trips* and *chained trips* (for household-related purposes).
- Women are more likely to travel *with kids, strollers, and grocery bags.*
- Women are more likely to travel *during mid-day hours and off-peak hours.*
- Women are more sensitive to *safety concerns, time, and stress.*
- Women have *less access to a car*, but if they have access, they *rely more on driving.*
- Gender gaps are *more significant* between married women and men, especially with the *presence of a child.*
- Compared to straight couples, gay/lesbian partners/couples have a *more equal division of household tasks* between partners/couples.
- Gays/lesbians tend to travel *shorter distances* and use *alternative modes* of travel, such as shared mode (carpool, transit) and non-motorized mode (bicycle, walk).

Regarding intersectionality, the four common attributes considered in the existing literature besides gender were *race*, *family members* (kids in particular), *employment status*, and *age*. Also, most studies often considered a combination of two or three attributes. We used these findings as references in our survey design and data analyses and compared these findings with findings from our analysis in this project in later sections.

CHAPTER 3: SURVEY DESIGN AND DATA COLLECTION

To study whether and how gender identity beyond the male-female binary affects people's travel needs, behaviors, and experienced emotions, we used the Daynamica smartphone application and collected 14 days of diaries and subjective wellbeing outcomes. We described the survey design and data collection procedures and summarized the recruitment outcomes in this section. And we included all the survey questions in Appendix B.

3.1 SURVEY DESIGN

Three surveys were designed, each collecting a different set of information from participants. The *intake survey* collected each participant's gender identity and attitudes toward gender roles as well as their basic demographics and travel preferences. The *Daynamica survey* collected participants' activity-travel diaries, which recorded the type, location, and timing of each activity, the travel mode, route, and timing of each trip, the experience and emotion during each activity and trip, and additional information such as trip purpose and companionship. Each day also contained an end-of-day survey that collected information such as time allocated to household supporting tasks. Finally, the *exit survey* was given to participants once they completed the 14-day travel diary collection, which collected their experiences during their participation. Please refer to Appendix B for all questions in these three surveys.

To address the complexity and dynamics of gender identity and gender roles, both the intake survey and the Daynamica in-app survey included sections for gender-related questions. The intake survey included one section that collected data on gender and gender identity, and another section that collected data on gender roles and their impacts on travel decisions and experiences. Each section provided contexts of questions in that section to make them understandable to the general audience, such as the reason that we are collecting and the links to external resources (Figure 3.1). The Daynamica in-app survey asked participants to specify whether each trip or activity involved household supporting tasks while they were recording their activity-travel diaries. The in-app survey also asked participants to record approximately how many hours were allocated to household tasks at the end of each survey day.

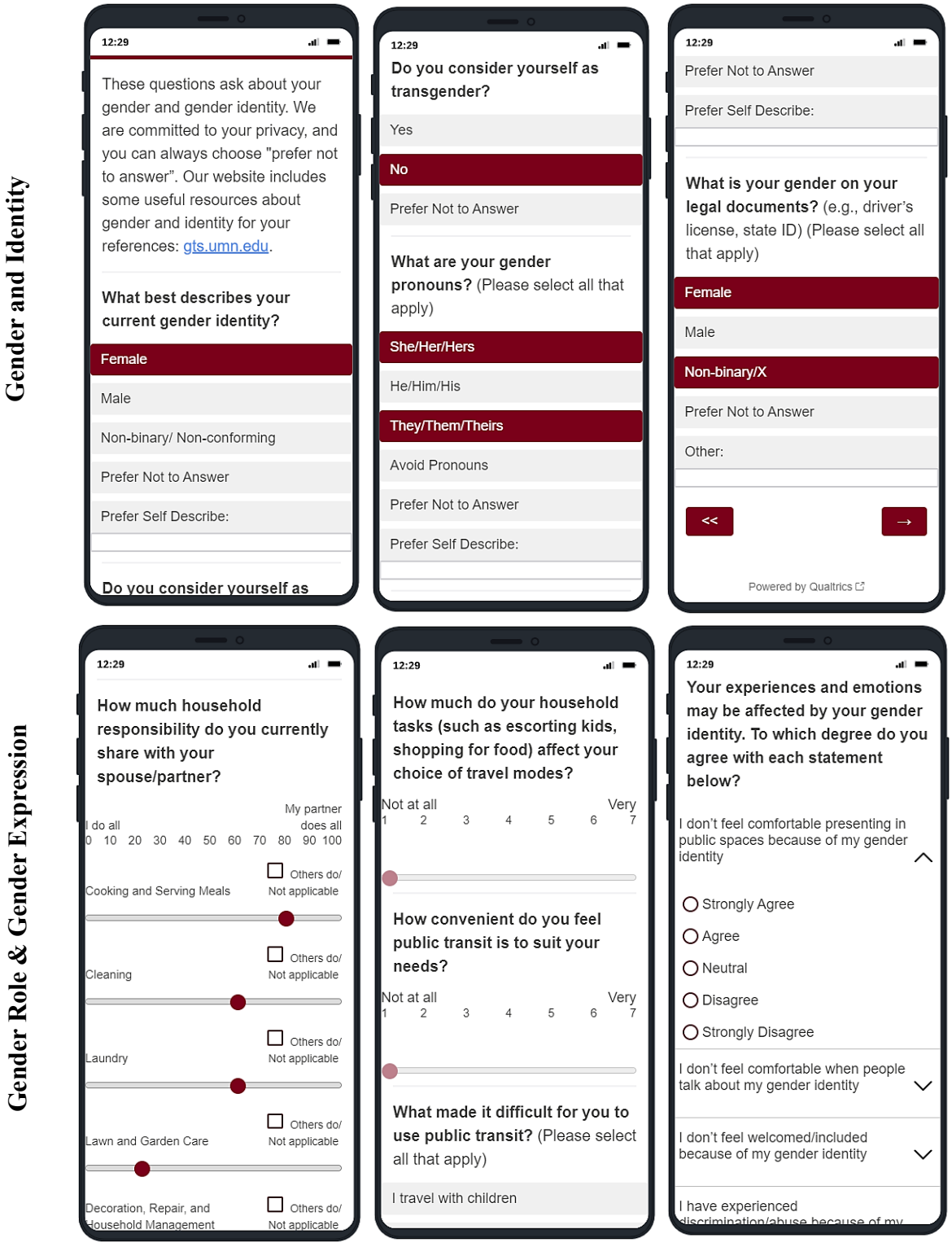


Figure 3.1 Questions on gender, identity, travel, and experiences in the intake survey.

3.2 DATA COLLECTION

3.2.1 Participant Recruitment

We recruited participants remotely via email and social media advertisements. We used paid service to post advertisements on Facebook and attract participants, and we filtered receivers of advertisements by age (18+) and location (Minnesota). Meanwhile, we worked with community partners to boost social media posts on Facebook, LinkedIn, and other social media and helped us distribute the recruitment email to community members. Table 3.1 listed the 15 social groups and organizations that responded and participated in the broadcasting and reaching out. In the later stage, we used the paid recruitment service provided by Qualtrics to achieve a more diverse sample. Based on the profiles of participants who finished the survey entry or were actively recording diaries, the targeted social groups for the follow-up Qualtrics recruitment were the non-white, female, and non-binary gender groups.

Table 3.1 List of organizations and social groups, groups targeted, and approach used for recruitment.

Organization	Targeted Population	Recruitment Approach
University of Minnesota		
Center for Urban and Regional Affairs (CURA)	all eligible participants	mailing list
Robert J. Jones Urban Research and Outreach-Engagement Center (UROC)	all eligible participants	mailing list
Center on Women, Gender, and Public Policy (CWGPP)	women	mailing list, Facebook post
Gender and Sexuality Center for Queer and Trans Life	non-binary gender	mailing list, newsletter
Duluth Office and Administrative Services Supervisor	tribal, minority	mailing list
State and Non-Profit		
Minnesota Department of Transportation (MnDOT)	all eligible participants	Crossroads, research blog
Women's Foundation of Minnesota	women	mailing list
Resilient Campus	non-binary gender	mailing list
Rainbow Health	non-binary gender	mailing list
Social Groups		
MN LGBTQ+ Therapists Network	non-binary gender	social media post (link)
LGBTQ+ Parents of MN	non-binary gender	social media post (link)
Minnesota Pride Rotary Club	non-binary gender	social media post (link)
Shift MN	non-binary gender	social media post (link)
Minnesota Queers DO WORK	non-binary gender	social media post (link)
Twin Cities Queer Families	non-binary gender	social media post (link)
NUMTOT-Twin Cities	all eligible participants	social media post (link)

The outreach materials directed interested participants to the project website at *gts.umn.edu* which was available for the duration of this study. There were five pages on the website containing essential information about survey participation, which were:

- **Home**: project introduction; participation eligibility criteria; the link to the intake survey; the contact information of the team
- **Details**: project objectives and participation procedures; the link to the intake survey; the contact information of the team
- **Daynamica User Guide**: a video demo to show how to use the Daynamica smartphone application; links to additional external references for user guidance
- **FAQ**: frequently asked questions to help participants quickly understand details surrounding their participation.
- **Other Resources**: references for gender terms; links to groups and organizations for gender studies; community resources for LGBTQ+ in and beyond Minnesota

Once the interested participants provided consent and finished the intake survey, the project manager (the graduate student researcher) emailed each participant the Daynamica log-in information, kept in touch with the participant during their participation, and sent reminders and suggestions to ensure the quality of the survey entry. Figure 3.2 illustrates the data collection procedures, and the next section described such procedures in more detail.

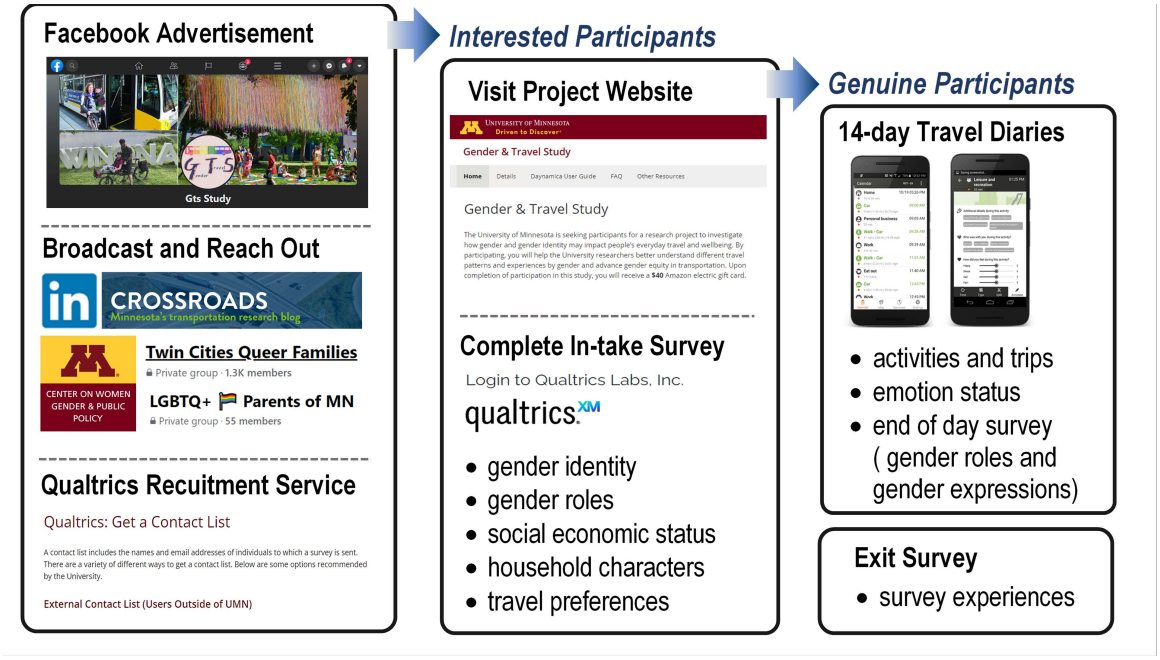


Figure 3.2 Participants recruitment and data collection procedure.

3.2.2 Data Collection and Administration

The team launched the intake survey and started collecting data on September 19th, 2021, deactivated the intake surveys on January 1st, 2022, and stopped all the data collection on February 1st, 2022. The team created two progress reports on October 15, 2021, and November 12, 2021, to assess participants' demographic profiles for use in adjusting recruitment strategies. The reports both identified the need to recruit more Black women and gender non-conforming people. The reports also identified the need for screening steps to exclude non-genuine or ineligible participants considering the criteria listed below:

- Fraud indices generated by Qualtrics survey system. In particular, the team excluded participants with high probabilities that (1) the person had already taken the survey; or (2) it was an auto-filled survey (i.e., bots).
- IP addresses of survey responses. The team used longitude and latitude generated based on the IP address to determine whether the participant was living in Minnesota while entering the survey.
- Ages and zip codes entered by participants. The team used the age and zip code to check whether the participant was (1) not 18+ years old or (2) living outside Minnesota.
- Installation of the Daynamica application. If participants did not install the application and log into the application, they were excluded from the 14-day travel dairy data collection.

The November report identified the lack of non-white females and males and people from gender non-conforming groups. To achieve the desirable sample, the team determined the targeted recruitment groups and the numbers for each group as below:

- Subgroup 1: non-white female – 80
- Subgroup 2: non-white male – 55
- Subgroup 3: white male – 30
- Subgroup 4: LGBTQ – 60

The team contacted the Qualtrics team and used their paid service to reach out to potentially interested participants. The Qualtrics team forwarded our invitation emails, and interested participants received links to our website to start their participation, following the same procedure as other participants.

Once participants finished entering 14 days of Daynamica data with good quality, they were asked to fill out the exit survey and end their participation. One day of good-quality data needed to have at least 20 hours of confirmed or edited trips and activities within the standard daily 24-hour period, at least 80% of the activity- and trip-level questions answered, and a completed end-of-day survey. The exit survey was not required, and the participants can provide feedback on their participation experiences. Participants can continue to collect data using Daynamica with no additional benefits or costs.

The team deactivated the intake surveys and stops enrolling participants on January 1, 2022. The team kept collecting the 14-day travel dairies from enrolled participants until they finished the 14-day travel diaries (or dropped out during the survey entry). All active participants were terminated at the end of the data collection period on February 1, 2022.

3.3 RECRUITMENT OUTCOMES

In this section, we summarized the recruitment outcomes, and we focused on the profiles of participants, including gender identity, race and ethnicity, household members, and residential location. According to the recruitment process in Figure 3.2, the five enrollment statuses for participants were:

- Inactive: completed the in-take survey, but did not install or initiate the Daynamica app
- In Process: in the process of completing the 14-day in-app survey at a given time
- Withdraw: withdrew from the study (formally notified by email; no more data entry)
- Complete: completed the 14-day in-app data collection with good quality
- Fraud/Bots: detected as non-genuine users by either Qualtrics or Daynamica data

In the end, 781 participants completed the in-take survey with no missing or artificial data, and 278 of them advanced and completed entering the 14-day travel diaries with good quality. Figure 3.3 showed the enrollment number overall time categorized by participants' final enrollment status at the end of the data collection period. As shown in Figure 3.3, participants recruited through Facebook advertisements and social groups reaching out were much more likely to complete the survey (orange lines) than be inactive (grey dashed lines) or withdraw (blue lines). Participants recruited by Qualtrics had much lower completion rates than participants recruited using other means; many of them did not install or initiate the smartphone app after completing the intake survey. In Figure 3.3, the left part was the period before we used the Qualtrics for recruitment and the right part was the period after we used the Qualtrics paid service.

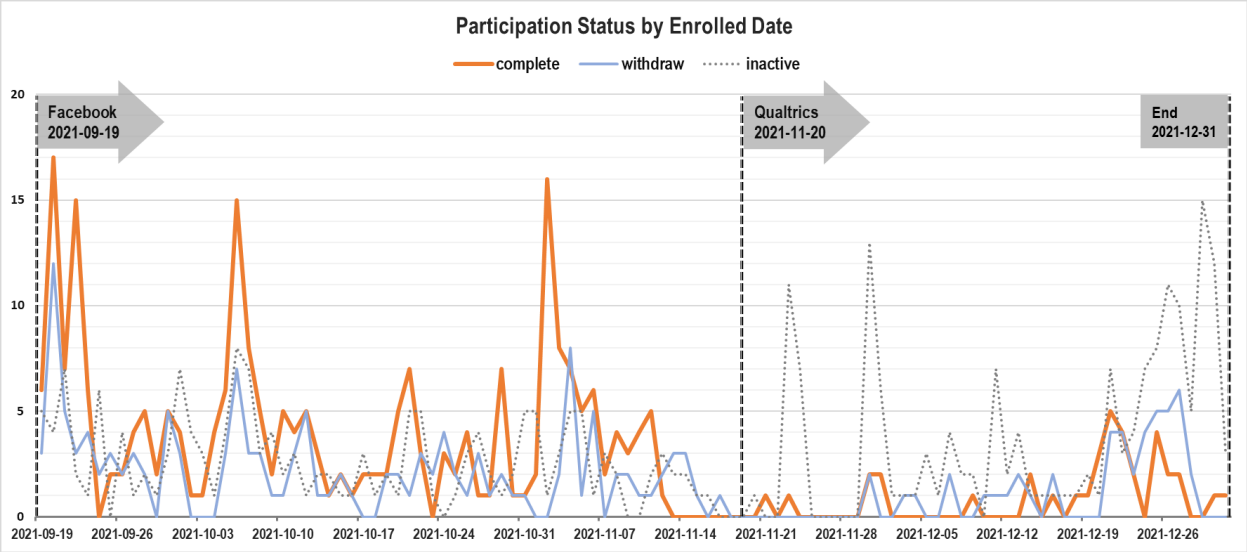


Figure 3.3 Number of participants by their final enrollment status over time.

Participants who completed the survey had diverse identities regarding their race, gender, age, and family type. Figure 3.4 showed how completion rates varied across race and gender identity. Specifically, non-white males and females were more likely to withdraw after completing the in-take survey, while

about 40% of white participants completed the 14-day of Daynamica data entry. This suggested that it was more challenging for non-white people to continuously provide or adopt new technologies like the smartphone app we used for data collection.

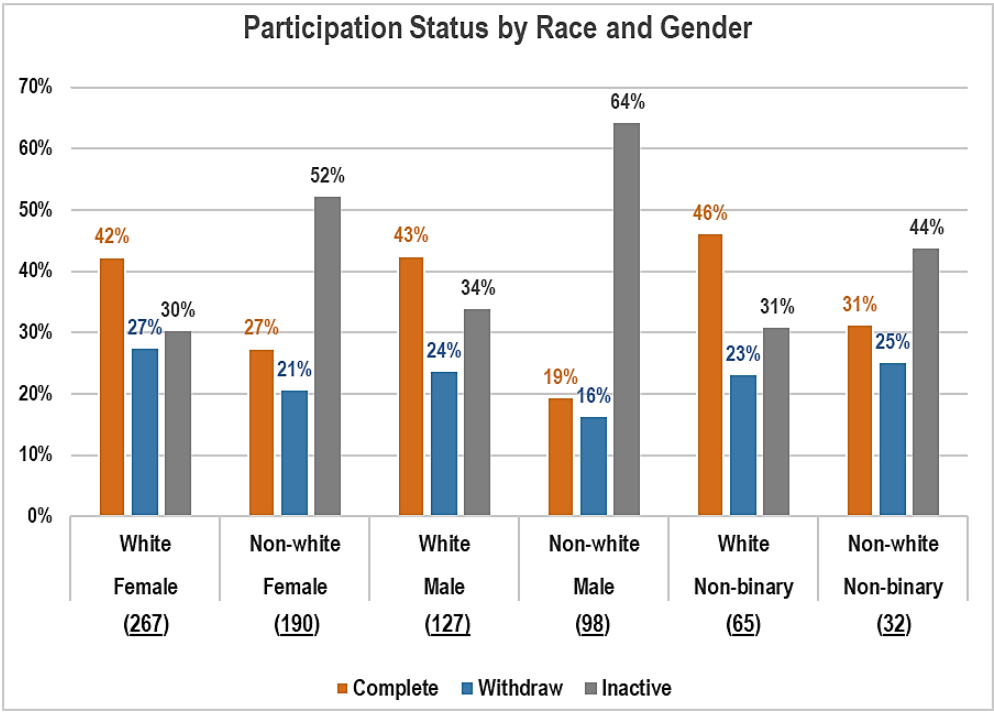


Figure 3.4 Completion, withdrawal, and inactive rates by gender identity and race.

Last, the team mapped the spatial distribution of participants who completed the 14-day travel survey and examined whether the sample had good spatial coverage across Minnesota. The map in Figure 3.5 showed the total number of participants by county. As shown in the figure, the participants were well distributed across Minnesota despite the small sample size. Specifically, 121 participants were from Hennepin County; 69 participants were from Ramsey County; and Anoka (10), Dakota (9), St. Louis (9), Washington (9), and Olmsted (8) counties had a few participants each. The remaining counties had 6 or fewer participants who completed the 14-day survey.

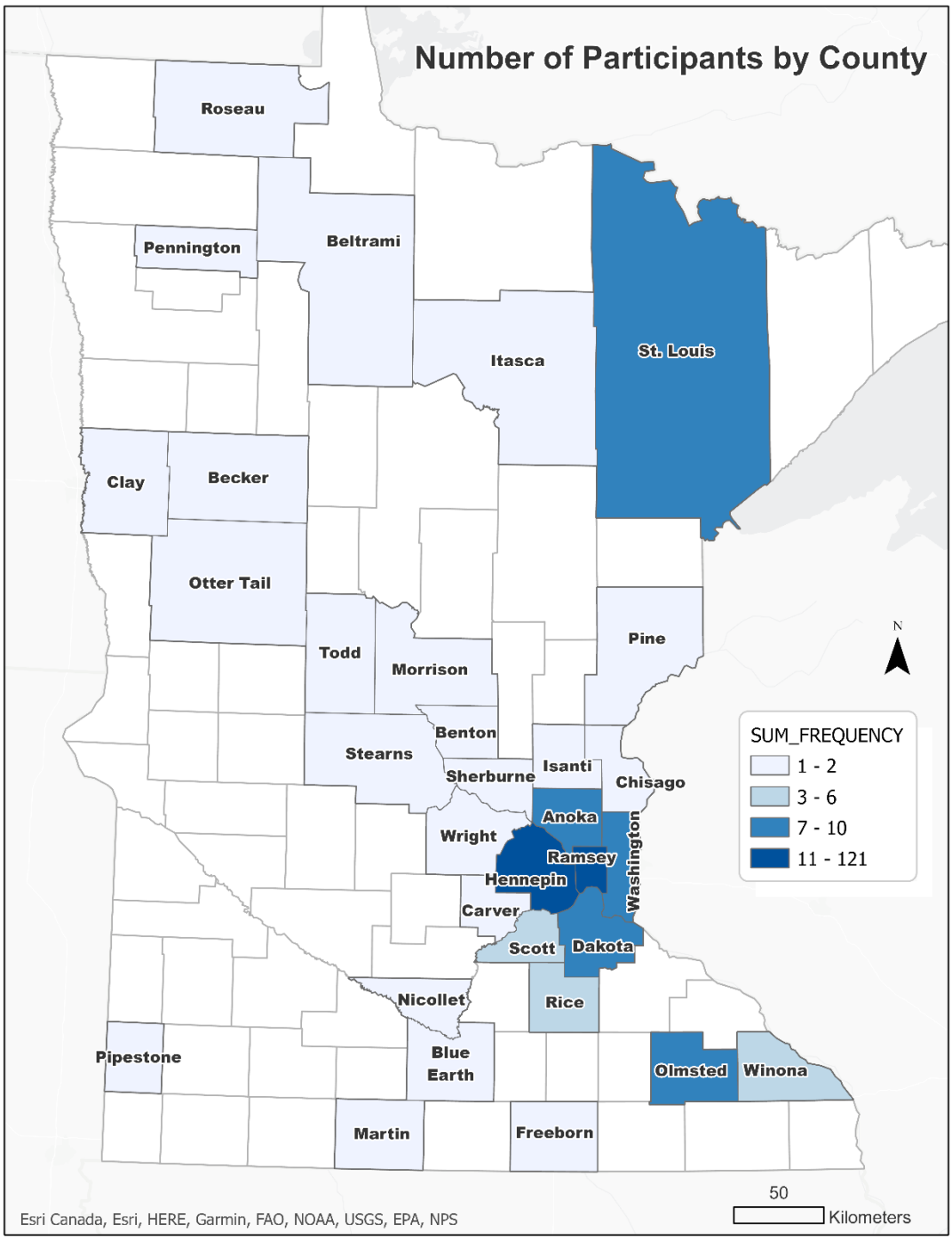


Figure 3.5 Spatial distribution of 278 participants aggregated by county in Minnesota.

CHAPTER 4: ACTIVITY-TRAVEL BEHAVIORS

The team analyzed data collected from two different surveys to identify distinct activity-travel patterns and related these patterns to participants' gender identity, race, employment status, and other social identities. These two surveys were the Travel Behavior Inventory (TBI) household travel survey collected by the Metropolitan Council between October 1, 2018 and September 30, 2019 (pre-pandemic), and the survey conducted by our team using the Daynamica smartphone application, which we used to collect data from our study participants between September 19, 2021 to February 1, 2022. There were 7,837 households participated in this 2018-2019 TBI survey. However, the TBI survey did not focus on gender identity; therefore, the TBI survey did not collect data regarding gender identity nor whether activities and trips involved household supporting tasks. To address these gaps, the team collected new activity-travel survey data. Among the 781 participants who finished their in-take survey, 278 provided 14-day activity-travel diaries of good quality. Our specific aims included:

- Describing travel patterns of participants from each dataset such as total time outside the home, number of trips, and total trips using household vehicles
- Extracting distinct activity-travel patterns from each dataset with a focus on household supporting activities and trips and the dependency on household vehicles
- Relating the extracted patterns with participants' gender, age, race, family type, and other socio-demographic characters from an intersectionality perspective
- Comparing activity-travel patterns derived from TBI data and Daynamica data to identify the potential impacts of COVID-19 on everyday activities and trips
- Investigating participants' gender identities beyond the binary male and female and their impacts on time allocations and travel choices using the Daynamica survey data

In the following subsections, we presented the methods used to prepare and analyze the data, summary statistics of travel patterns, distinct activity-travel patterns across days of the week, representative social identities of these distinct patterns, and the impacts of gender identities on these patterns.

4.1 DATA PREPARATION

The team prepared the data as sequences of activities and trips and reclassified activity and trip types considering our project's focus on gender identity and gender roles. Figure 4.1 presents the processing methods and an example output sequence with labels for part of a person's travel diaries. To address trips with multiple travel modes, we labeled trip legs between two activities by their sequences in the trip. For instance, the second trip in Figure 4.1 from school to work contains four trip legs: a car trip from school to the transit station, a waiting episode at the transit station, and two consecutive bus trips to the work location. We also processed the data to make sure trips and activities are continuous in space and time, that is, there were no gaps between two consecutive activities or trips. If there was a small gap between two episodes (3 minutes and 10 meters), we extended the time from the two ends to fill in the gap. For an example, see leg 3 and leg 4 of trip 2 in Figure 4.1. If the temporal gap was large, we created a new episode in between and labeled it as "Missing". If the spatial gap was large, we viewed it as a trip with missing information; otherwise, we viewed it as an activity with missing information.

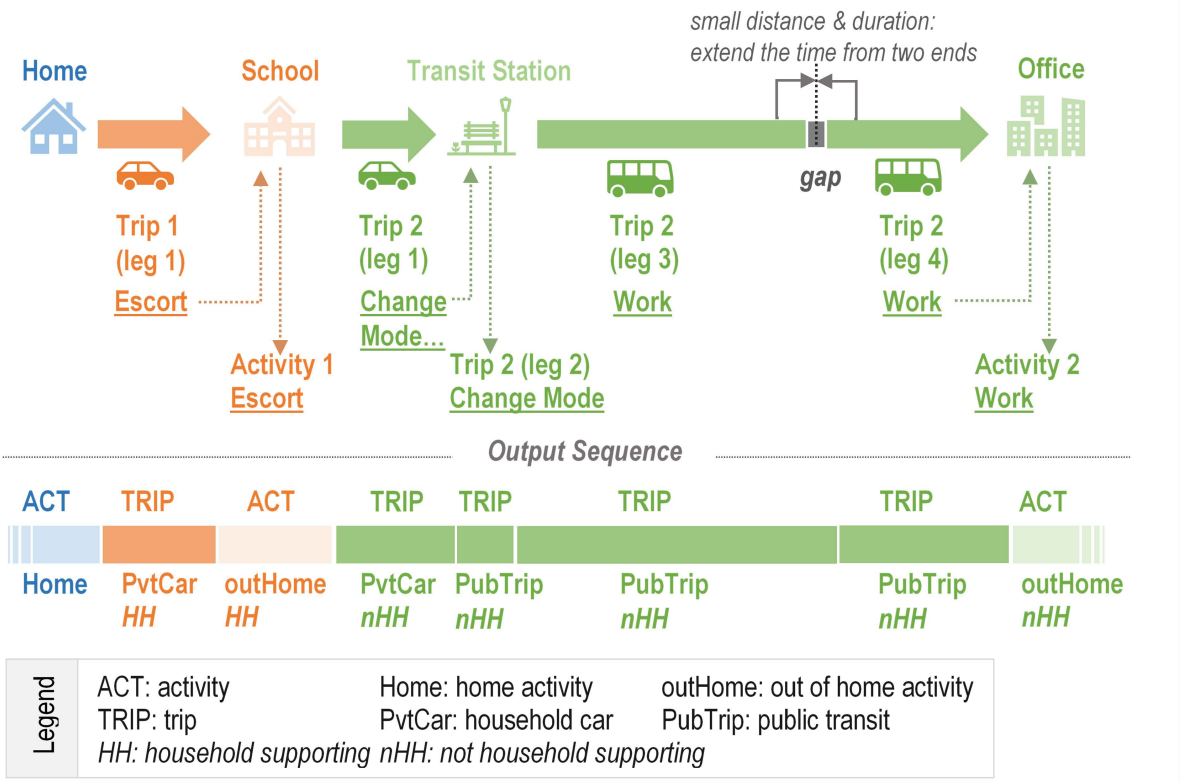


Figure 4.1 An example of input activity-travel diaries and output sequence with labels.

For TBI data, the original survey only contained trips but did not record activities. To construct the activity-trip sequences as shown in Figure 4.1, we used the trip purpose recorded in TBI to impute the type of activity at the trip destination. We categorized each activity considering whether it was at home (Home) or out of home (outHome), and whether it was a household-supporting (HH) or non-household-supporting (nHH) activity (see Appendix C for details). After imputing activity types, we checked the spatial and temporal profiles of each leg of a trip to ensure that the trip was continuous in both space and time. If a large spatial or temporal gap existed, we created a 'MISSING' episode. If the duration and distance of the gap were small, we edited the spatial-temporal profile of the two trip legs similar to the example in Figure 4.1. After dealing with the gaps, we categorized each trip leg into going home (Home), household-supporting (HH) trips, and non-household-supporting (nHH) trips. We also labeled each trip leg based on whether it used household vehicles (PvtCar) or other travel options (PubTrip).

The Daynamica data contained activity types, so we did not need to impute activities and their types. The Daynamica survey also asked users to specify whether each trip leg or activity involved household tasks, so we can directly use user-entered information to categorize activities into Home, outHome, HH, and nHH and trips into Home, HH, and nHH. The Daynamica survey asked whether a 'Car' trip used shared services such as Uber or Lyft, and we used such information to labeled the 'Car' trip as PvtCar or PubCar accordingly. We also derived another set of labels for the Daynamica data using the same imputation method we used for the TBI data, which allowed us to show how the user-entered information can provide an additional and more accurate understanding of activity-travel patterns (see Section 4.3 for results)

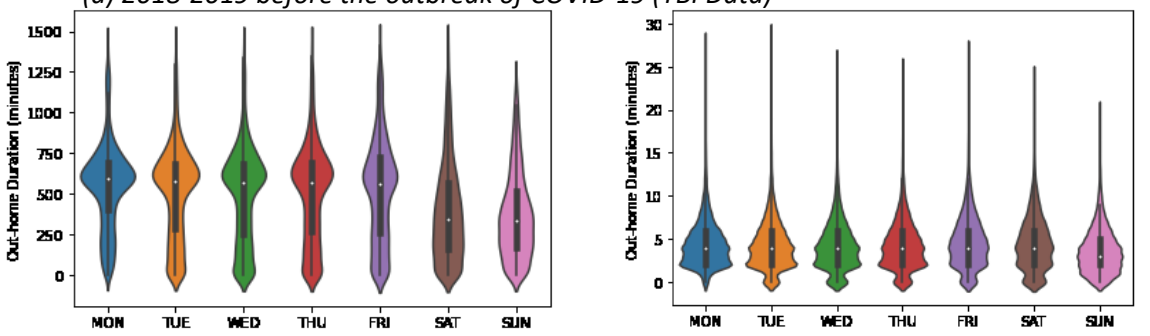
4.2 VISUAL EXPLORATION OF MOBILITY PATTERNS

Before statistical analysis, we summarized basic mobility indicators such as the number of trips per day and visually compared these indicators across days of the week and among different social groups. The visualizations in the following subsections showed general mobility patterns in Minnesota before and after the outbreak of COVID-19 as recorded in the TBI and Daynamica data.

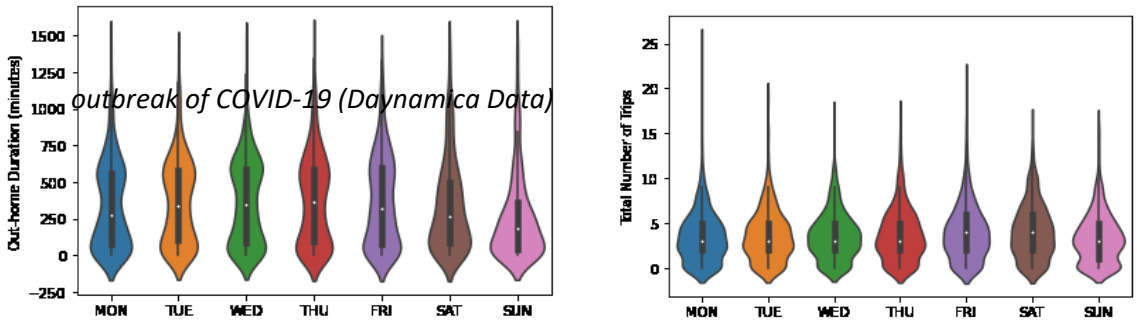
4.2.1 Days of the Week

First, we visualized the total duration of out-of-home activities and trips per day and the total number of trips per day, and we compared out-of-home durations and trip counts across seven days of the week. As shown in Figure 4.2[1], the median out-of-home durations were around 10 hours during weekdays and 4.5 hours during weekends before the pandemic. The median durations dropped to about 4.5 hours during the weekdays and 4 hours during the weekends after the outbreak of COVID-19. The number of trips per day did not change much and remains around 4 trips per day across all days of the week. In Figure 4.2, the dots in the middle showed the median out-of-home duration. The width of the violins showed the likelihood.

(a) 2018-2019 before the outbreak of COVID-19 (TBI Data)



(b) 2021-2022 after the outbreak of COVID-19 (Daynamica Data)



outbreak of COVID-19 (Daynamica Data)

Figure 4.2 Daily out-of-home duration and number of trips by days of the week using violin graph.

[1] The violin graph visualizes the distribution of numerical data. The white dot in the central-middle shows the median value, the thicker line shows the upper and lower interquartile range, and the think line shows the 1.5 times of the interquartile range. The wider part of colored region indicates more data points fall in that part.

The distribution of total out-of-home time from Monday to Friday was wider on the top (above the median value) before the pandemic, while the bottom (below the median value) became wider than the top after the outbreak of COVID-19. This was very likely due to the increase in employees who started to work from home after the outbreak of COVID-19. To validate this, we examined the daily out-of-home duration by employment status across days of the week (Figure 4.3). For TBI data, the four employment statuses were: full-time, part-time, self-employed, and not employed. For Daynamica data, we further categorized the full-time employee into work-from-home only (WFH), work-out-of-home only (OUT), and work-from-home sometimes (MIX). Figure 4.3(b) supports our intuition that full-time employees who only WFH had much less out-of-home time than other full-time employees, leading to the changes in overall out-of-home durations in Figure 4.2.

(a) 2018-2019 before the outbreak of COVID-19 (TBI Data)

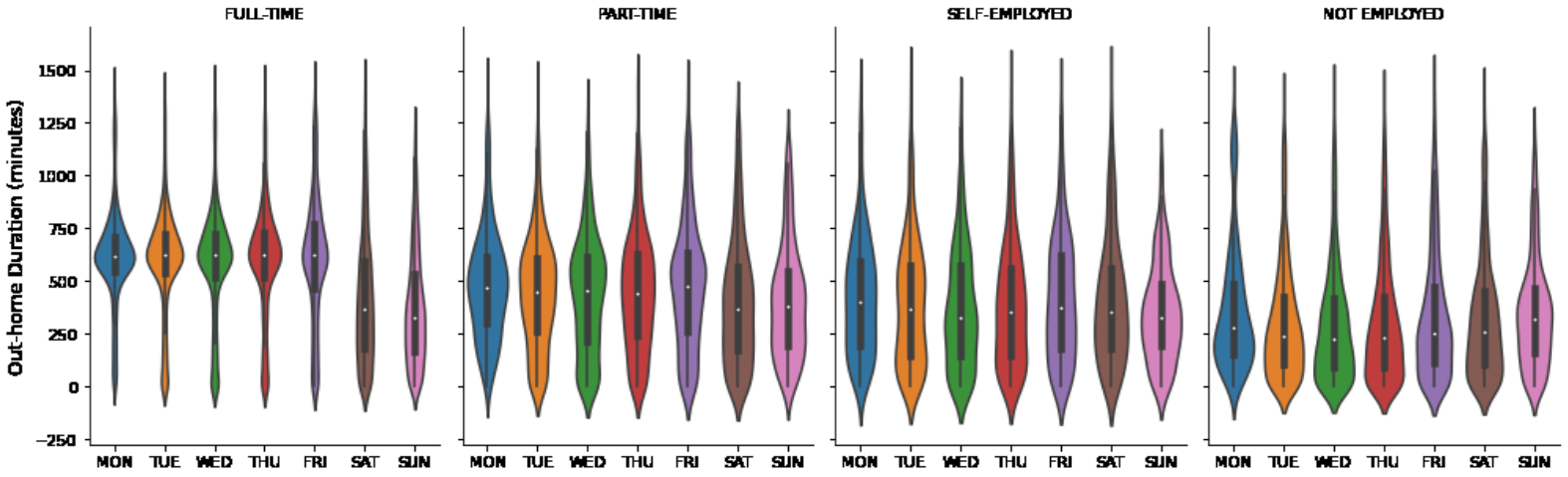


Figure 4.3 Daily out-of-home duration and number of trips by employment status across days of the week (a) before and (b) after the outbreak of COVID-19.

(b) 2021-2022 after the outbreak of COVID-19 (Daynamica Data)

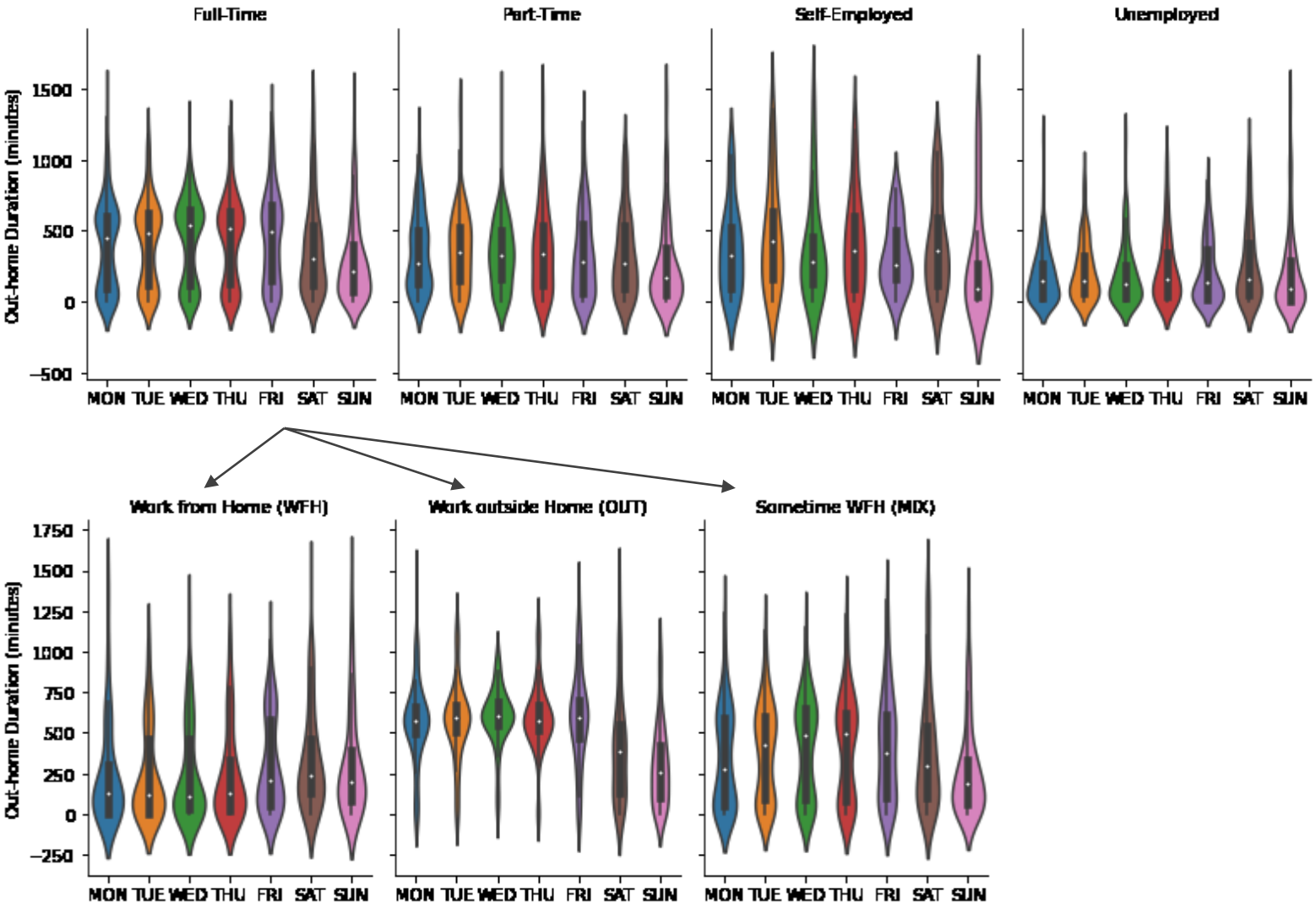


Figure 4.3 (continued) Daily out-of-home duration and number of trips by employment status across days of the week (a) before and (b) after the outbreak of COVID-19.

4.2.2 Gender, Employment Status, and Family Type

Based on the literature review in Section 2, living with kids can affect the travel needs and behaviors of women and men differently. Therefore, we continued to examine how the total number of trips per day may vary among gender identities and family types. The five family types were: (F1) living with partners only, (F2) living with partners and own or adopted kids, (F3) living only with own or adopted kids but without partners, (F4) living alone, and (F5) living with someone other than partner and kids. The three gender groups were female (or women), male (or men), and non-binary people.

In Figure 4.4, we present the number of trips per day by employment status, family type, and gender identity for weekdays. Each box plot in the figure showed the median value, upper (third) and low (first) quantiles, and minimum and maximum scores. Results from the TBI data collected before the pandemic suggested that:

- For full-time employees, living with their own/adopted kids tended to increase the number of trips for both females and males.
- Males tended to have slightly more trips per day than females for all employment statuses and family types, except when they were single parents who lived with their own/adopted kids only.
- No-binary people had unique patterns: if they were full-time employees, they tended to have more trips than females and males unless they were living with their partner and kids.

And results from the Daynamica data collected after the outbreak of COVID-19 suggested that:

- For all groups, there was an overall reduction in the total number of trips per day.
- Female full-time employees who were single parents and only WFH had more daily trips after the outbreak of COVID than before the pandemic.
- With the same employment status, females tended to have more daily trips than males while living with their adopted/own kids.
- Males had more trips than females if they were full-time/self-employed and living alone.

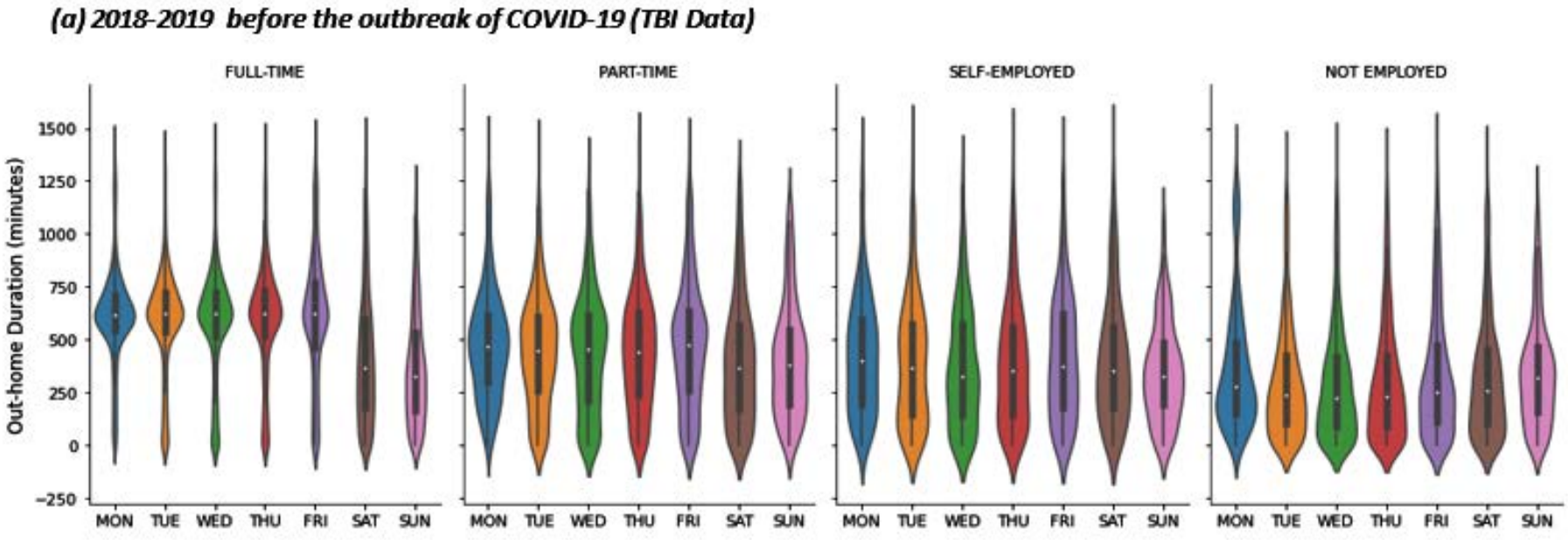


Figure 4.4 Daily number of trips by employment status, family type, and gender (weekday) (a) before and (b) after the outbreak of COVID-19.

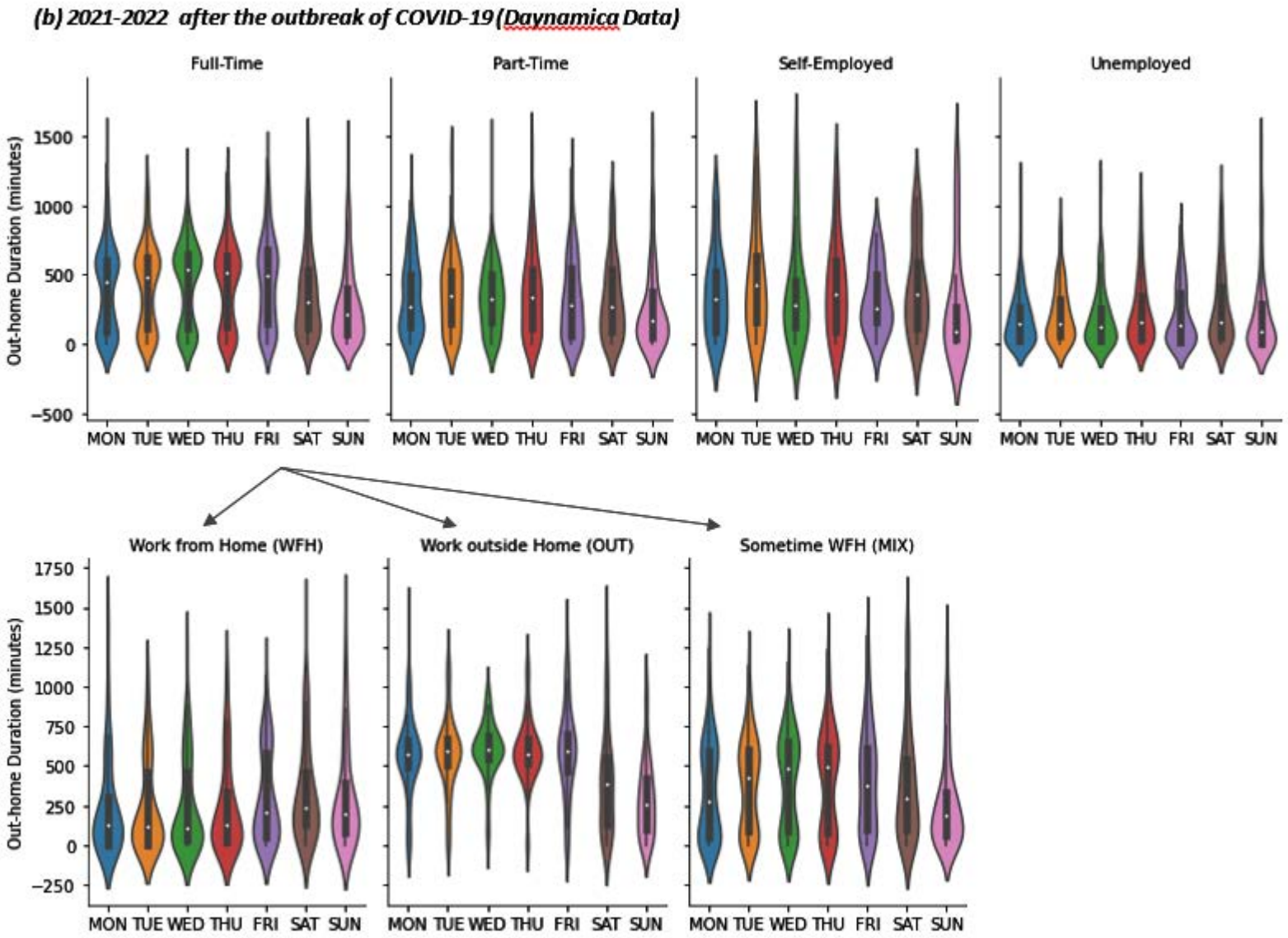


Figure 4.4 (continued) Daily number of trips by employment status, family type, and gender (weekday) (a) before and (b) after the outbreak of COVID-19.

Figure 4.5 shows the patterns for weekends. Results from the TBI data collected before the pandemic indicated that:

- For full-time employees, males and females had similar patterns for all family types in general.
- Self-employed people tended to have slightly more trips than other employment groups, especially when they were females living with kids.

Results from the Daynamica data collected after the outbreak of the pandemic suggested that:

- The number of trips per day remained at four trips per day for full-time employees and reduced to two for other employment types.
- The differences among gender identities and family types became more obvious and dynamic. For instance, for people living with kids and partners, females had more trips than males. But for other family types, females had fewer trips, which might be because people make trips such as shopping for groceries more often during weekdays while they were out for other tasks than during the weekends.

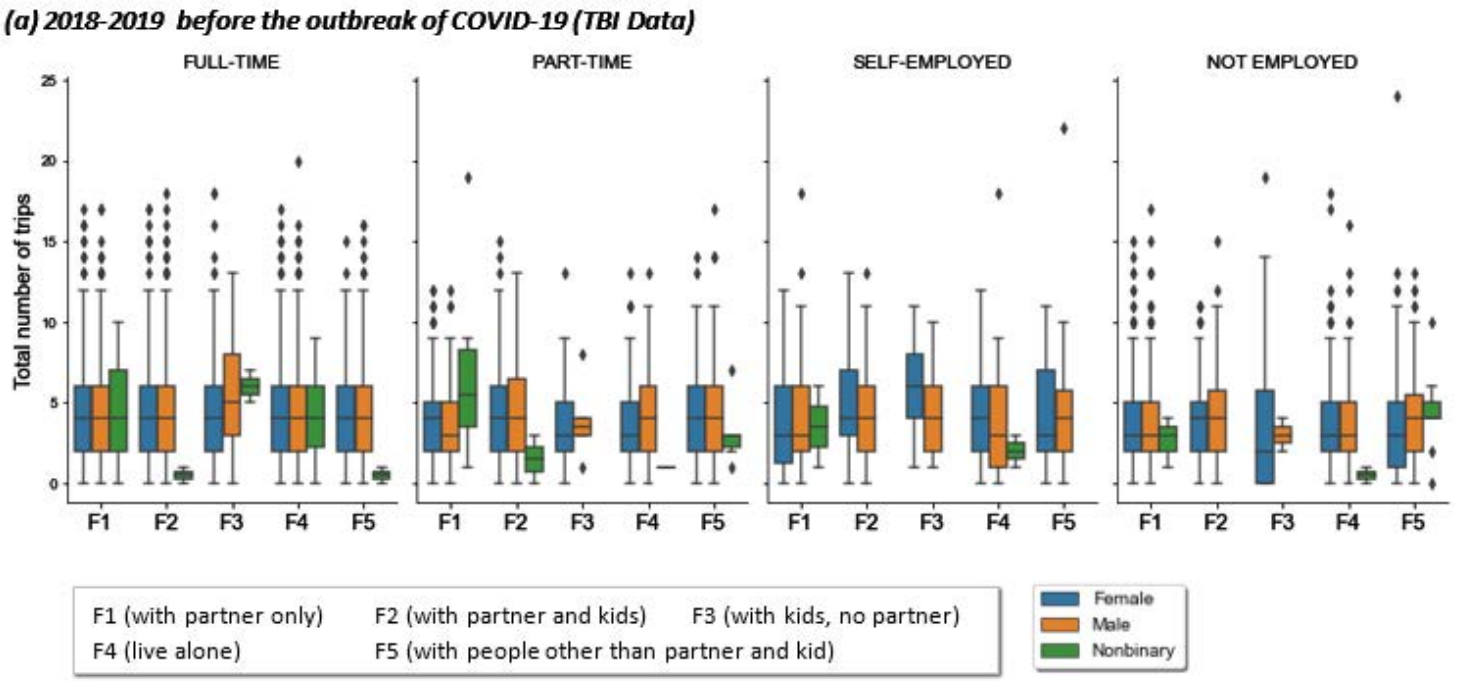


Figure 4.5 Daily number of trips by employment status, family type, and gender (weekend) (a) before and (b) after the outbreak of COVID-19.

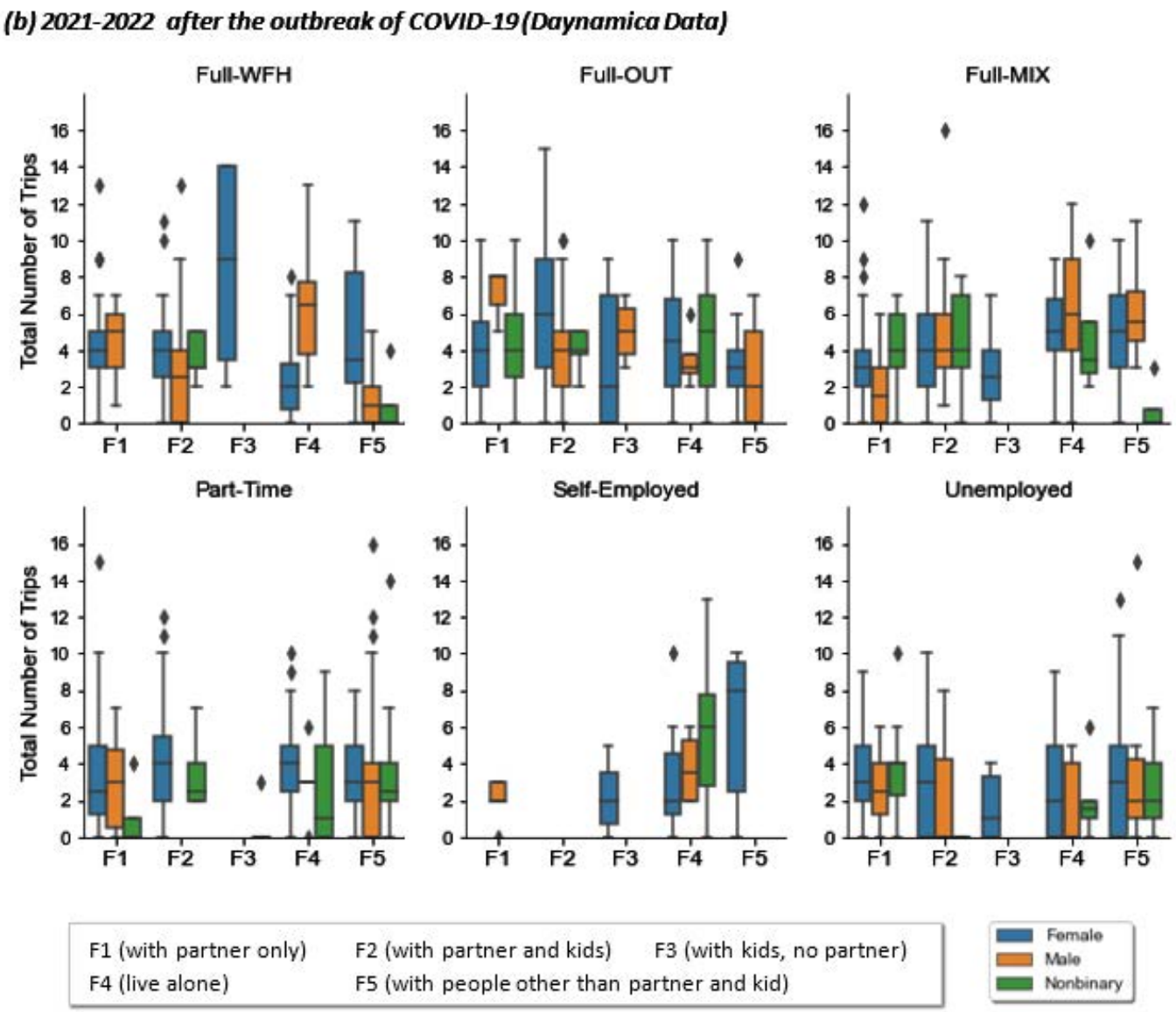


Figure 4.5 (continued) Daily number of trips by employment status, family type, and gender (weekend) (a) before and (b) after the outbreak of COVID-19.

Despite that the two datasets collected information for different participants, comparisons of the results from the two datasets revealed some similar patterns, including:

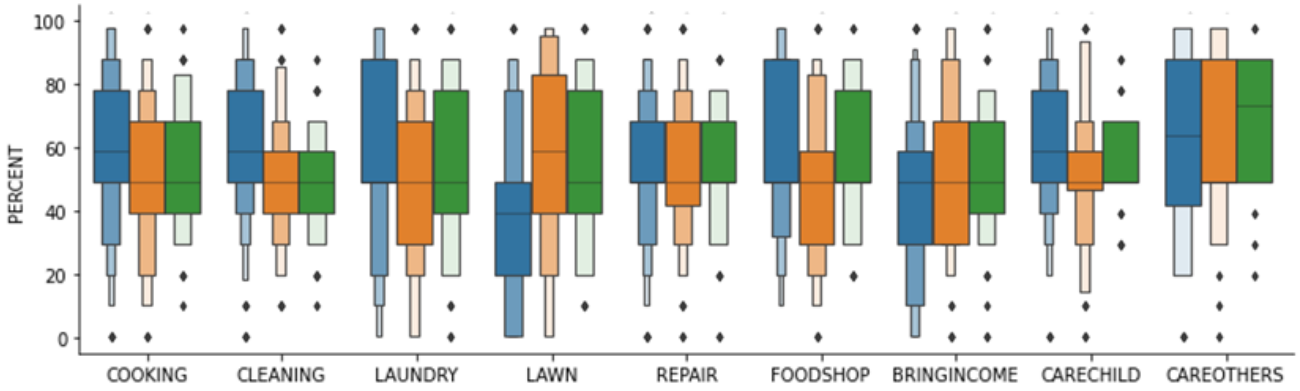
- The presence of kids tended to increase the daily trips for females before and after the outbreak of COVID-19, but the daily trips for males became less even with the presence of kids. This was probably because females and males shared different household tasks, and some of these tasks required travel even during the pandemic such as shopping or picking up groceries. To confirm this, we analyzed the types of household tasks shared by different genders below (Figure 4.6).
- It was necessary to distinguish WFH from other employment statuses because it resulted in distinct travel needs and mobility patterns. In specific, full-time employees who WFH tended to have much fewer trips than other full-time employees during weekdays. During weekdays, with the presence of kids, females who WFH had much more trips than males and non-binary people who also WFH.
- The presence of kids did not always increase the number of trips for non-binary people. There were no obvious patterns for non-binary people for both weekdays and weekends, which might be due to the relatively small sample size.

To examine whether females and males shared different household tasks, the in-take survey included questions regarding sharing of various household-supporting tasks. Figure 4.6 presents the current and desirable shares of household tasks by gender identity for those who lived with their partners.

As showed in Figure 4.6 (a), females shared more household-supporting tasks than males in cooking, cleaning, laundry, repairing, shopping for food, and taking care of kids, and males shared more tasks for lawn care, bringing home income, and caring for people other than their kids. People who identified themselves as non-binary had patterns similar to males but shared more food shopping and caring for kids or others. This can potentially explain why females had more trips than males after the outbreak of COVID-19 as discussed earlier.

We then compared the current and desirable shares of household-supporting tasks. As shown in Figure 4.6(b), females, in general, shared more household tasks than they expected (except for lawn care and bringing in income). Interestingly, the males did not believe they should share more childcare and food shopping, cleaning, and cooking. This suggested that gender stereotypes still existed in today's society, and it was common for males to believe they should bring more income than females but were less responsible for household chores and childcare.

(a) Current shares of household-supporting tasks



(b) Desirable shares compared to current shares

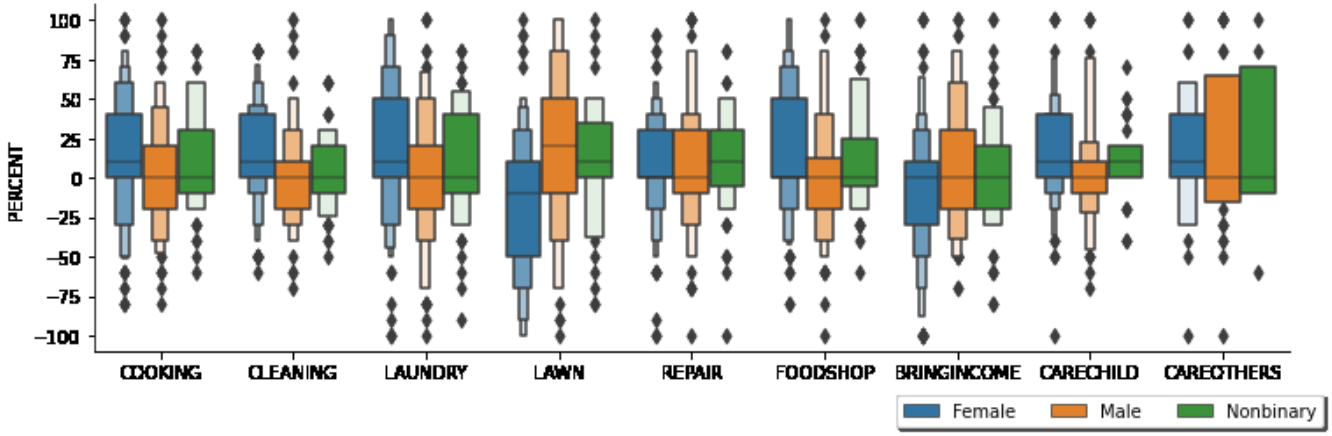


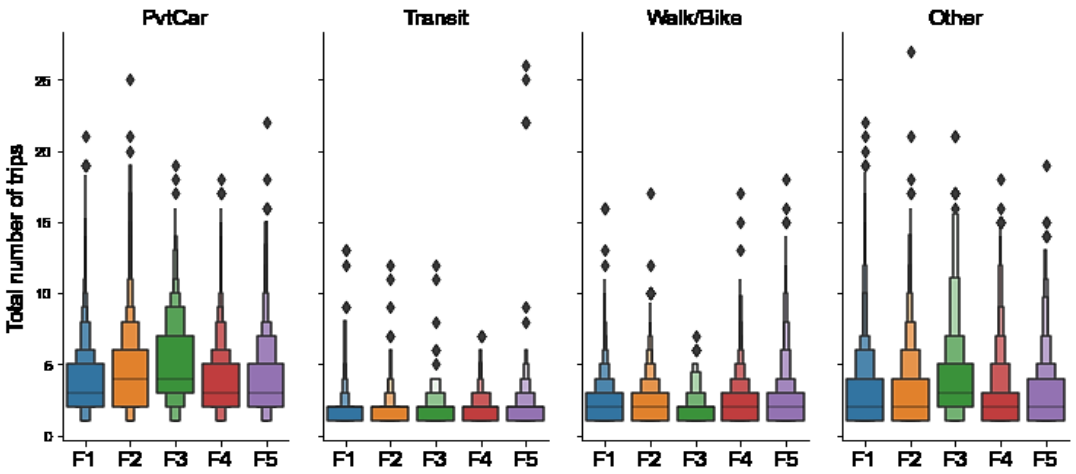
Figure 4.6 Shares of household-supporting tasks with partner/couple by gender identity.

4.2.3 Weekdays by Travel Modes, Gender, Family Type, and Race

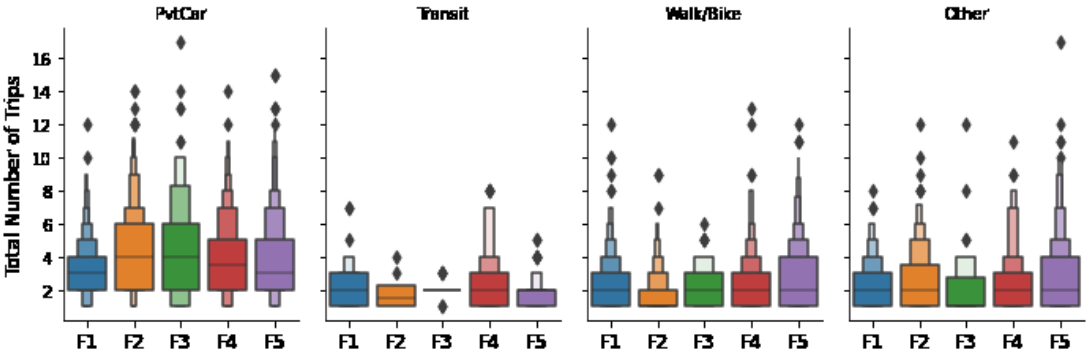
To further address how the intersection of gender identity with other social identities may affect travel decisions, we summarized the number of trips by modes across gender identity, family type, and race. We categorized the mode for a trip into four types: (1) using household vehicles for the entire or part of the trip (*PvtCar*), (2) using public transit (*Transit*), (3) walking or bicycling (*Walk/Bicycle*), and (4) other modes such as ridesharing (*Other*).

Figure 4.7 presents the number of trips per day by travel mode and family type before and after the outbreak of COVID-19. Before the pandemic, we found that single parents had more trips by household vehicle or other modes but had fewer walk/bicycle trips than other groups. And couples living with kids tended to have more trips using household vehicles than couples not living with kids. This suggests that the presence of kids made people more dependent on household vehicles for travel. After the outbreak of COVID-19, the number of trips using household vehicles dropped. However, people living with kids still had more car trips than people not living with kids. This suggests that living with kids still leads to higher dependency on household vehicles even during the pandemic. For patterns using travel options other than household vehicles, single parents living with kids had the most significant change: a sharp decrease in using other travel modes and an increase in walk/bicycle trips. This might be due to the reduction in available car-sharing services or their intention to reduce close contact with other people.

(a) 2018-2019 before the outbreak of COVID-19 (TBI Data)



(b) 2021-2022 after the outbreak of COVID-19 (Daynamica Data)



F1 (with partner only); F2 (with partner and kids); F3 (with kids, but no partner)
F4 (live alone); F5 (with people other than partner and kid)

Figure 4.7 Number of trips by travel mode and family type.

Last, we tried to examine the intersection of family type, gender identity, and race on mode choices. The visualizations became cumbersome and hard to interpret due to the amount of information. However, we did find that before the pandemic (see Figure 4.8 (a)):

- African American groups had the most obvious gender differences: females had much more PvtCar trips than males if they were living with their partners and/or kids.
- Females who were living with kids (F2 and F3) were less likely to use travel modes other than driving household vehicles than males across all race groups.
- Females in the 'Other' race group who lived only with their partner (F1) had fewer trips using household vehicles and more transit trips than males. This contradicted the general pattern that females in most other intersectional groups had fewer transit trips and relied more on personal vehicles than males.

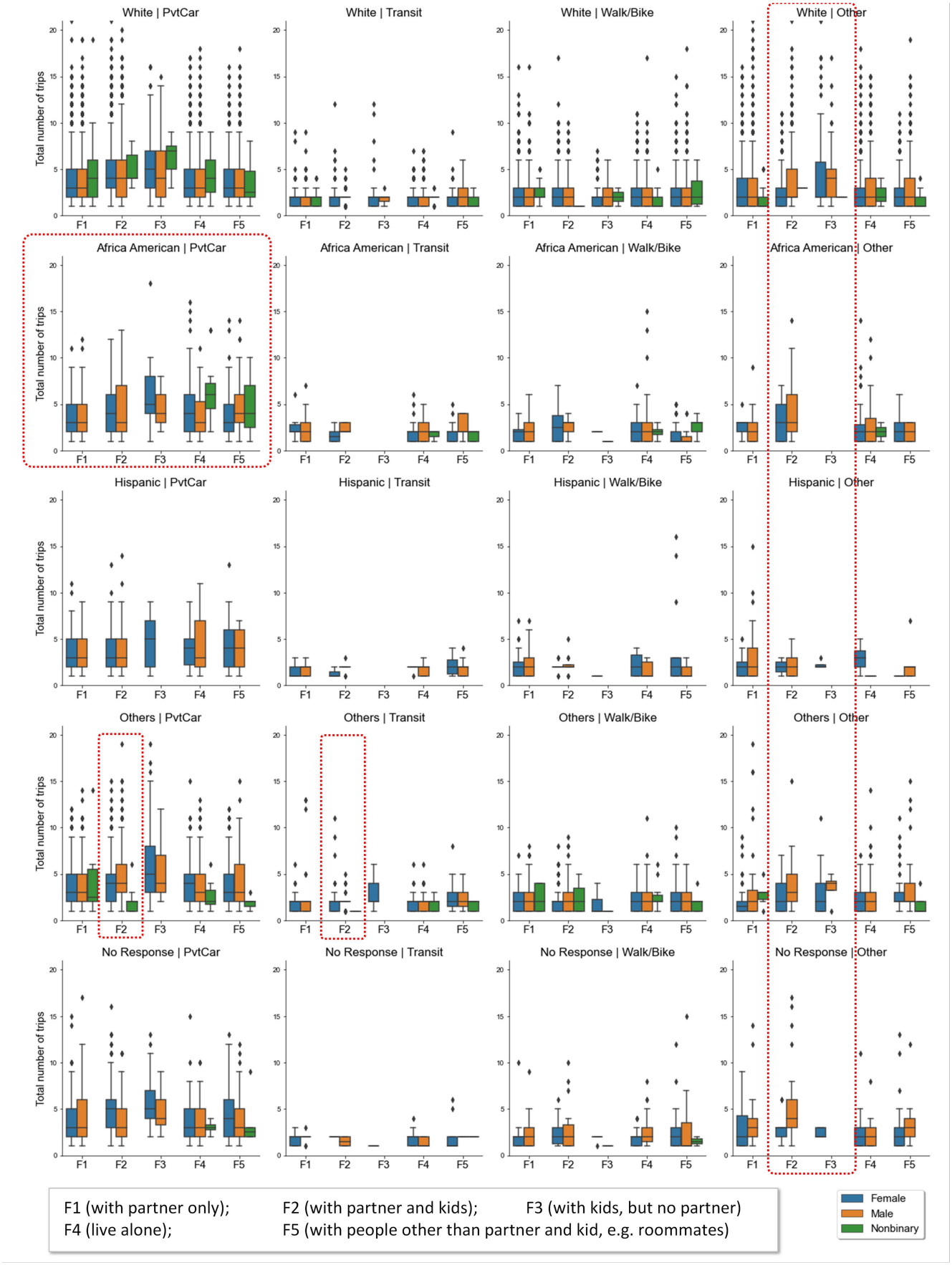


Figure 4.8 Number of trips by race (row), travel mode (column) and gender (color): pre-pandemic.

In comparison, after the outbreak of COVID-19, we found that (see Figure 4.9):

- White people had more walk/bicycle trips and fewer PvtCar trips than pre-pandemic
- For females, black females made more PvtCar and transit trips than females of other races.
- Females tended to make more trips than males for most travel modes, except for transit trips.

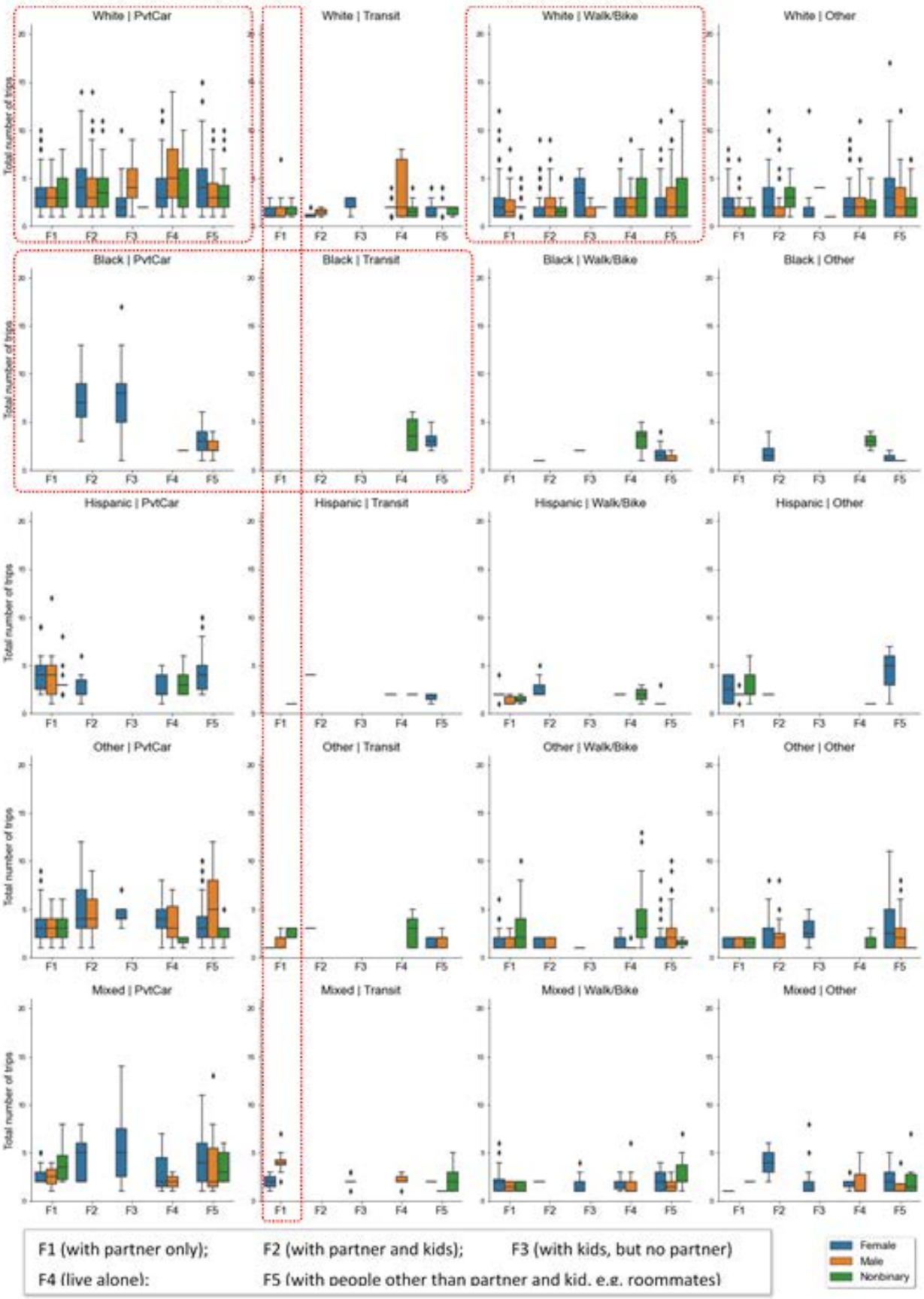


Figure 4.9 Number of trips by race (row), travel mode (column) and gender (color): post-pandemic.

To further examine the obstacles to choosing transit as the travel mode among genders, the Daynamica survey included one question regarding perceived challenges. Figure 4.10 shows the percentage of people in each gender group checking a reason. The top reasons were “lack of destination access”. “too slow”, “too many transfers”, “timing of services”, and “frequency of services” across all gender groups. However, we observed some significant gender differences for other reasons:

- The most obvious gender difference was safety concerns. Non-binary people were about two times more likely to feel not safe on public transit and three times more likely to feel not safe on their way to it than males. Females also had a much higher likelihood of not feeling safe both on the public transit and on their way to the public transit than males.
- The next two obvious gender differences were carrying belongings and trip chaining. Females and non-binary people both were over twice as likely as males felt difficult to use transit due to the need to carry bags/carts/strollers or to make multiple trips in a row.
- Compared to males, females and non-binary people were more concerned about on-time arrivals and the cleanliness/comfort of transit services than males.
- For non-binary people, there were extra challenges in using public transit because they were also more likely to feel uncomfortable in the public space while waiting for the buses/trains.

In sum, females and non-binary people were both more likely to find it difficult to use public transit than males. These findings were consistent with those in existing studies such as the LA Metro Transit’s 2019 report entitled “Understanding How Women Travel” (LA Metro Transit 2019).

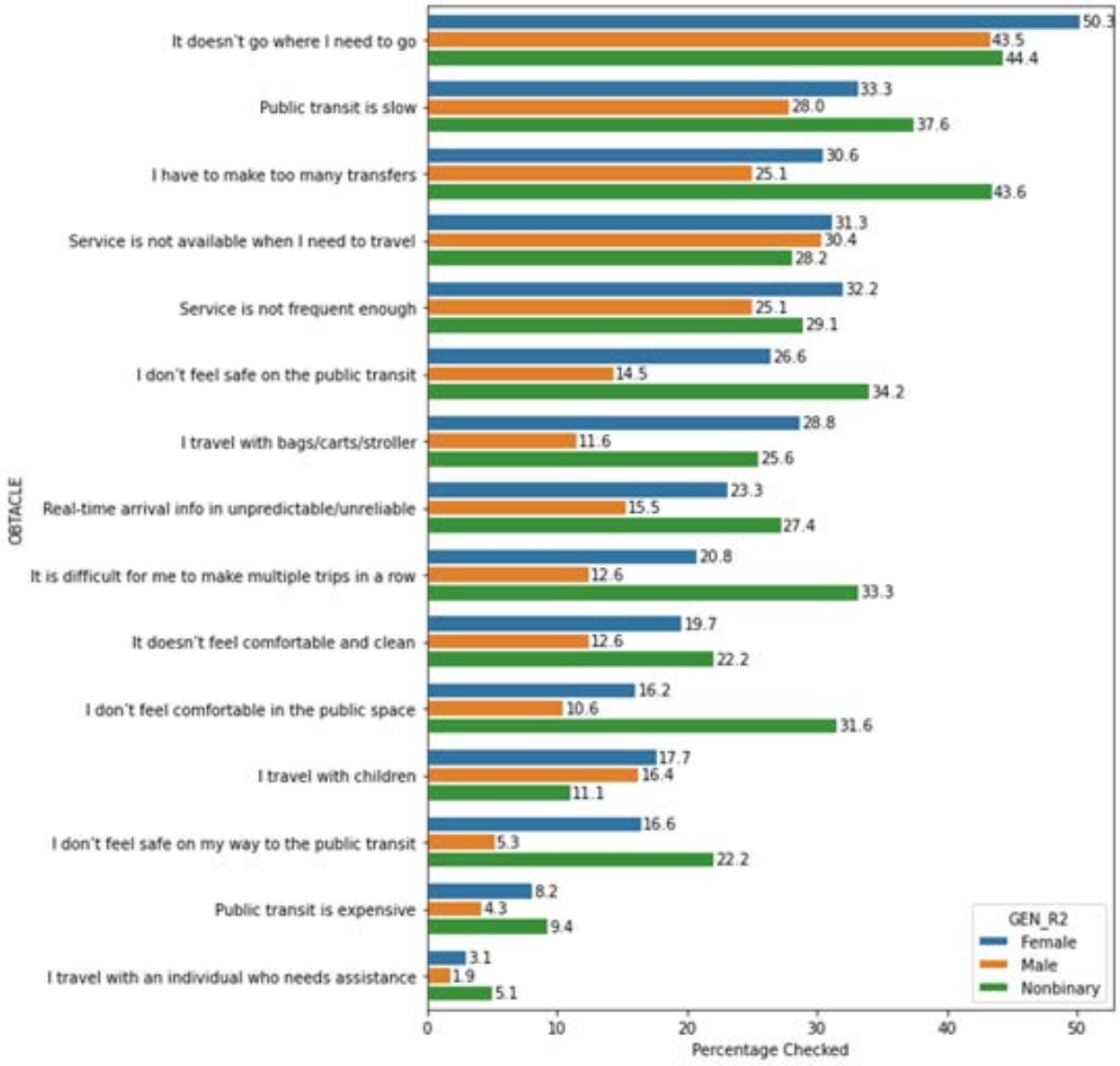


Figure 4.10 Percentage of respondents who check each reason for not using public transit.

4.3 STATISTICAL EXTRACTION OF MOBILITY PATTERNS

Considering the limited abilities of visual explorations to address more than two social-demographic attributes while comparing activity-travel patterns across social groups, we introduced and applied the sequence alignment methods (SAMs) to extract distinct activity-trip patterns and related these patterns with people's social identities. In this section, we introduced the SAMs, presented the distinct patterns extracted from TBI and Daynamica data, and compared the profiles of people in each group both visually and statistically.

4.3.1 Sequence Alignment Methods

In this section, we illustrate the sequence alignment method (SAM) that we adopted and modified to extract distinct activity-travel patterns with a focus on household supporting tasks (Song et al. 2021). We present an example procedure in Figure 4.11. First, we created an activity-trip sequence for each day. We used 5 minutes as the interval, so each activity-trip sequence contains 288, 5-minute intervals. We labeled each time interval based on the activity or trip that occurs during those 5 minutes. Second, we calculated the dissimilarity index between each pair of sequences by comparing the 288 time intervals of those two sequences. Last, we grouped similar sequences into a distinct activity-travel pattern so that differences were minimized within each group and maximized between groups.

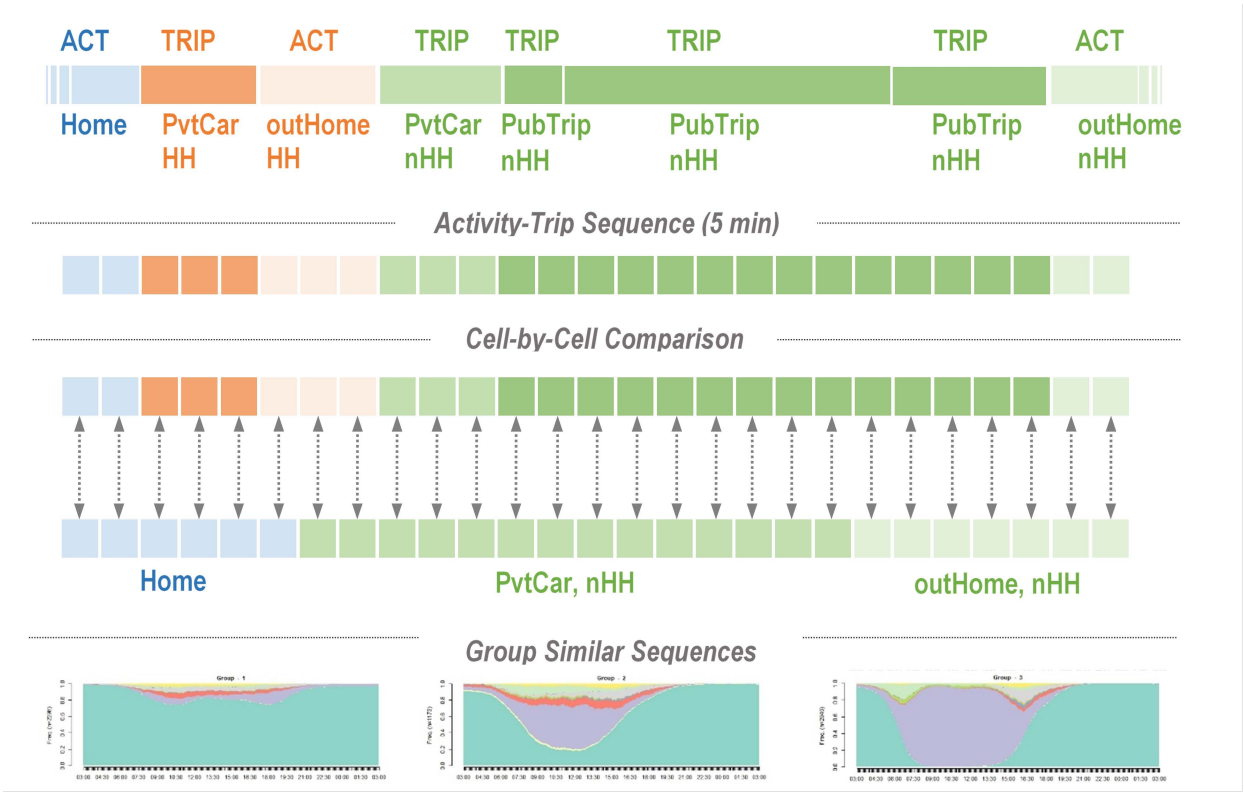


Figure 4.11 Procedure to process the input diary data and extract distinct patterns.

One activity-trip sequence contained 288 of 5-minute intervals, each labeled with an activity or trip recorded during that interval. The differences between two sequences were calculated by comparing the 288-time intervals. And similar sequences were grouped together to show an activity-travel pattern that was distinctly different from other groups.

A key component of the SAM is to define the cost metric, which specifies the distance or cost between each pair of labeled time intervals. Given the focus of this project, we defined the cost metric to account for three aspects of differences: (1) whether the state was an activity at home (H) or out-of-home (O), or a trip using household vehicles (Pv) or other travel modes (Pb) (2) whether the activity or trip involved

household-supporting tasks (Y) or not (N), and (3) whether the activity or trip occurred in private space (H, Pv) or public space (O, Pb). For the TBI data, the cost metric with 12 possible labeled states was:

	HH	MM	ON	OY	PbH	PbM	PbN	PbY	PvH	PvM	PvN	PvY
HH	0.0											
MM	1.5	0.0										
ON	2.0	1.5	0.0									
OY	1.0	1.5	1.0	0.0								
PbH	2.0	1.5	2.0	1.0	0.0							
PbM	2.5	1.5	1.5	1.5	0.5	0.0						
PbN	3.0	1.5	1.0	2.0	1.0	0.5	0.0					
PbY	2.0	1.5	2.0	1.0	0.0	0.5	1.0	0.0				
PvH	1.0	1.5	3.0	2.0	1.0	1.5	2.0	1.0	0.0			
PvM	1.5	1.5	2.5	2.5	1.5	1.5	1.5	1.5	0.5	0.0		
PvN	2.0	1.5	2.0	3.0	2.0	1.5	1.0	2.0	1.0	0.5	0.0	
PvY	1.0	1.5	3.0	2.0	1.0	1.5	2.0	1.0	0.0	0.5	1.0	0.0

By default, any pair of two different states had a unit distance of 1.0, and we modified the unit distance matric for the study of gender-typical behaviors. The distances in the metric were calculated based on three criteria accordingly: (1) activities and trips had a unit distance of 1.0, (2) household tasks and non-household tasks had a unit distance of 1.0, and (3) in private space and public space had a unit distance of 1.0. The overall distance was the sum of distances at two levels. For time intervals in the sequence missing the activity or trip types, we set its distance to H, Y, and N types as 0.5. And for time intervals that did not contain any data (MM), we set its distance to all other 11 types as 1.5 considering the three levels of missing data. Please note that the TBI data did not contain data entered by survey participants regarding whether trips and activities involved HH tasks, and we imputed such information from trip purposes as shown in Appendix C.

For the Daynamica data, we directly used the user-entered information regarding whether each trip or activity involved household-supporting tasks to label the time intervals. This allowed us to further label each home activity (HH) as household-supporting (HY), non-household-supporting (HN), or missing user-entered info (HM). Therefore, the cost metric for the Daynamica data had 13 possible states instead of 12 states, and the distances in the second metric were calculated based on the same three criteria as in the first metric:

	HY	HN	HM	OY	ON	OM	PbY	PbN	PbM	PvY	PvN	PvM	$MISS$
HY	0.0												
HN	1.0	0.0											
HM	0.5	0.5	0.0										
OY	1.0	2.0	1.5	0.0									
ON	2.0	1.0	1.5	1.0	0.0								
OM	1.5	1.5	1.5	0.5	0.5	0.0							
PbY	2.0	3.0	2.5	1.0	2.0	1.5	0.0						
PbN	3.0	2.0	2.5	2.0	1.0	1.5	1.0	0.0					
PbM	2.5	2.5	2.5	1.5	1.5	1.5	0.5	0.5	0.0				
PvY	1.0	2.0	1.5	2.0	3.0	2.5	1.0	2.0	1.5	0.0			
PvN	2.0	1.0	1.5	4.0	2.0	2.5	2.0	1.0	1.5	1.0	0.0		
PvM	1.5	1.5	1.5	2.5	2.5	2.5	1.5	1.5	1.5	0.5	0.5	0.0	
$MISS$	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	0.0

In the next sub-section, we applied the first metric to both TBI and Daynamica data to compare patterns before and after the outbreak of COVID-19, and we applied the second metric to Daynamica data to get distinct patterns that can address the household tasks sharing at home and its impact on out-of-home trip and activity scheduling.

4.3.2 Distinct Patterns in TBI and Daynamica Data

Since both TBI and Daynamica data were collected over three months, instead of using the calendar date, we used the day of the week (DOW) and divided sequences into seven subsets, each for one day of the week. Also, instead of defining a day as the period from midnight to midnight of the following day, we used [3:00 am, 27:00 am] to define a day, similar to how transit agencies have commonly defined a service day to capture overnight services and trips. And we chose six as the number of behavior groups for each subset of data because the SAM results suggest that the classification had its best performance with six behavior groups.

4.3.2.1 Distinct Patterns in TBI Data

We used the state distribution, a type of graph, to illustrate the activity-travel patterns of each group for SAMs. Figure 4.12 shows an example of state distribution of an activity travel pattern on Tuesday using the TBI data. To highlight the household-supporting (HH) tasks, we used red for out-of-home HH activities (OutHome.Y), bright yellow for HH trips using household vehicles (PvtCar.Y), and dark yellow for HH trips using public transit (PubTrip.Y). The x-axis showed the series of five-minute time intervals from 3:00 am to 3:00 am the next day. For each time interval, the y-axis showed the percentage of sequences in each group with a specific state. For instance, at the beginning of the day from 3:00 am to 3:05 am, almost all the sequences had at-home (Home.Home) as their states, while from 9:00 am to 3:00 pm, most sequences had out-of-home activities or trips. Another way to interpret the graph would be to examine changes in the percentage for a given type across time. For instance, if we focused on studying all trips across the day, the example in Figure 4.11 had a morning peak travel time of around 7:00 am with trips using household vehicles for non-HH tasks (PvtCar.N) as the dominant travel state. The example also had an afternoon peak travel time of around 4:30 pm with the most frequent travel state as trips using household vehicles for going home (PvtCar.Home) followed by using household vehicles for HH and non-HH trips (PvtCar.Y and PvtCar.N).

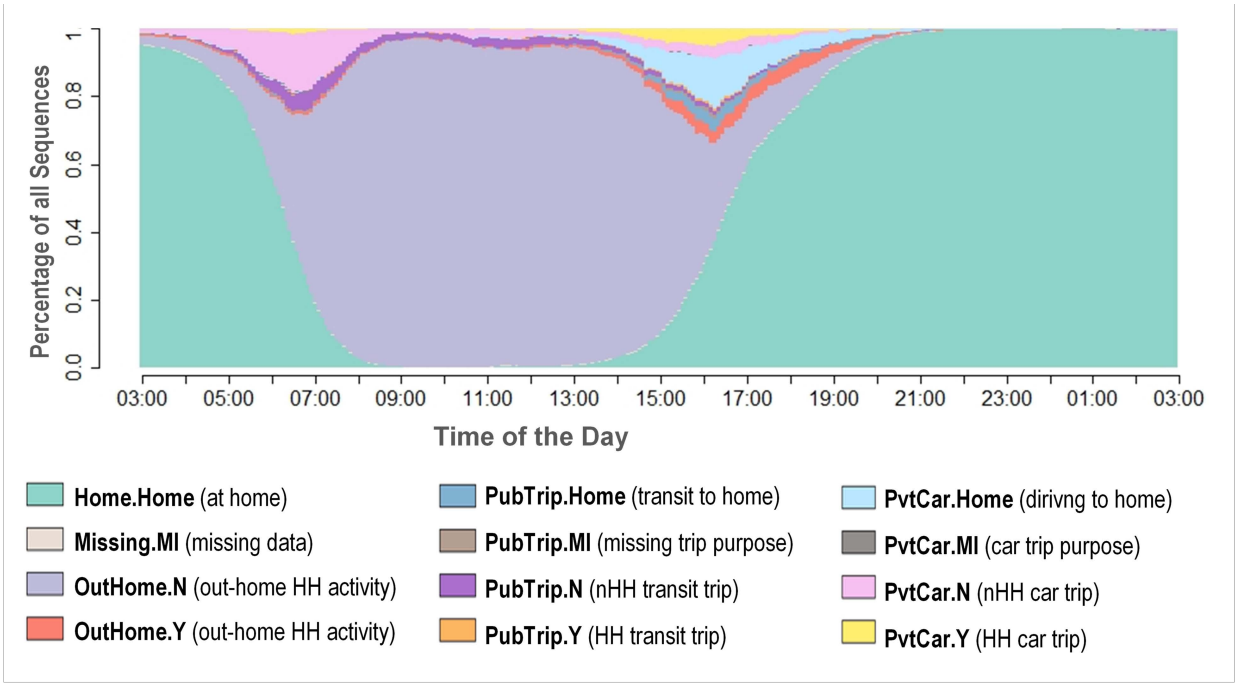


Figure 4.12 An example state distribution of sequences with a distinct activity-travel pattern.

The x-axis corresponded to the time of the day and the y-axis showed the percentage of sequences belonging to each possible activity or trip type. The example showed that most sequences had out-of-home activities that were not for household supporting tasks (lavender color) and also had trips during morning and afternoon traffic peak hours (light and dark purples, light yellow, light and grey blues).

We used results for Tuesdays[2] as an example to demonstrate the detected distinct patterns from the TBI data collected before the pandemic. The six groups in Figure 4.13 can be interpreted as (1) people who stayed at home most of the time, (2) people who had some out-of-home activities during the mid-day, (3) full-time employees with regular working hours, (4) full-time employees who had late-afternoon activities, (5) people who were out-of-home for HH tasks most of the day, and (6) people who were out-of-home for non-HH tasks most of the day.

Groups 1, 2, and 3 had different amounts and timing of HH activities and trips: (1) Group 2 had HH trips and activities occurring during different periods of the day; (2) Group 1 stayed at home most of the time and had HH tasks done mostly in the late morning; and (3) Group 3 had HH trips only on their way home after work/school.

[2] We chose Tuesday as an example given that participants often started recording travel diaries on Monday using and their first record of activity or trip tended to be during the middle of the day instead of from the midnight. And Sunday as the last day of data entry tended to have the last records provided by participants in the evening rather than the midnight. So, Tuesday to Saturday had a larger sample size and we chose Tuesday as an example to show how to get behavior patterns from state distributions of behavior groups.

Regarding travel modes, Group 6 used public transit and other modes as much as household vehicles, while the other 5 groups relied primarily on household vehicles for travel. Group 3 who were out-of-home during regular working hours also used options other than driving household vehicles but relied on household vehicles for HH tasks.

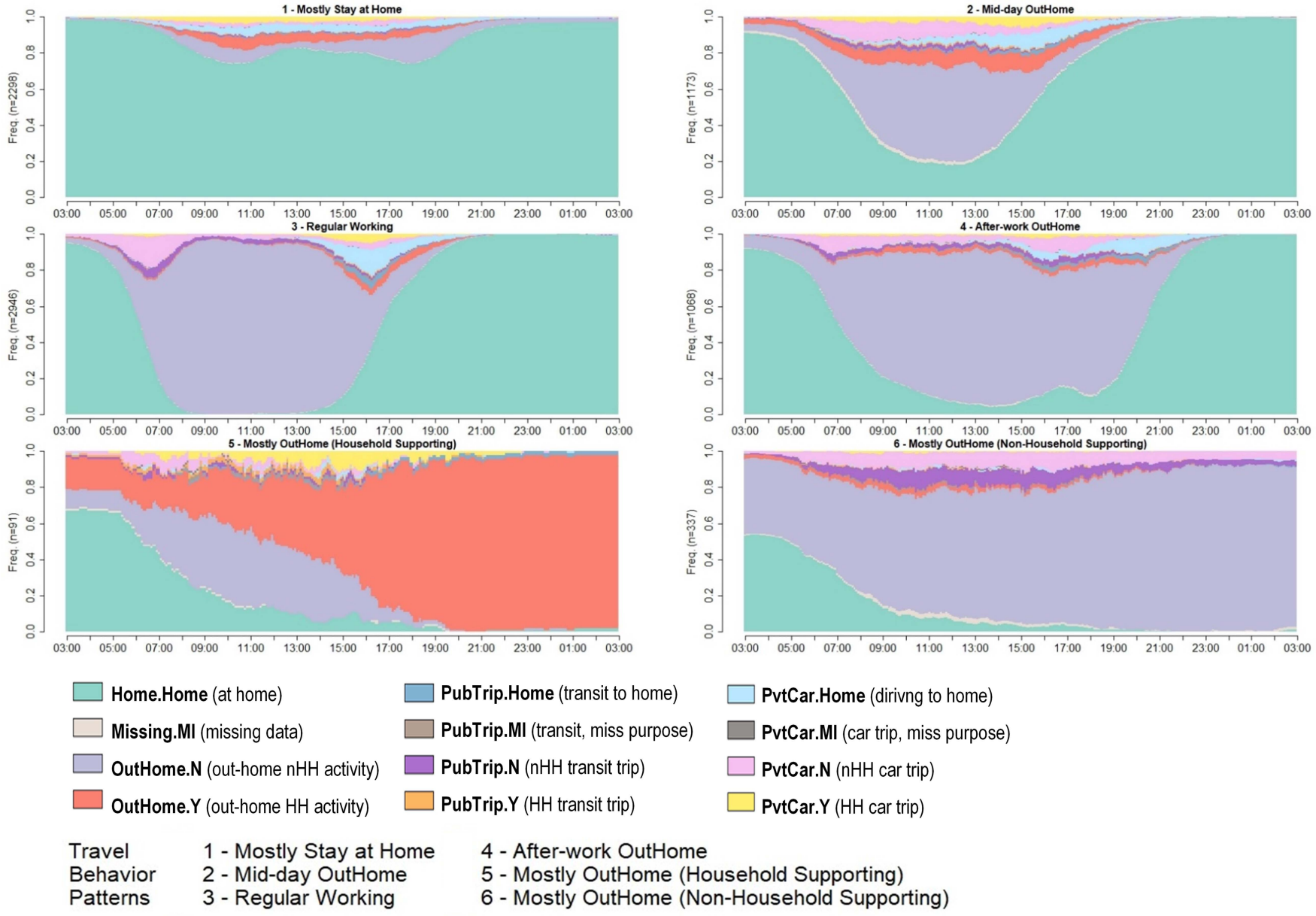


Figure 4.13 District travel patterns and state distribution (TBI data, Tuesday).

We include the analysis results for the rest days of the week in Appendix D. We found that all the other four weekdays had similar patterns as Tuesdays. Group 3 and Group 4 were most likely to be full-time employees who are out-of-home during regular working hours, and they had similar patterns across all weekdays likely due to their relatively fixed working hours. Group 1 stayed at home most of the time, and the timings of their out-of-home activities and trips varied across days of the week. Specifically, on Tuesdays and Wednesdays, out-of-home activities and trips mostly occurred in the late morning; on Thursdays and Fridays, they occurred mostly around 7:00 pm in the early night; and on Mondays, they were evenly distributed around noon.

We also observed similar travel modes and timing of trips across all weekdays. For instance, Group 3 had a small number of PubTrips during peak hours. Interestingly, the PubTrips were slightly less on Fridays than on other weekdays, while the HH tasks on Fridays were slightly more than on other weekdays. This suggested that HH trips were very likely to rely on household vehicles.

Compared to weekdays, the weekends had less obvious patterns. We observed some common patterns such as (1) more HH tasks on weekends than weekdays for Group 1 (staying at home most of the day), (2) fewer HH tasks on Saturday than Sunday for all groups; and (3) more PubTrips for Group 6 (staying out of home most of the day) similar to weekdays.

Overall, the difference between groups for weekends was primarily regarding when activities and trips were taken place. For instance, Group 2 (employees with regular-working hours) tended to have most out-of-home activities and trips around 7:00 pm, and Group 3 (employees with activities before going home) were out of the home during the middle of the day. But such differences were very subtle and did not have direct practical implications.

4.3.2.2 Distinct Patterns in Daynamica Data

We continued to extract distinct patterns from the Daynamica data and compared them to the results from the TBI data. We used Tuesdays as an example to demonstrate the results. Figure 4.14 presents the five distinct patterns using the same cost metric as the TBI data analysis: (1) Group 1 who stayed at home most of the time, (2) Group 2 who were employees with regular working hours, (3) Group 3 who were employees and have after-work, late-afternoon activities, (4) Group 4 who were out-of-home for non-HH tasks most of the day, and (5) Group 5 who were out-of-home for both HH and non-HH tasks throughout the day. These patterns were similar to those from the TBI data. However, there were much more people (about 50%) who mostly stayed at home compared to the TBI results (about 25%). This was probably because many people started to work from home (WFH) during the pandemic.

We include the results for the rest days of the week in Appendix E. We found similar patterns for all other weekdays. For instance, Group 2 (employees with regular working hours) had more HH tasks after work on Fridays, which were probably for grocery shopping or similar tasks on their way home before weekends. And Group 3 (employees with late-afternoon activities) had small variations regarding the total duration and timing of out-of-home activities and trips. Like Tuesday, other weekdays had much

more people who mostly stayed at home during the pandemic compared to the TBI results before the pandemic.

Weekends had quite different patterns from Weekdays. People were likely to go out, in the late morning before lunch and an early night before dinner, instead of during the regular working hours. This was also different from weekend patterns before the pandemic based on TBI data, when out-home activities and trips occurred across the entire day.

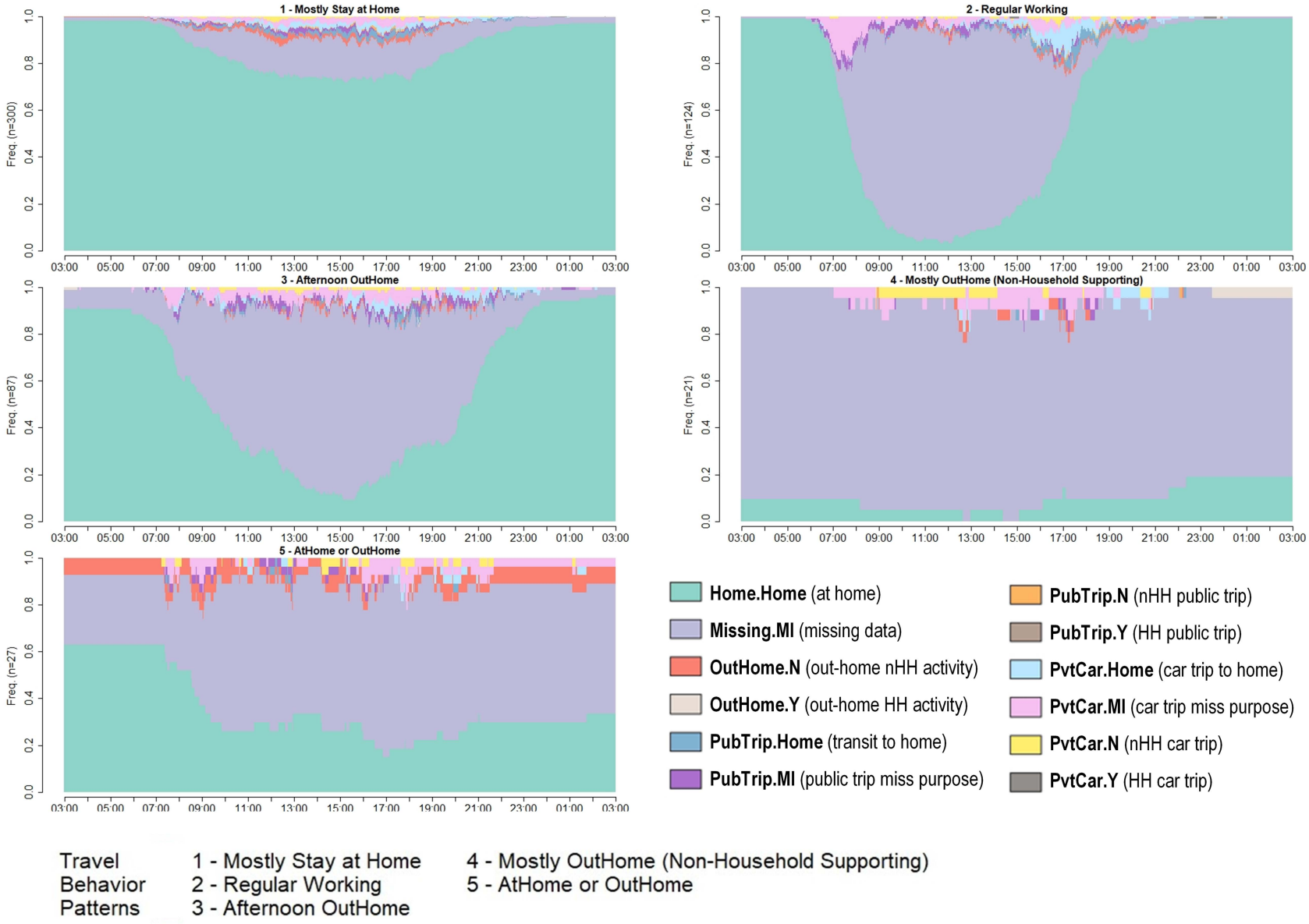


Figure 4.14 District travel patterns and state distribution (Daynamica data, 1st cost metric, Tuesday)

We then used the second metric that recognized WFH and HH tasks at home instead of the same metric as we used in the TBI data analysis. We continued to use state distributions to present the extracted behavior patterns. As illustrated in Figure 4.15, people in Group 1 (stay at home most of the time) and Groups 2 and 3 (work out of home) were further divided into subgroups, based on whether they shared HH tasks at home. It also distinguished people who were in Group 2 (out of the home for HH tasks) from Group 6 (out of the home for non-HH tasks). Besides, the household supporting trips during the early afternoon for Group 4 supported our earlier discussions on the likelihood of HH trips after work. These findings suggested that the new information about HH tasks in the Daynamica data could distinguish Group 3 (employees WFH) from Group 1 (stay at home but may not work) and therefore could better capture the shares of household responsibilities.

We include the results for the rest days of the week using the second metric in Appendix F. We found similar patterns from Monday to Thursday, and we observed some unique patterns for Friday. During Fridays, group 4 (employees not WFH) tended to have many HH activities during the daytime. This was consistent with our early discussion on the first metric's results: the possibility of shopping for groceries on Friday afternoons. It also reveals the likelihood that some of such HH tasks may happen during the weekdays during people's trips back from work.

Weekends had quite different patterns compared to results using the first metric. The typical duration and timing of out-of-home activities and trips became less obvious and the shares of HH tasks were quite different across all behavior groups.

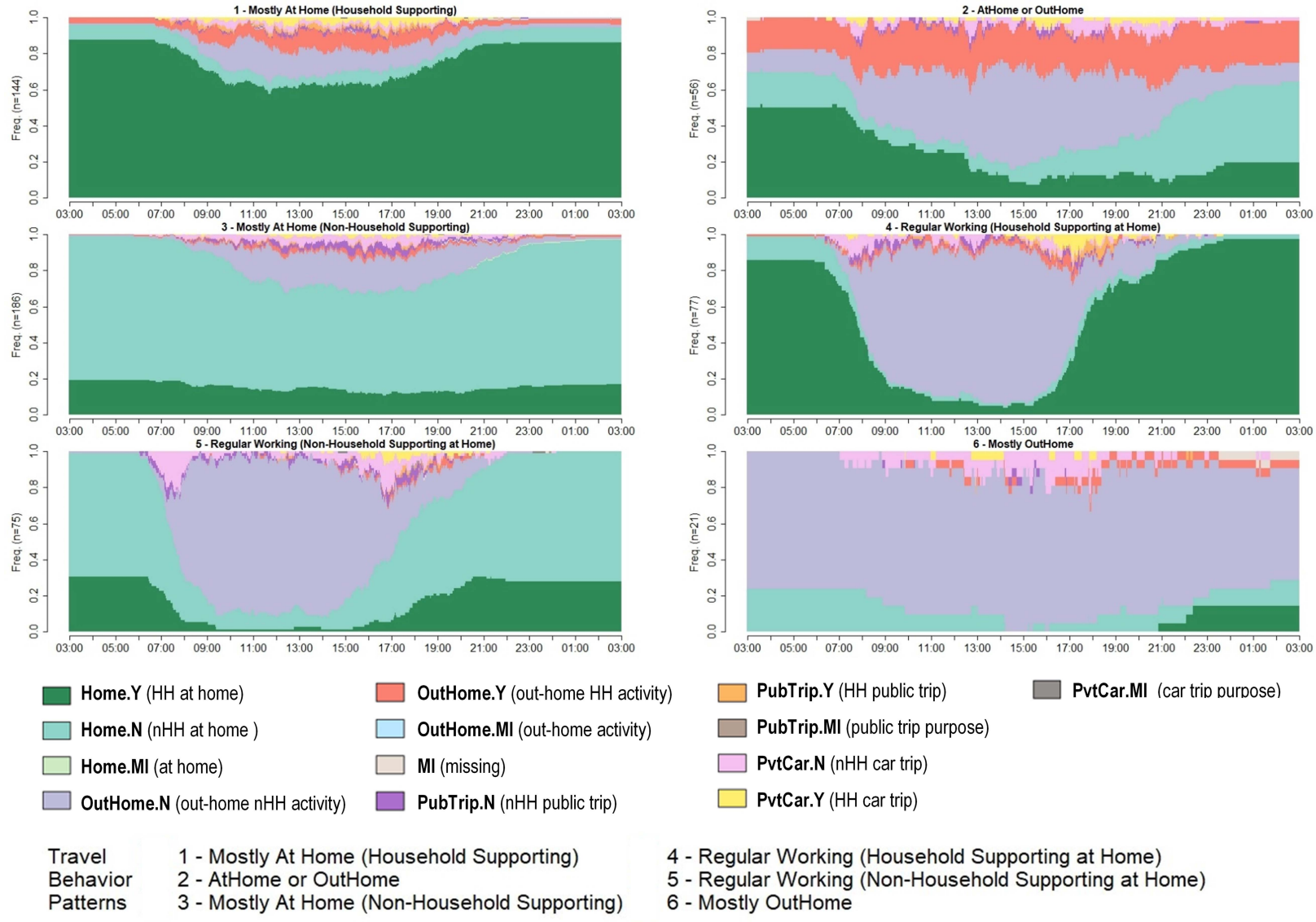


Figure 4.15 District travel patterns and state distribution (Daynamica data, 2nd cost metric, Tuesday).

To further examine whether and how the second metric can better capture HH tasks among genders, we compared the durations of HH tasks and counts of HH trips per day using the two metrics. Figure 4.16 (a) compared the durations of HH trips and activities per day, and Figure 4.16 (b) compared the number of HH trips per day. Both results indicated that the first metric (imputed by the destination activity type) may underestimate both the time spent on HH tasks and the number of HH trips per day. Figure 4.16 (c) examines how such differences may vary across gender groups. It revealed that females and non-binary people were more likely to have trips that were labeled as nHH using the first metrics while these trips did involve HH tasks as reported by the participants. Based on these comparison findings, we decided to use the second metric and relate the identified groups with district patterns to the social identities of participants in each group in later sections.

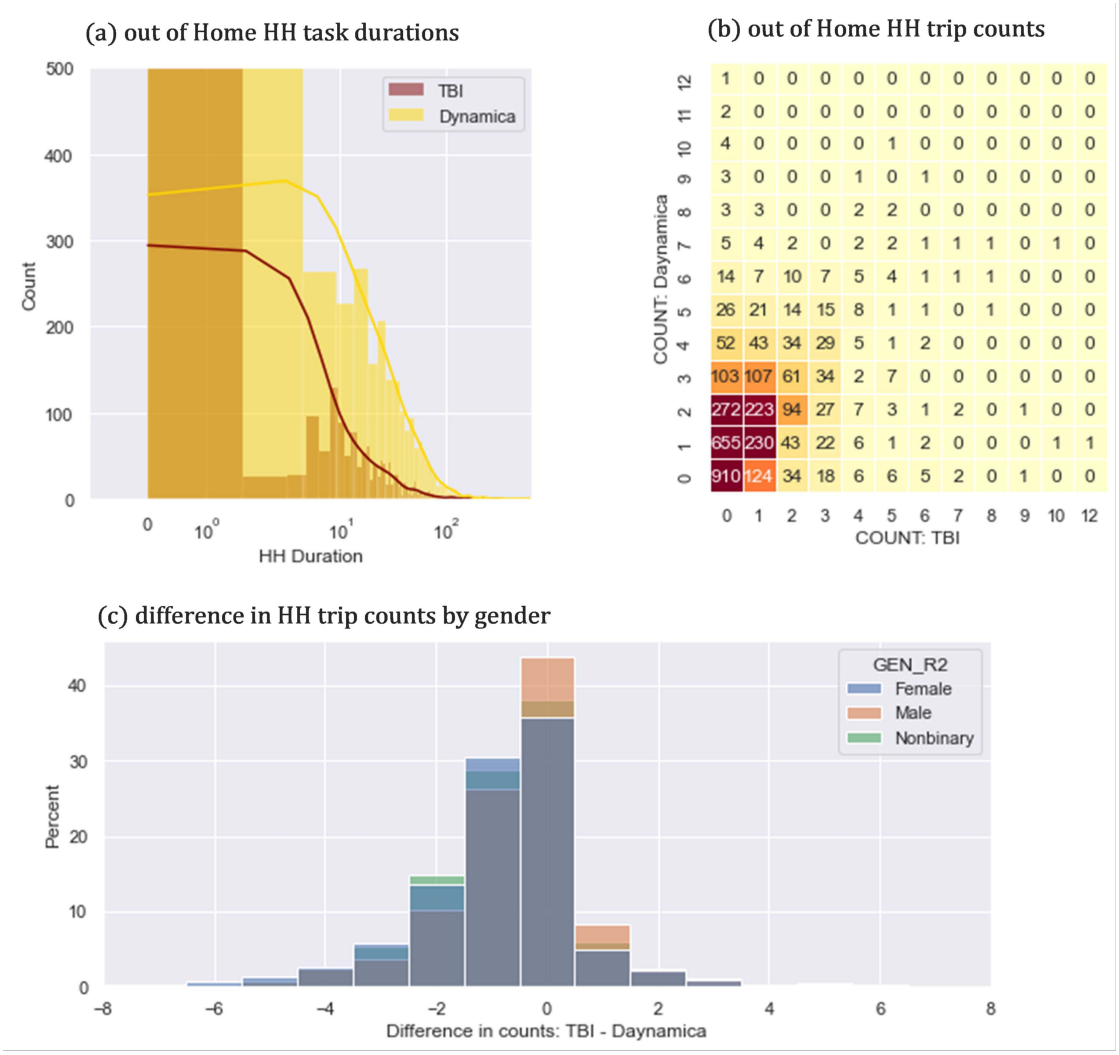


Figure 4.16 Home activities with or without household tasks by gender.

4.3.3 The Comparison of Proportions and Detection of Interactions

4.3.3.1 The Comparison of Proportions

We compared the social-demographic profiles of participants in the detected behavior groups, and we selected gender identity, family type, and employment status as the three attributes based on literature review and visual explorations. Since we needed to account for three attributes at the same time, we applied the method to compare propositions of subgroups to the propositions of the entire sample (Gart 1971). We used the method to examine whether the proportion $p_i = Y_i/N_i$ of the intersectionality group N_i equaled the proportion $p_I = Y_I/N_I$ of the total population N_I. Our null hypothesis was that the proportion of any intersectional group equals the proportion of the total population, that is, $p_i - p_I = 0$. The test statistic for testing the difference in two proportions can be analytically defined as:

$$Z = \frac{(\hat{p}_i - \hat{p}_I) - 0}{\sqrt{\hat{p}(1-\hat{p})(\frac{1}{N_i} + \frac{1}{N_I})}} \quad \text{(Eq.1)}$$

Where:

$$\hat{p} = \frac{Y_i + Y_I}{N_i + N_I} \quad \text{(Eq.2)}$$

$$(\hat{p}_i - \hat{p}_I) \sim N((p_i - p_I), \left(\frac{p_i(1-p_i)}{N_i} + \frac{p_I(1-p_I)}{N_I}\right)) \quad \text{(Eq.3)}$$

We rejected the null hypothesis at the 90% confidence level (p-value < 0.05) if $Z < -1.65$ or $Z > 1.65$. Similarly, we can also test the hypothesis at 95% and 99% confidence levels (PSU Open Course).

We continued to use Tuesday as an example to illustrate the results. We used gender identity, family type, and employment status to create intersectionality groups and compared proportions for each group. As shown in Figure 4.17 based on TBI data, we found differences in mobility patterns across intersectionality groups; however, most differences were not significant. The two exceptions were:

- Unemployed females and males living alone or with their partners (no kids) were significantly more likely to be in Group 1 who stayed at home most of the time
- Self-employed females living with partners were significantly more likely to stay at home most of the time.
- Full-time employees mostly tended to be in Groups 3 and 4, but female parents living with kids were less likely to have after-work out-of-home activities. This implied that female employees tended to lose their after-work personal time after having kids.
- Participants in non-binary gender groups did not have any obvious differences. However, such a result was likely due to the small sample in each intersectionality group for non-binary.

We conducted the same analysis for the rest days of the week and include the results in Appendix G. On weekdays, female part-time employees were more likely to be in groups that shared more HH tasks (e.g., Group 5 for Thursday). Moreover, female parents living with kids had fewer after-work activities than females in other groups. These findings suggests that females tended to share more HH tasks, especially in the presence of kids. For weekends**,** two groups were more likely to stay at home mostly than other groups: (1) female full-time employees living with kids, and (2) females not employed and living with patterners.

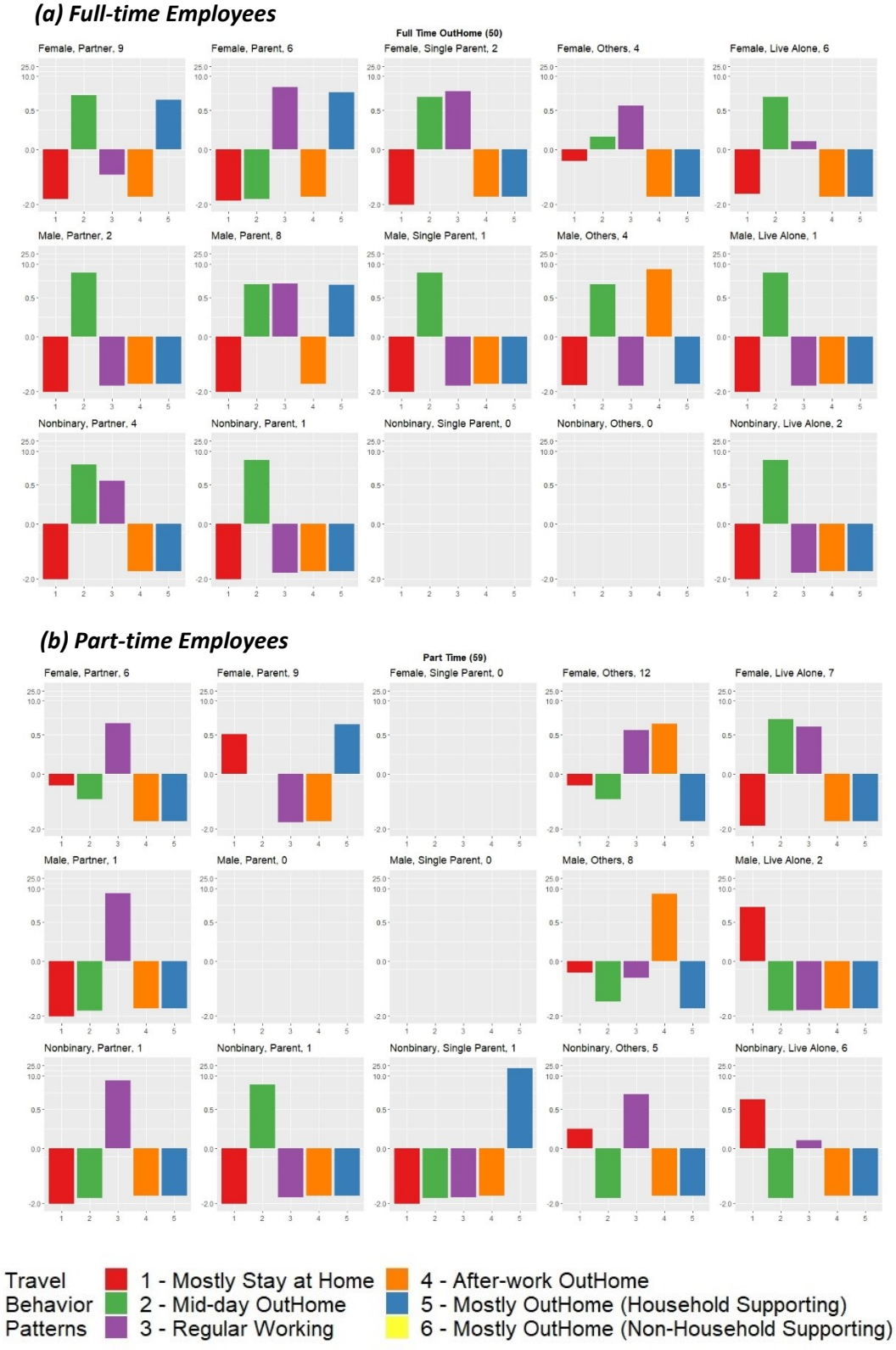
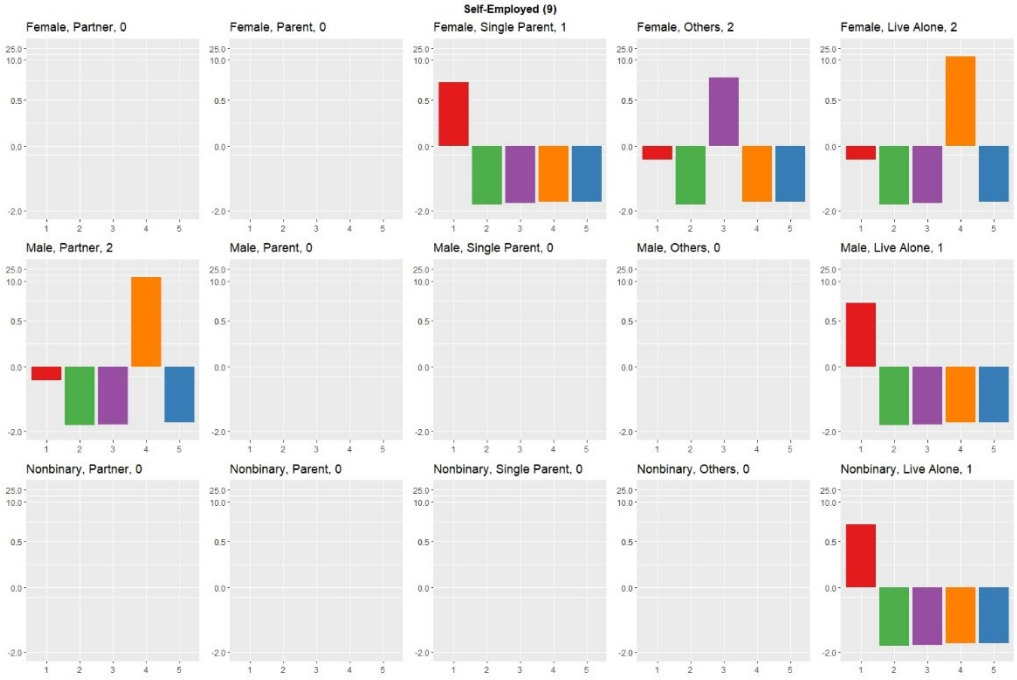


Figure 4.17 Propositions for 6 patterns and 60 intersectional groups (TBI Data, Tuesdays).

(c) Self-Employed



(d) Not Employed

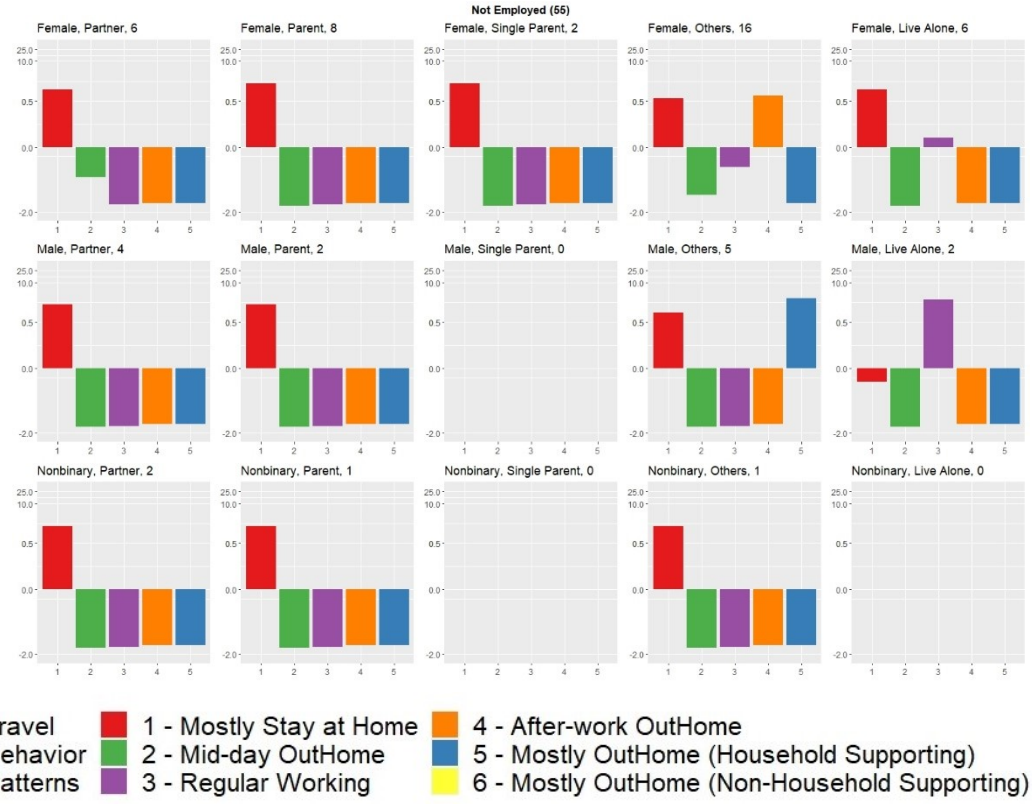


Figure 4.17 (continued) Propositions for 6 patterns and 60 intersectional groups (TBI Data, Tuesdays)

For the Daynamica data, we had six employment statuses considering the WFH cases. In Figure 4.18, we show the comparison of proportions for all the 75 intersectional groups of five employment statuses, three gender identities, and five family types. Due to the relatively small sample sizes of the Daynamica diaries entered by 278 participants, the differences were not significant for most cases. However, we still observed some patterns regarding gender differences:

- For full-time employees, WFH, female parents were more likely to be in Group 4 and less likely to be in Group 2 and Group 5 than male parents. This suggested that, while WFH, females tended to share more household tasks than males.
- For people who were not employed, females were more likely to be in Group 1, and males were more likely to be in Group 5, with the only exception of females who lived with their partners only (but no one else). This suggested that when staying at home for most of the day, females tended to share more household responsibilities than males and non-binary people.

We included the analysis results for the rest of the week in Appendix H for reference.

(a) Full-time Employee (Work from Home)

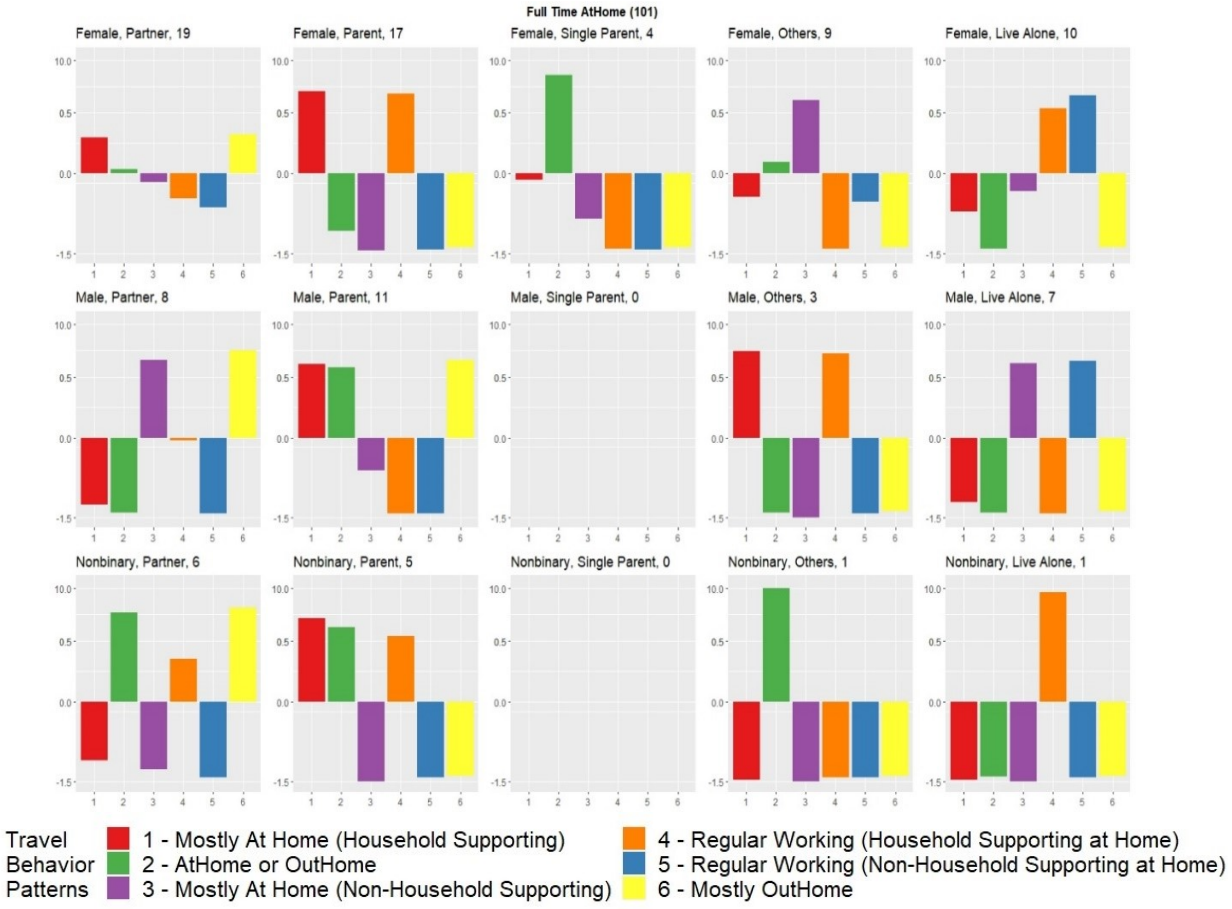
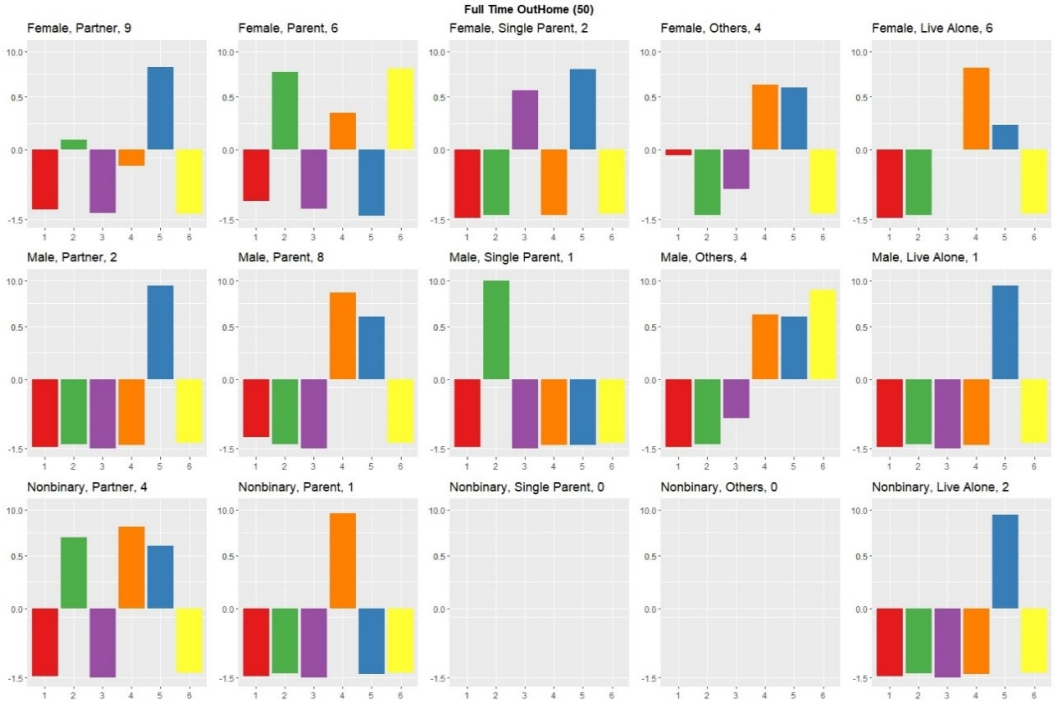
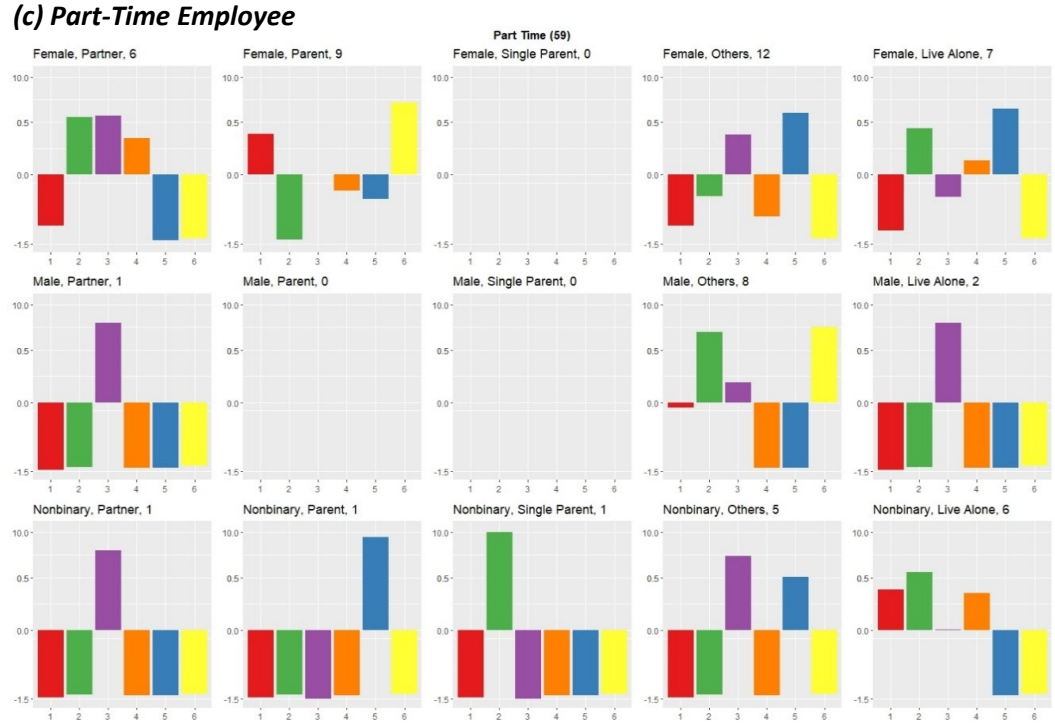


Figure 4.18 Propositions for 6 patterns and 75 intersectionality groups (Daynamica Data, Tuesdays).

(b) Full-time Employee (Work Outside Home)



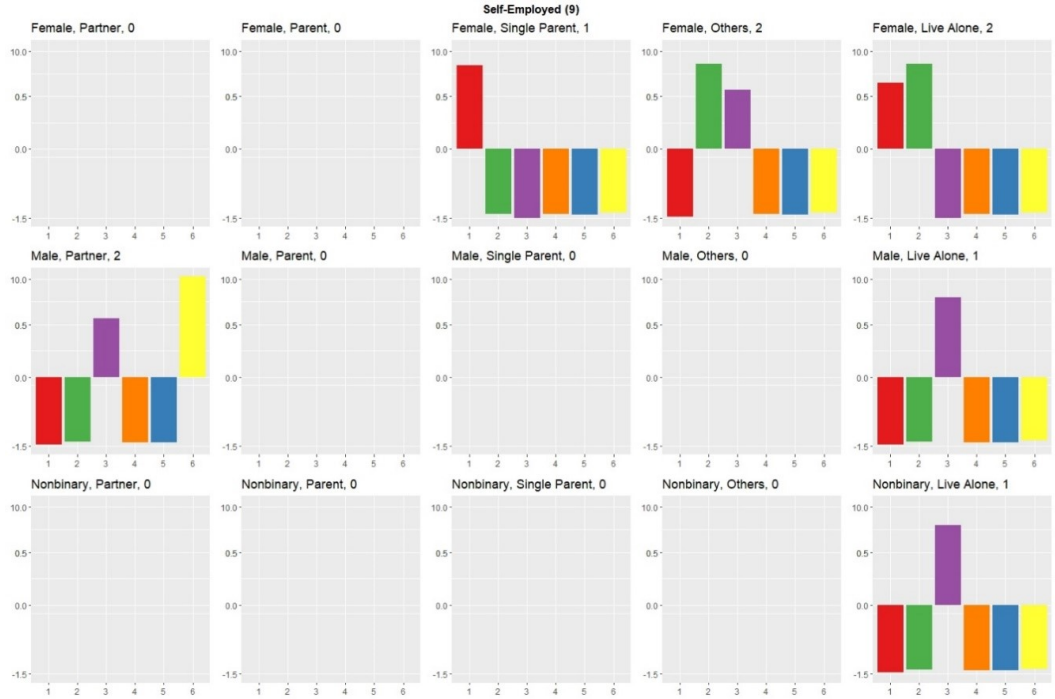
(c) Part-Time Employee



Travel Behavior Patterns
1 - Mostly At Home (Household Supporting)
2 - AtHome or OutHome
3 - Mostly At Home (Non-Household Supporting)
4 - Regular Working (Household Supporting at Home)
5 - Regular Working (Non-Household Supporting at Home)
6 - Mostly OutHome

Figure 4.18 (Continued) Propositions for 6 patterns and 75 intersectionality groups (Daynamica Data, Tuesdays).

(d) Self-Employed



(e) Not Employed

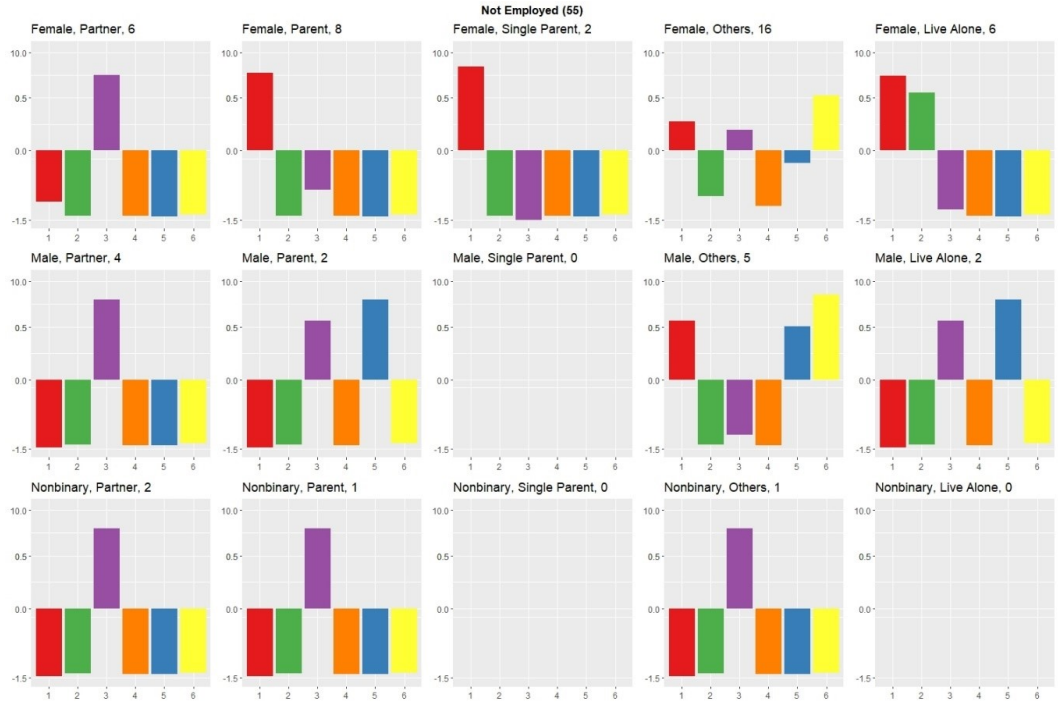


Figure 4.18 (continued) Propositions for 6 patterns and 75 intersectionality groups (Daynamica Data, Tuesdays).

4.3.3.2 Gender and Intersectionality

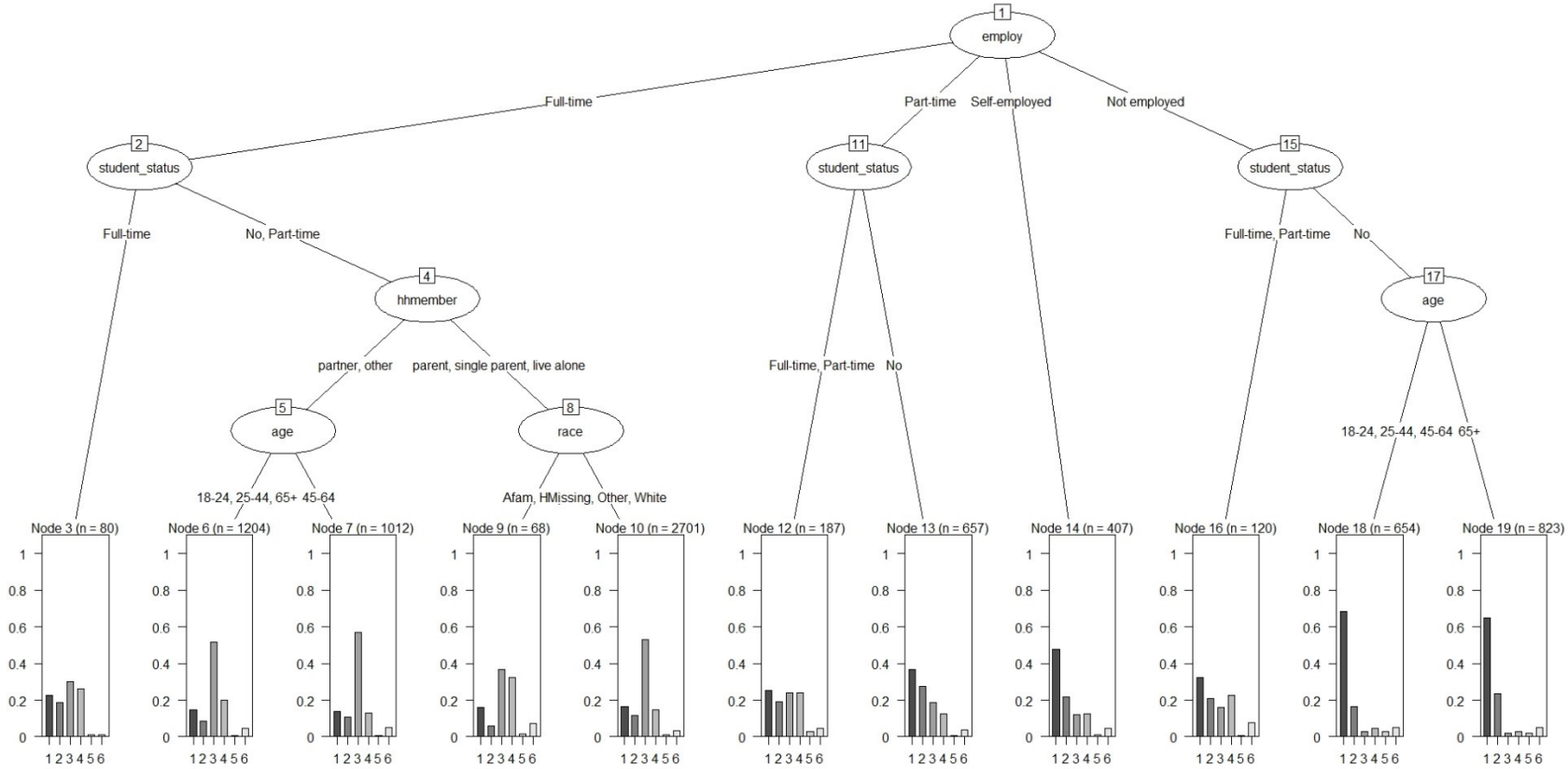
The comparison of proportion method was effective to relate behavior patterns to participants' profiles. However, as we accounted for more social-demographic attributes, such a method became less effective given the small number of sequences in each intersectionality subgroup as well as the large number of sub-graphs to present. Therefore, the team reviewed existing methods and chose the CHAID (Chi-square automatic interaction detection) to examine interactions among various personal characters that may lead to intersectionality groups with unique behavior patterns. The CHAID is a classification method that deals with categorical data. It has been applied in identifying specific groups of consumers for targeting marketing to achieve a set of given outputs (e.g., Kass 1980, Powell 2018).

Based on the literature review, we chose gender identity, employment status, family type, race, age, student status, and education attainment as the seven key indicators of mobility patterns. We used Tuesday as an example again to demonstrate the results generated by CHAID. Figure 4.19 presents the Tuesday results for the TBI data. Each node in the tree specified the attribute that was used to define a subdivision of a group, and each branch directly below the node listed the values for that attribute. For instance, node 11 corresponded to part-time employees and was further divided into two sub-groups based on the student status: node 12 for full-time or part-time students, and node 13 for non-students.

Results in Figure 4.19 suggest that employment and student status were two key factors determining the activity-travel patterns before the pandemic. Specifically, for full-time employees who were not full-time students (node 4), family types played a key role and interact with age (node 5) or race (node 8) to create distinct activity-travel patterns. For instance, for people living alone or with their kids, African American (Afam) and Hispanic (Hisp) groups (node 9) were less likely to be in Group 3 (full-time with no after-work activities) and more likely to be in Group 4 (full-time with after-work activities) compared to other racial groups. This suggested that Afam and Hisp groups were more likely to work longer hours or have after-work activities even with the presence of their kids. As for the gender identity, Figure 4.19 suggests that gender identity did not largely affect activity-trip scheduling on Tuesdays.

We conducted the same analysis for the rest days of the week and presented the results in Appendix I. Like Tuesday, employment status, student status, and household types affected activity-travel patterns during other weekdays in similar ways. Gender identity only played a role on Thursday for part-time employees who were 25 or older. In specific, females were more likely to be in Group 2 (have out-of-home activities and trips in the early night), and males and non-binary people were more likely to be in Groups 1, 4, and 5 (go out in the morning). Gender also affected Friday's behaviors, but not significantly. Females and non-binary groups were less likely to be in Groups 4 and 5 (stay outside the home for a long time). For weekends, parents living with kids tended to be in Group 1 (have fewer out-of-home activities or trips), but gender did not play a significant role in shaping people's behaviors.

In sum, we found some similar patterns across days of the week. First, African Americans and Hispanic people living with kids had their behavior patterns affected more by gender and family responsibilities than other social groups. Second, females and non-binary people in a subgroup often had different durations and timings of out-of-home activities and trips compared to males in that subgroup. Third, employment played a key role and intersected with student status, age, race, and family types to create intersectional groups (nodes on the bottom of the tree) with distinct behavior patterns.



Note: abbreviations of each parameter and it corresponding attribute: (1) EMPLOYMENT: employment status; (2) student_status: student status; (3) age: age groups; (4) hhmemeber: family type; (5) race: race and ethnicity; and (6) GEN_R: self-identified gender.

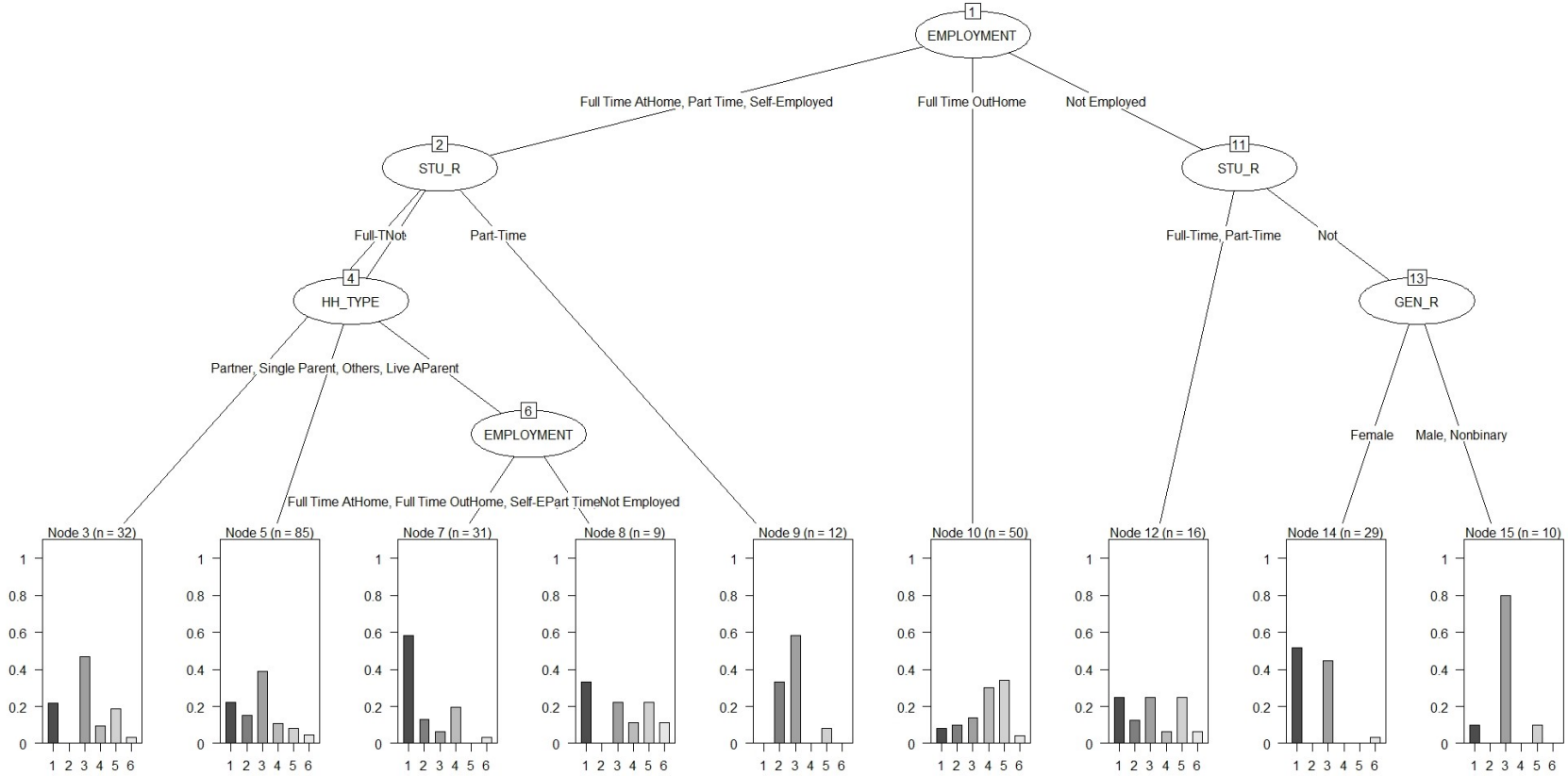
Figure 4.19 Chi-square automatic interaction detection of intersectional groups (TBI Data, Tuesdays).

We applied CHAID to the Daynamica data using the same set of seven key indicators. As shown in Figure 4.20, employment and student status remained to be the two key determinants of activity-travel patterns as in the TBI data analysis. However, for unemployed people, gender identity started to play a significant role in some of the subgroups. For example, within the social group who were not employed and not a student (node 13), females stayed at home most of the time, usually sharing HH tasks, while males also stayed at home but did not share as many HH tasks as females.

We conducted the same analysis for the rest days of the week and presented the results in Appendix J. Results showed that, for Monday, Thursday, and Friday, the gender identity played an indispensable role in determining social groups with certain behavior patterns.

- For Monday, we observed some similar patterns as Tuesday. For people who were aged 25 to 54 and not employed, gender played a key role in determining behavior patterns within the group (node 12): females tended to be in Groups 1 and 2 (always share HH tasks at home) while males tended to be in Group 3 (seldom share HH tasks at home).
- For Thursday, gender identity played a more significant role (node 2) than Tuesday and Monday. Specifically, for full-time employees who WFH, males, and females had quite different patterns compared to non-binary people. For males and females, gender identities interacted with age, family type, and student status and created subgroups with diverse patterns.
- For Friday, gender also played a key role at a higher level (node 5) like Thursday. For full-time employees not WFH all the time, males were mostly in Groups 4 and 6 (out of home for non-HH tasks), while females and non-binary people were relatively evenly distributed among behavior groups. This suggested that males still shared fewer HH tasks while there was a significant difference in behavior patterns within a social group.

For Saturday and Wednesday, gender identity did not play a key role in determining social groups with certain behavior patterns. And for Sunday, none of the seven social-economic attributes had a key role in determining the behavior patterns.



Note: abbreviations of each parameter and it corresponding attribute: (1) EMPLOYMENT: employment status; (2) student_status: student status; (3) age: age groups; (4) hhmemeber: family type; (5) race: race and ethnicity; and (6) GEN_R: self-identified gender.

Figure 4.20 Chi-square automatic interaction detection of intersectional groups (Daynamica Data, Tuesdays)

4.4 SUMMARY OF FINDINGS

Analysis results using the TBI and Daynamica data both indicated the importance of intersectionality in understanding gender differences in activity-travel behaviors. Key findings included:

- Compared to males, females shared more household tasks and relied more on household vehicles for travel.
- African American females were more likely to use transit compared to females of other races.
- The presence of kids in the households increased the total number of trips for all genders and the dependency on household vehicles for travel.
- During the weekdays, females living with kids were less likely to have out-of-home activities and trips than males in the late afternoon. Compared to females of other races, African American and Hispanic females were more likely to have late-afternoon activities, which was very likely due to their working hours after the afternoon traffic peak hours (around 5 pm) or household-supporting tasks on their way home.
- Employment status was a key determinant for total out-of-home durations, the number of trips per day, and distinct activity-trip patterns for all gender groups.

Compared to the TBI data, the new information in the Daynamica data enabled us to better capture the shares of household tasks among gender groups. The comparisons of results from these two datasets revealed obvious changes in travel behaviors after the outbreak of COVID-19. Key findings included:

- It was crucial to account for working from home while defining employment status, especially for full-time employees, to gain an accurate and comprehensive view of behavior patterns.
- The information about shares of household tasks at home in Daynamica data can distinguish people who shared household tasks at home from people who did not share.
- For people who stayed at home most of the time, females shared more household tasks than males even when they were employed and working from home. Such gender gaps remained similar across all other employment statuses.
- Shopping trips during weekends were reduced compared to pre-pandemic periods and were likely rescheduled during weekdays when people were out for work or other essential tasks.
- Females made more trips than males and non-binary people, relied more on household vehicles for travel and reduced their use of public transit.

Besides revealing changes in travel behaviors after the outbreak of COVID-19, the new data regarding travel preferences revealed gender differences in barriers to use transit. Females and non-binary people were much more likely to feel unsafe while using public transit and on their way to public transit than males. They also found it difficult to use public transit because they traveled with bags/carts/strollers or needed to make multiple stops. For males, the low frequency and speed and lack of destination access were the top two barriers. The team used these findings regarding the activity- travel patterns to guide the analysis of relationships between the detected activity-travel patterns and with subjective wellbeing outcomes of participants.

CHAPTER 5: WELLBEING OUTCOMES

Based on the analysis results of travel behaviors in Section 4, the team examined individuals' subjective well-being (SWB) outcomes concerning their activity-travel behavior patterns. Considering that Monday to Thursday had similar patterns that were different from Friday and weekends, the team conducted the same set of analyses for (1) Monday to Thursday, (2) Friday, and (3) Saturday and Sunday to capture the variation of activity-travel patterns across days of the week. Specific aims included:

- Extracting distinct activity-travel patterns for Mon-Thu, Friday, and Sat-Sun from the Daynamica data and relating the patterns to the socio-demographic variables.
- Visually comparing the SWB outcomes across social groups and behavior groups. Like Section 4, key socio-demographic variables included gender identity, employment status, family type, age, race, student status, and educational attainment.
- Investigating whether the SWB outcomes were statistically significantly different across social groups. The variables used for statistical analysis were selected based on the analysis results of activity-travel patterns.
- Comparing statistical analysis results across behavior groups to examine how activity-travel patterns may affect the SWB outcomes.

This section presented the methods to calculate SWB outcomes, summary statistics of SWB outcomes, and statistical analysis of the impacts of social identities and behavior patterns on the SWB outcomes.

5.1 ACTIVITY-TRAVEL BEHAVIOR PATTERNS

The team applied the sequence alignment method in Section 4 and presented the analysis results in this sub-section. These results were used to select socio-demographic variables of participants for use in the visual exploration and statistical analysis of subjective well-being in the following sub-sections.

Figures 5.1 showed the state distributions of six distinct patterns from Monday to Thursday. Specifically:

- Group 1 stayed at home most time of the day and shared some household supporting (HH) trips and activities in the middle of the day. When they were at home, they always shared HH tasks.
- Group 2 stayed at home most time of the day but had activities and trips that were not for HH tasks more often. When at home, Group 2 had non-HH activities more often than Group 1.
- Group 3 stayed at home most of the time and had a few trips during the middle of the day. However, both at-home and out-of-home activities and trips were not for HH tasks.
- Group 4 went out of the home in the morning during morning peak hours (around 8 am) and came back home in the afternoon during afternoon peak hours mostly (around 5 pm). When they were at home, they always shared HH tasks.
- Group 5 had similar out-of-home patterns compared to Group 4, but they often did not share HH tasks when they were at home. Group 6 did not stay at home most of the time during the day and their activities and trips were either for HH tasks or not.

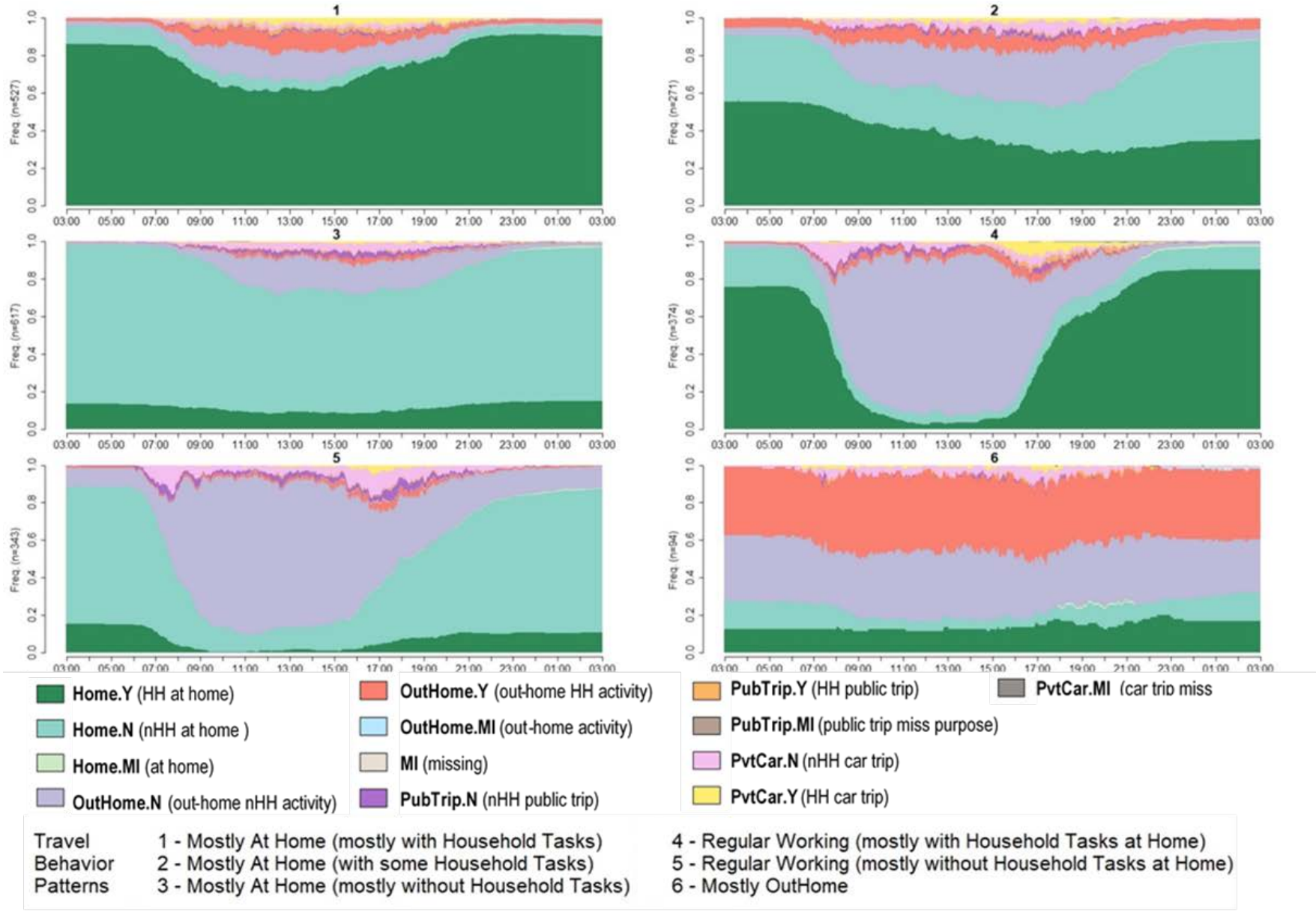
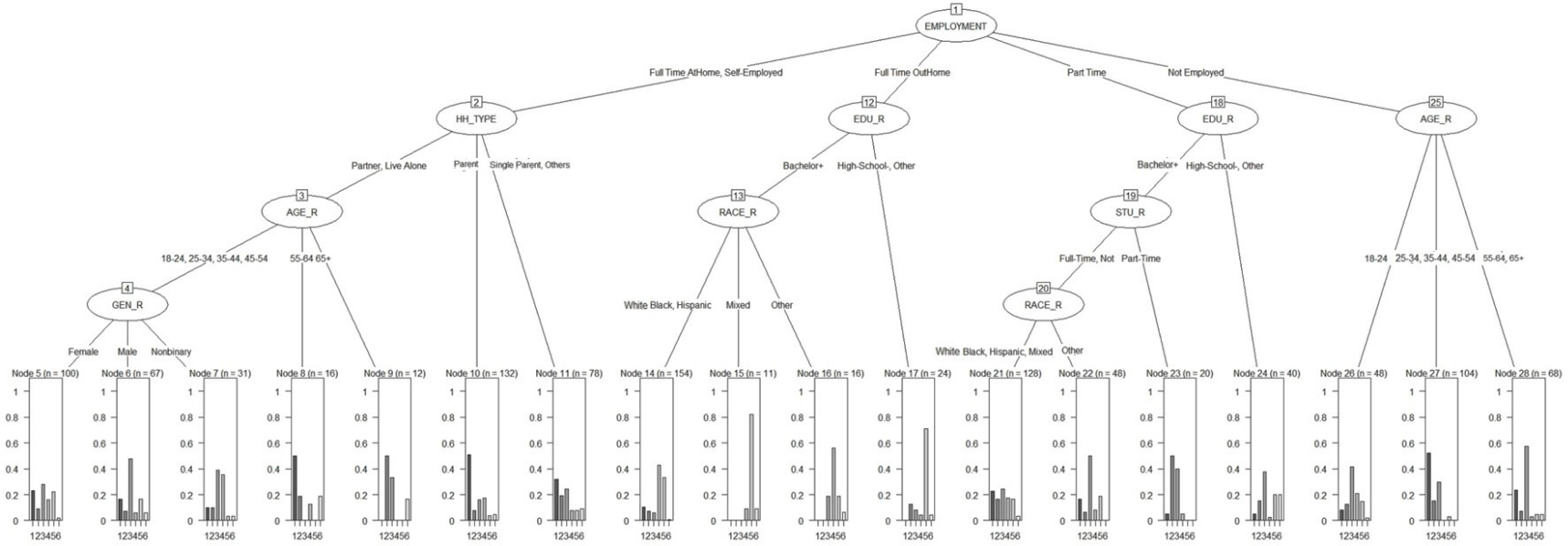


Figure 5.1 State distribution for six distinct activity-travel patterns (Daynamica Data, Monday-Thursday).

Figure 5.2 shows the analysis results using the Chi-square Automatic Interaction Detector (CHAID). Employment status remained the key determinant variable. Gender identity, family type, race, student status, age, and educational attainment intersected with each other and created intersectional groups with unique behavior patterns. For instance, nodes 15 and 17 corresponded to full-time employees who did not work from home (WFH); they either had bachelor's degrees and were mixed-race (node 15) or had high-school degrees or other types of certificates (node 17). These two intersectional groups both tended to belong to the behavior Group 5 in Figure 5.1, who were out of the home during regular working hours and do not share much of the household tasks at home. Another example was the case for nodes 5, 6, and 7 who were younger than 55, either full-time employees WFH or self-employed. For these subgroups, males were most likely to be in Group 3 who rarely shared any HH tasks at home.



Note: Abbreviations of parameters and their corresponding attributes: (1) EMPLOYMENT: employment status; (2) HH_TYPE: family type; (3) EDU_R: educational attainment; (4) AGE_R: age groups; (5) RACE_R: race and ethnicity; (6) STU_R: student status; (7) GEN_R: self-identified gender.

Figure 5.2 Chi-square automatic interaction detection of intersectional groups (Daynamica Data, Monday-Thursday).

As shown in Figure 5.3, compared to patterns from Monday to Thursday, Friday had (1) more out-of-home activities and trips that involved HH tasks for Group 4 and (2) more late-night out-of-home activities and trips for Groups 3 and 4. As for key socio-demographic attributes, educational attainment no longer played a significant role in affecting activity-travel patterns as shown in Figure 5.4.

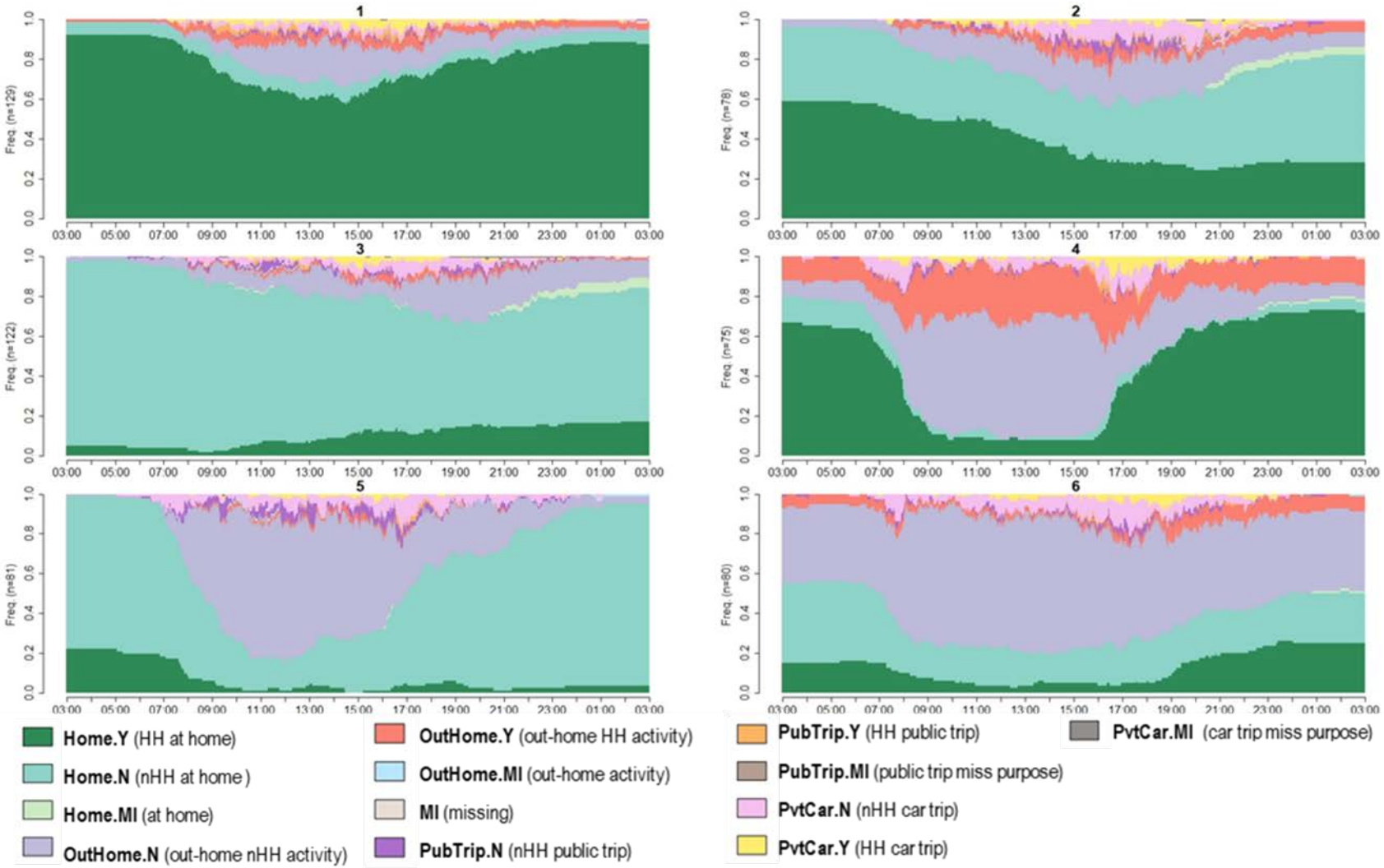
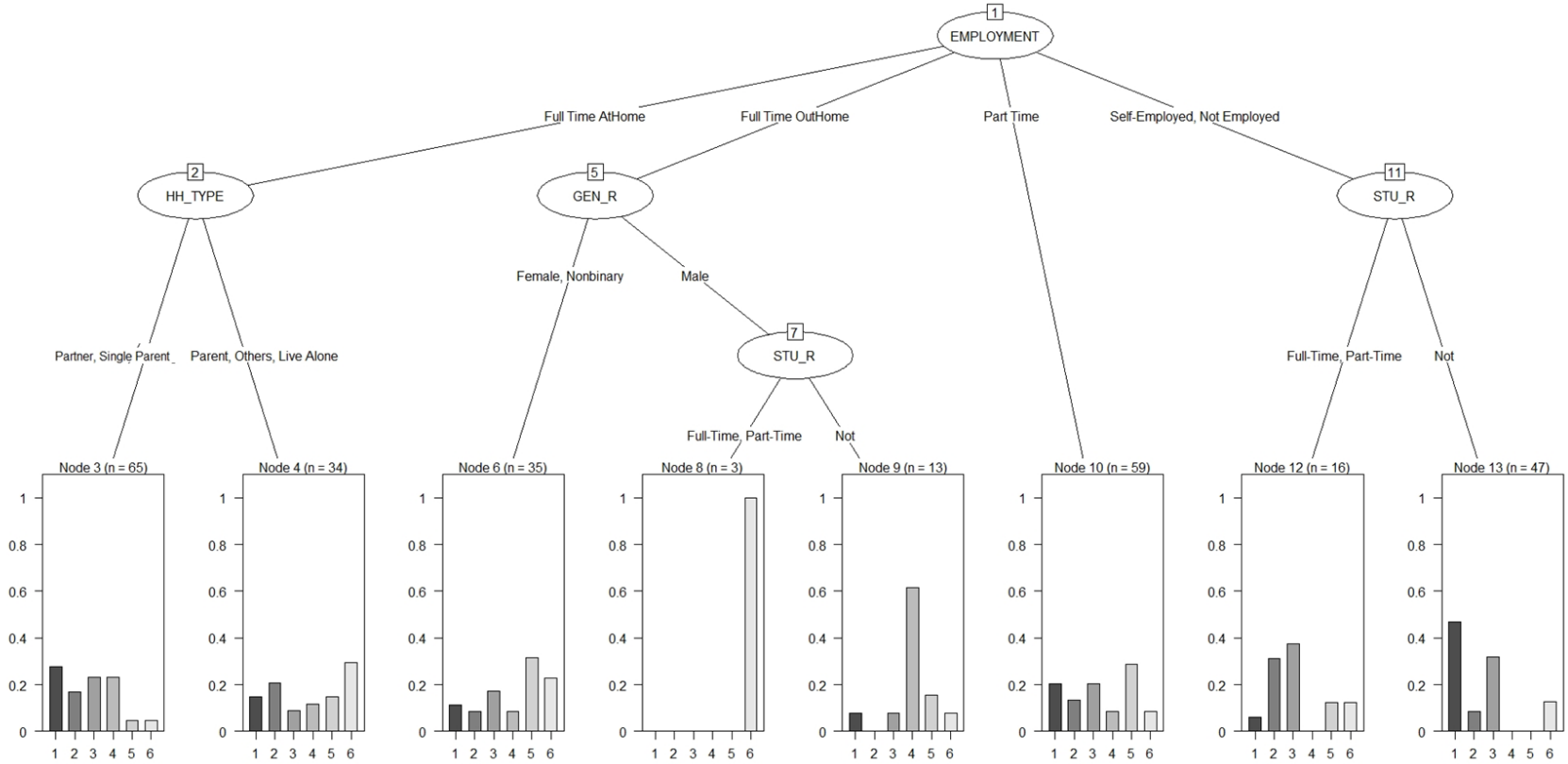


Figure 5.3 State distribution for six distinct activity-travel patterns (Daynamica Data, Friday).



Note: Abbreviations of parameters and their corresponding attributes: (1) EMPLOYMENT: employment status; (2) HH_TYPE: family type; (3) EDU_R: educational attainment; (4) AGE_R: age groups; (5) RACE_R: race and ethnicity; (6) STU_R: student status; (7) GEN_R: self-identified gender.

Figure 5.4 Chi-square automatic interaction detection of intersectional groups (Daynamica Data, Friday).

Saturday and Sunday had different patterns from weekdays: the six behavior groups differed regarding sharing of HH tasks and timing of out-of-home activities and trips (see Figure 5.5). Employment status was no longer the most influential factor on behavior patterns; instead, the family type became the key determinant variable and intersected with other socio-demographic attributes in shaping participants' activity-travel patterns (see Figure 5.6).

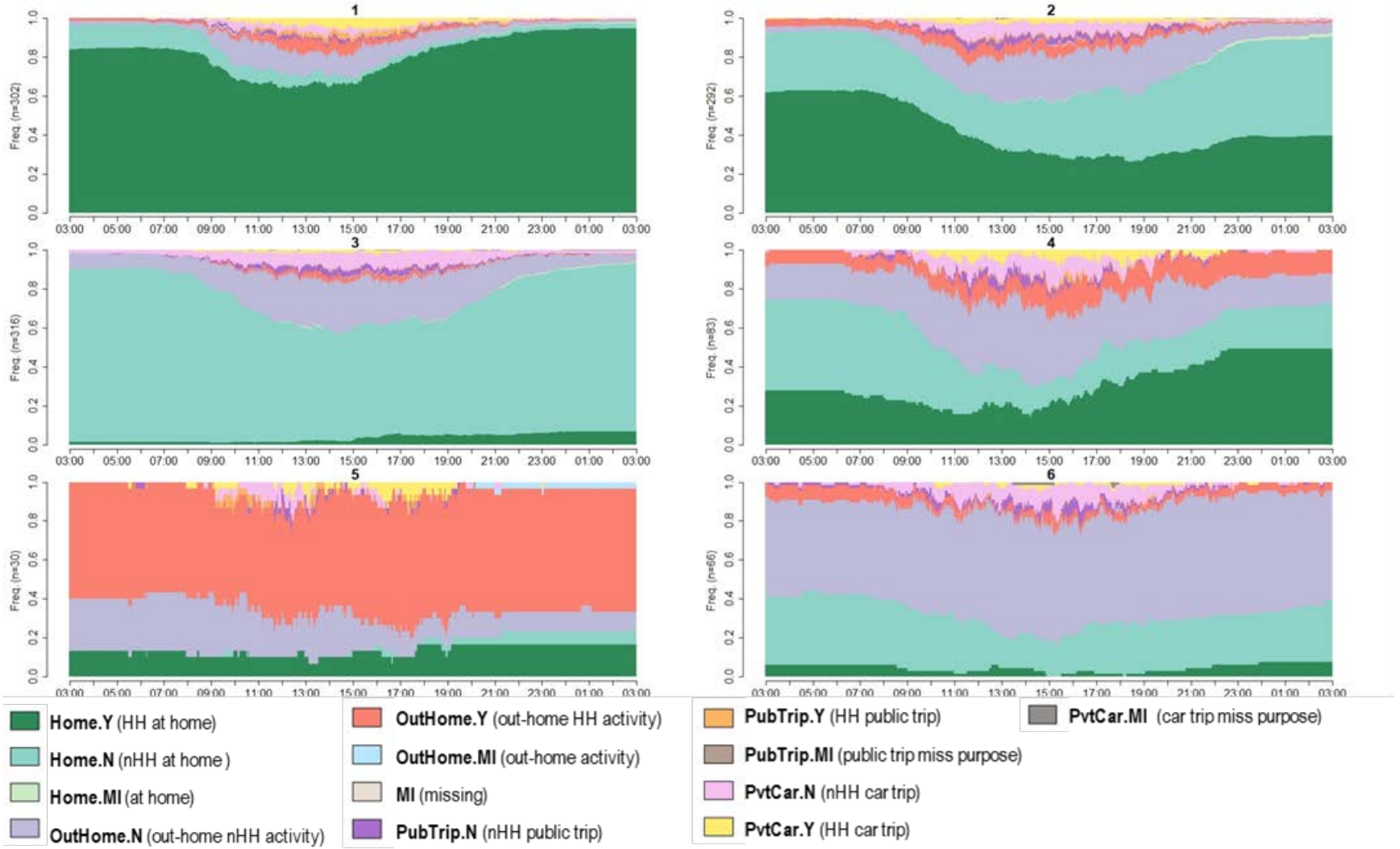
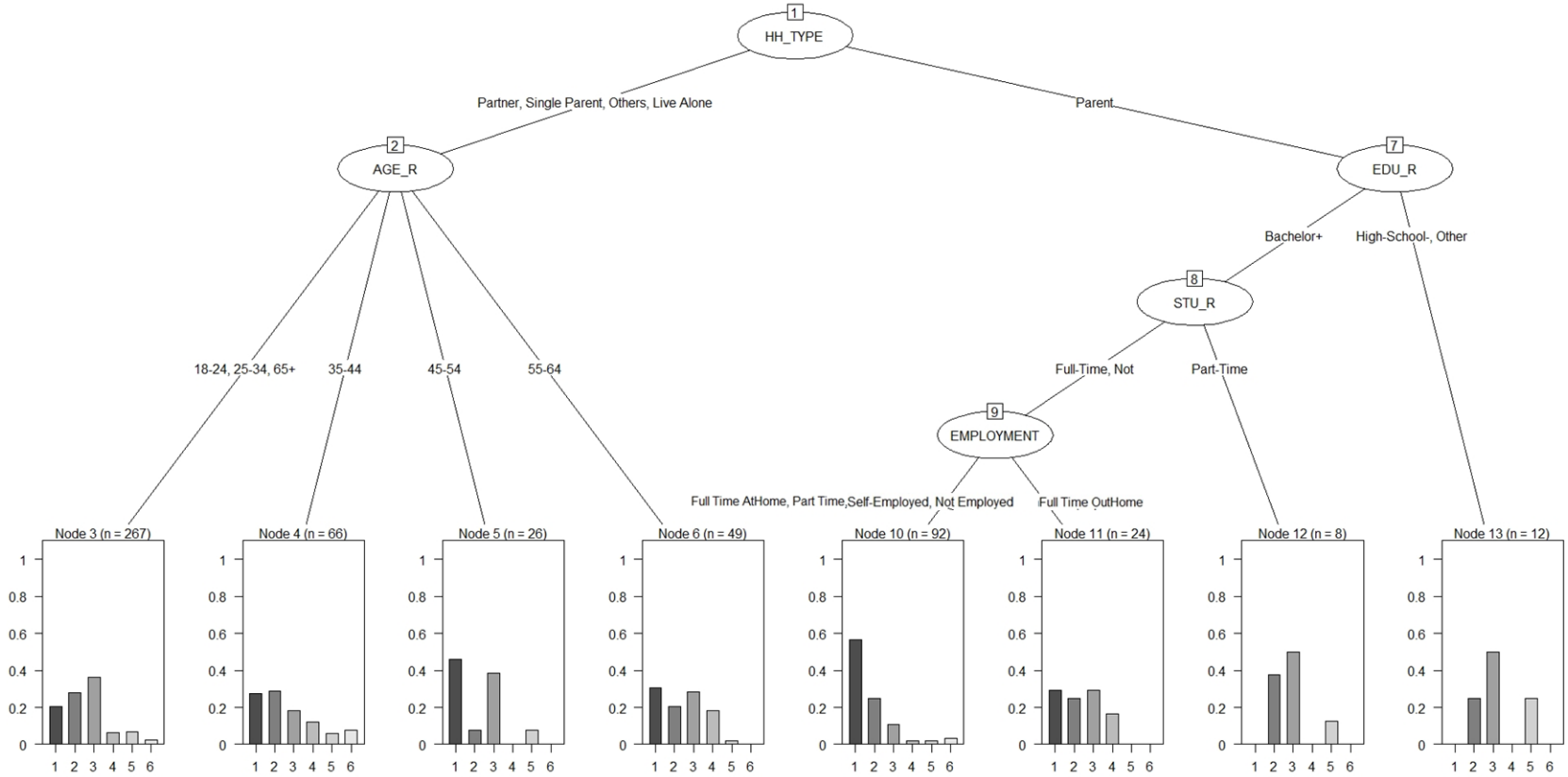


Figure 5.5 State distribution for six distinct activity-travel patterns (Daynamica Data, Saturday-Sunday).



Note: Abbreviations of parameters and their corresponding attributes: (1) EMPLOYMENT: employment status; (2) HH_TYPE: family type; (3) EDU_R: educational attainment; (4) AGE_R: age groups; (5) RACE_R: race and ethnicity; (6) STU_R: student status; (7) GEN_R: self-identified gender.

Figure 5.6 Chi-square automatic interaction detection of intersectional groups (Daynamica Data, Saturday-Sunday).

5.2 SUBJECTIVE WELL-BEING (SWB) MEASURES

Before examining participants SWB outcomes and associating them with participants' behavior patterns and social identities, we provided a brief description of the SWB data collected by the Daynamica in-app survey and introduced the SWB measure we used in this project in this subsection.

The Daynamica smartphone application recorded participants' experienced emotions during each trip and activity, which included happy, meaningful, and safe for positive emotions, and pain, sad, tired, and stressful for negative emotions. These emotions have been identified as key determinants of the overall SWB of individuals (Das et al. 2020). The intensity I_e of each emotion ranged from 1 to 7, with 7 being the most intensive and 1 being the least intensive. For instance, an intensity of 1 for happy indicated not happy at all, and an intensity of 7 indicated being as happy as one could possibility be.

Based on the 7 emotions, the team calculated the net affect. The net affect is an SWB measure that has been widely applied in the study of SWB (e.g., Kahneman and Kruger 2006, Krueger and Schkade 2008, Zhu and Fan 2018). The net affect is calculated by subtracting the average intensity of negative emotions from the intensity of average positive emotions. A higher value of net affect indicates a more positive emotional outcome.

Given the seven emotions recorded in our project, we calculated the net affect of each activity and trip episode using the formula below.

$$I_{net\_affect} = \frac{I_{happy} + I_{meaningful} + I_{safe}}{3} - \frac{I_{pain} + I_{sad} + I_{tired} + I_{stressful}}{4} \quad (1)$$

Given the emotions and net affect of each episode, the overall emotional outcome of one day was calculated as the duration-weighted sum of the outcomes of all episodes during that day:

$$I_k = \frac{\sum(I_{k,\ i} \times T_i)}{\sum T_i} \quad (2)$$

where I_k and T_i were the emotional outcome and the duration of the episode i respectively, and $k \in \{happy,\ meaningful,\ safe,\ pain,\ sad,\ tired,\ stressful,\ net\_affect\}$. We presented the visual and statistical analysis of daily emotion outcomes.

5.3 VISUAL COMPARISON OF SWB OUTCOMES

Before statistical analysis, we visually compared the SWB outcomes of participants across behavior groups detected in Section 5.1. As shown in Figure 5.7 (a), the net effects across all groups were quite similar for Monday to Thursday. Specifically:

- Group 4 who were out-of-home during regular working hours and shared HH tasks at home had a slightly higher median net affect and less variation than other groups. After examining the 7 emotions, we found that Group 4 had less variations across all emotions and felt

happier, more meaningful, and safer than most of other groups, which explained their higher overall net affect.

- Like Group 4, Group 1 who stayed at home and shared household tasks most of the time, also felt happier, more meaningful, and safer than other groups, but felt more stressed at the same time. Their median net affect was the second highest among all groups.

The above findings regrading Groups 1 and 4 suggested that sharing HH tasks at home can potentially bring more positive overall emotional outcomes even though people tended to feel more stressed.

As shown in Figure 5.7(b), patterns for Friday were slightly different from those for Monday to Thursday. Groups 1 and 4 still had the highest median net affect values. However, Group 2 who had some late-night out-of-home activities became the happiest group even though they had more pain and felt more tired. Moreover, Group 4 who were out-of-home during regular working hours and shared few HH tasks at home, had much lower net affect values due to the increased levels of tiredness and stress than other groups. These suggested that working longer hours without having family and leisure time could lead to more negative overall SWB outcomes.

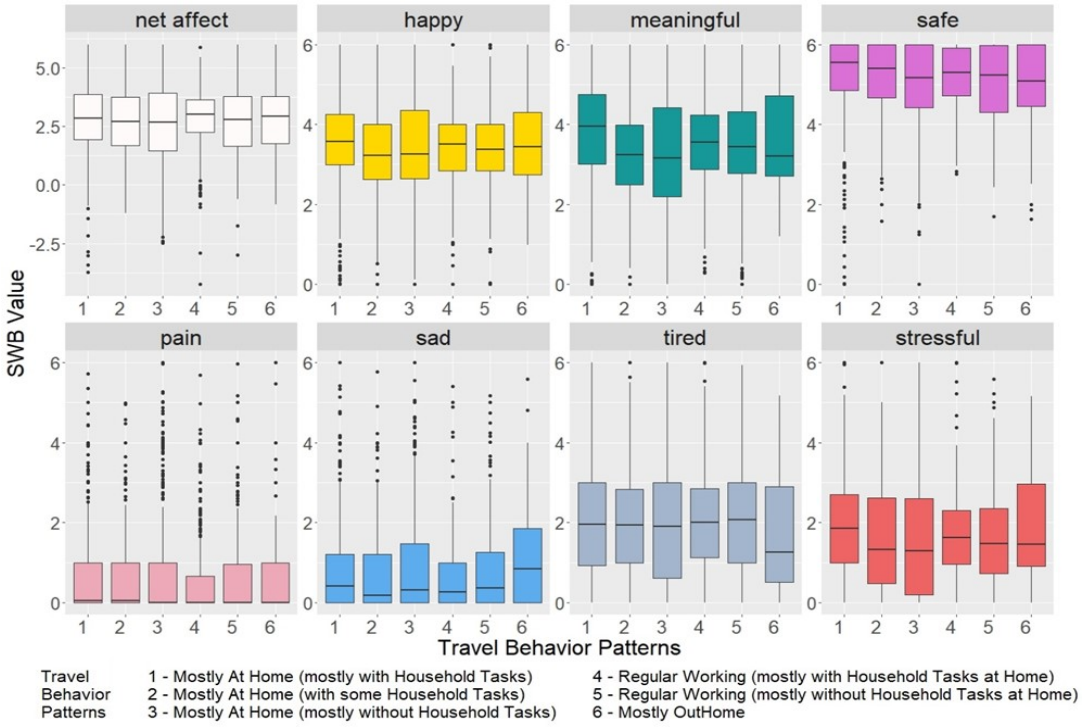
Behavior groups for Saturday and Sunday had different activity-travel patterns from weekdays, and the SWB outcomes across these groups were also different as shown in Figure 5.7(c).

- Group 1 stayed at home sharing HH tasks most of the time during weekends like Group1 for weekdays. They also had the highest net affect values and had the highest tiredness and stress levels like Group 1 for weekdays.
- Group 4 were out of the home during the middle of the day and share HH tasks at home during weekends like Group 4 for weekdays. But they did not travel during peak hours like weekdays, and many of the trips were for HH tasks.
- Regarding emotions, Group 4 had the highest net affect, but their pain levels were much higher compared to weekdays.

These findings suggested that having out-of-home activities and trips during weekends might result in more pain compared to staying at home, but it could make people feel happier at the same time.

Based on the above findings, the team concluded that the work-life balance can potentially bring more positive SWB outcomes in general. In specific, sharing household tasks may make people more tired but could increase their happiness and meaningfulness levels at the same time. And leisure and family time beyond work and study appeared to be essential to improve the overall SWB outcomes.

(a) Monday to Thursday



(b) Friday

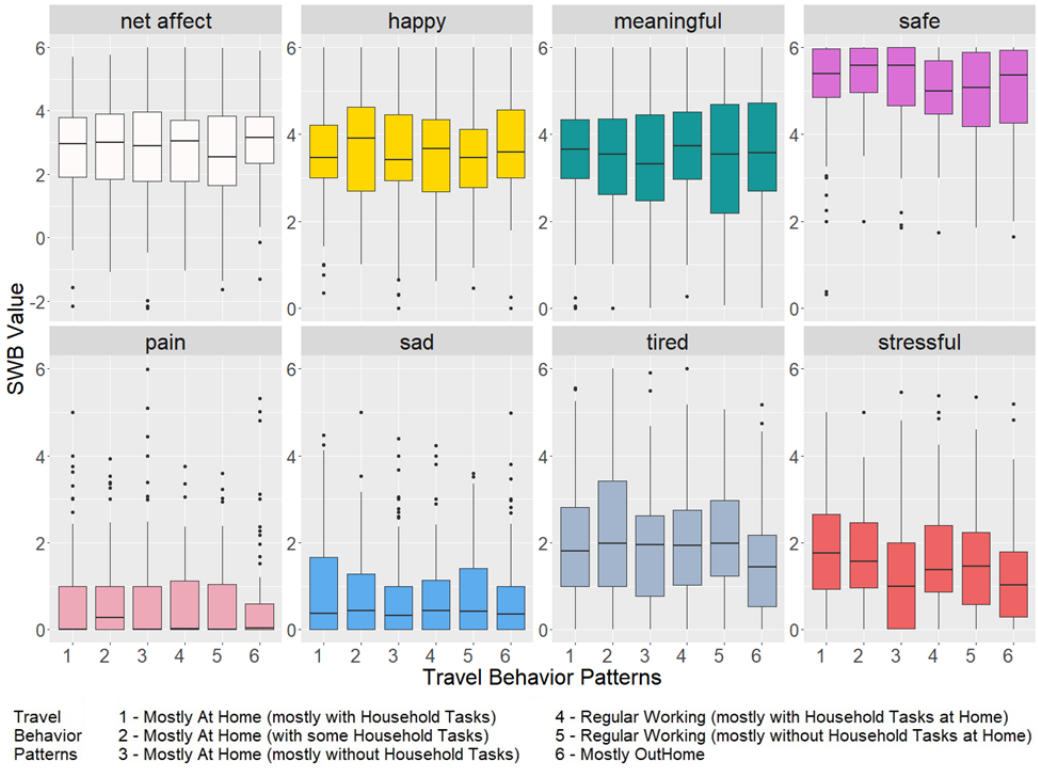


Figure 5.7 SWB outcomes across behavior groups (Daynamica Data).

(b) Saturday & Sunday

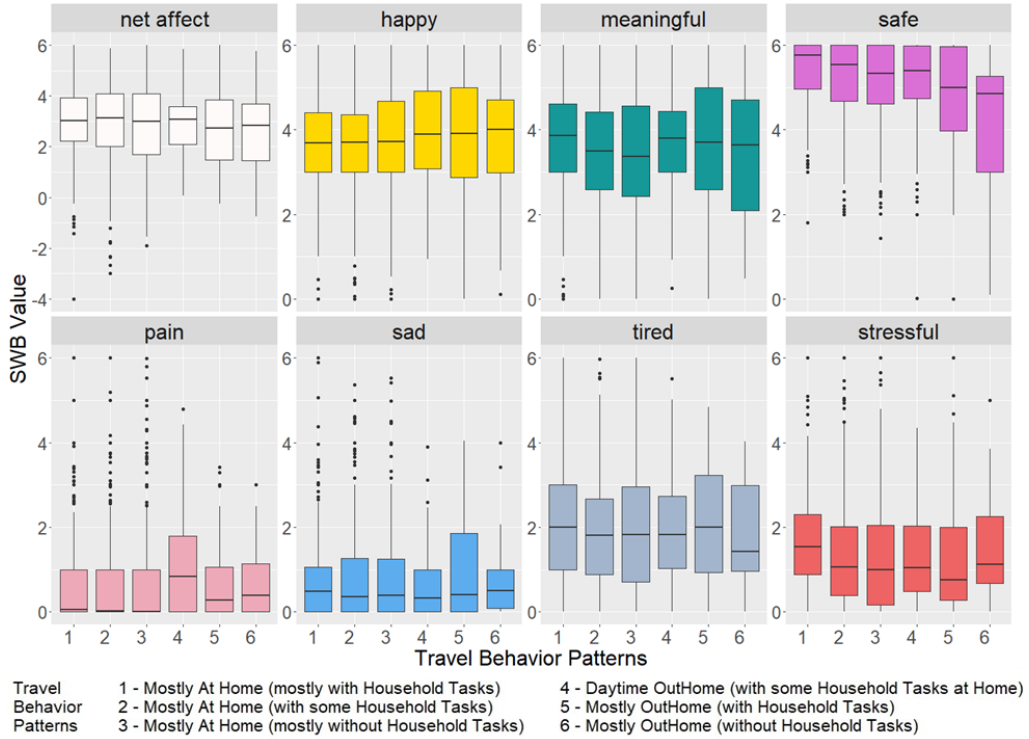


Figure 5.7 (continued) SWB outcomes across behavior groups (Daynamica Data).

The team further examined how the emotional outcomes patterns above varied across gender groups. Figure 5.8 (a) and (b) showed results for Monday to Thursday and for Friday respectively, which were quite similar. In general, non-binary people had lower median net affects than males and females across all six behavior groups. Within behavior Groups 1, 4, and 5, males had higher net effects than females in the same behavior group. This was because males felt less tired and stressed than females when they shared HH tasks at home. In contrast, males in behavior Groups 2 and 3 who shared few HH tasks had slightly lower net affect values than females in the same behavior group, resulting from decreases in all three positive emotions and increases in sadness, tiredness, and stress. Compared to Groups 1, 4, and 5, the lower net affect values of males suggested that sharing HH tasks while at home could bring more intense positive emotions, especially for males.

(a) Monday to Thursday

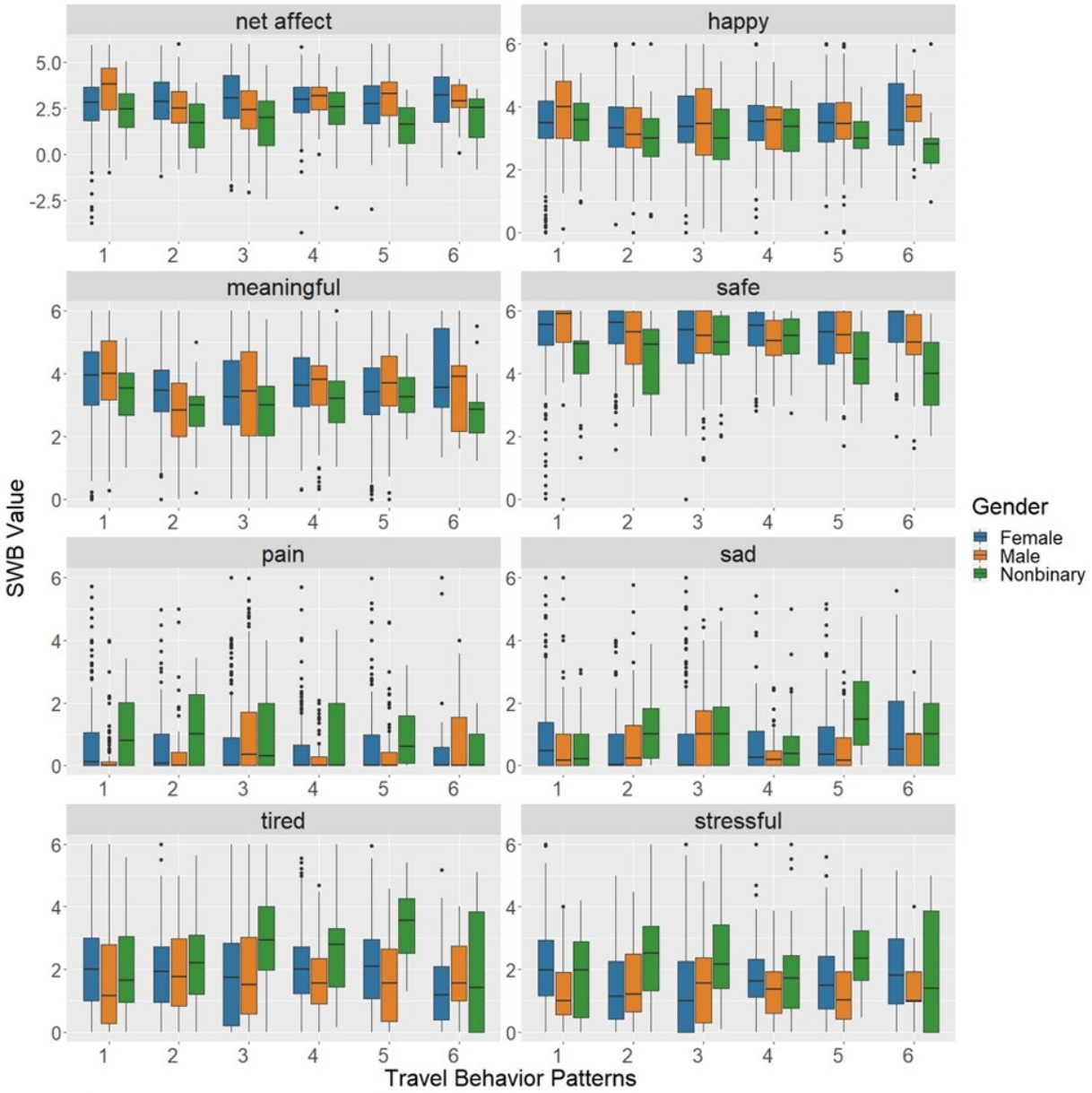


Figure 5.8 SWB outcomes across behavior groups and genders (weekdays).

(b) Friday

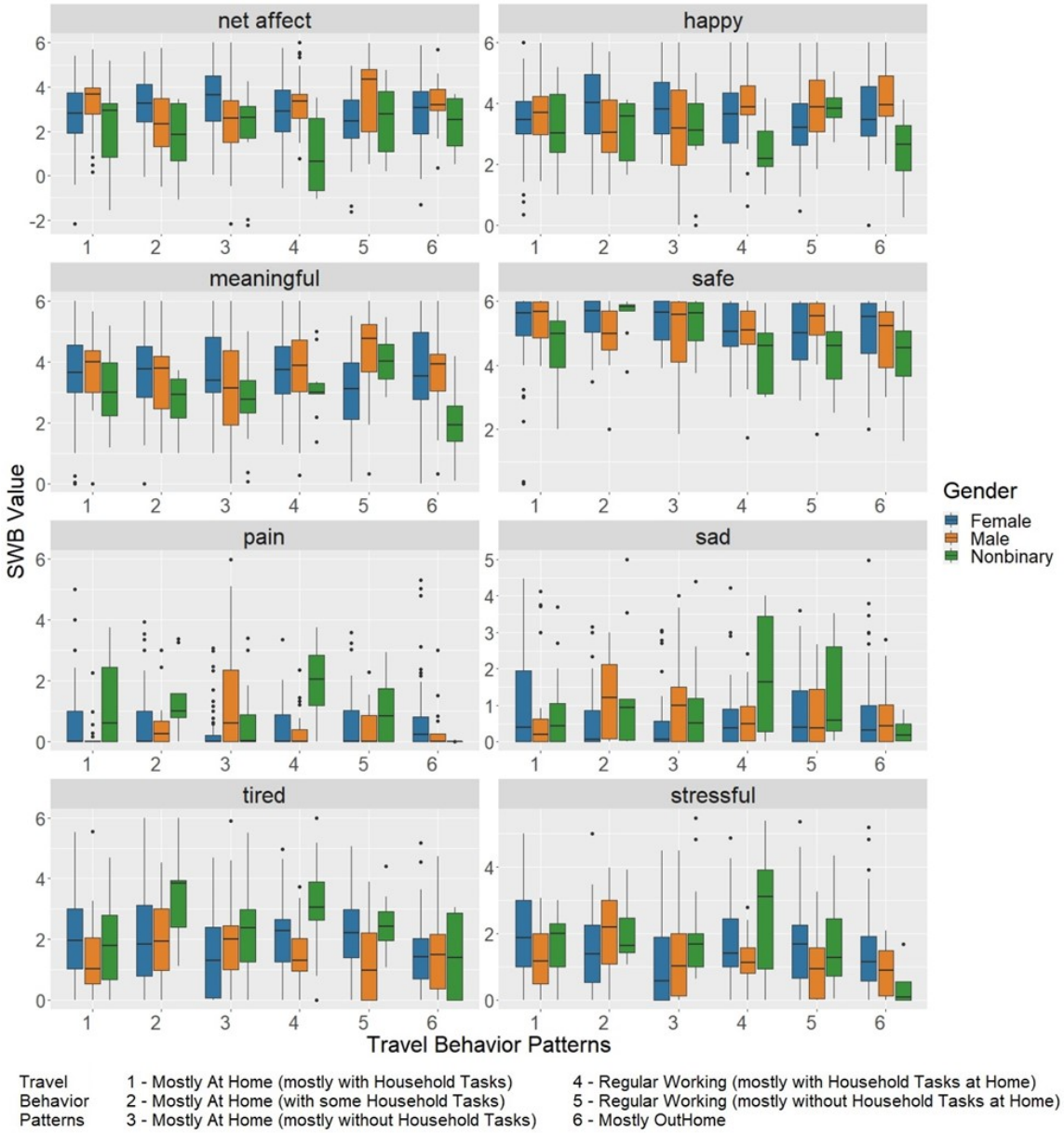


Figure 5.8 (continued) SWB outcomes across behavior groups and genders (weekdays).

For Saturday and Sunday, across all the six behavior groups, non-binary people remained to have lower median net affects than males and females as shown in Figure 5.9. For males and females in the same behavior group, the differences were not quite significant except for Group 4, who were out of the home in the middle of the day. Specifically, females in Group 4 had higher levels of positive emotions and lower levels of negative emotions than males for all seven emotions. This suggested that out-of-home activities and trips during the weekends can bring more positive emotions for females than males, even when those tasks were for HH tasks such as shopping for groceries.

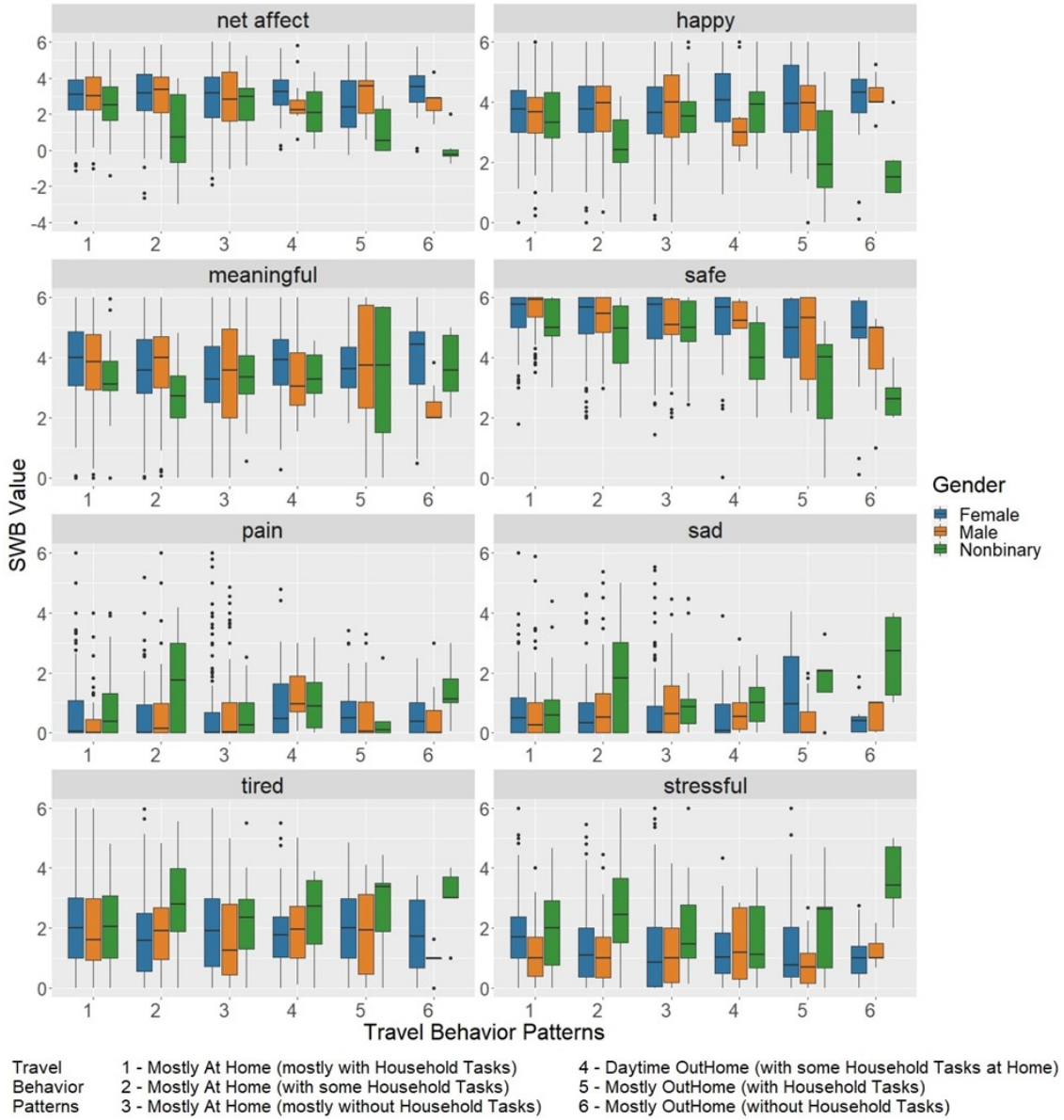


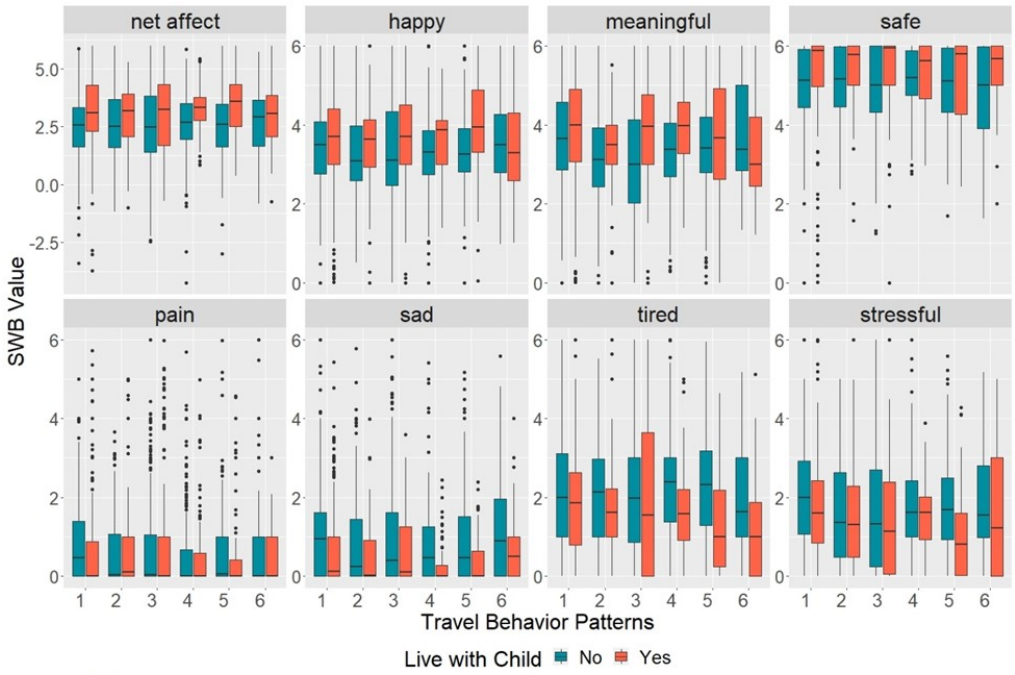
Figure 5.9 SWB outcomes across behavior groups and genders (weekends)

Since living with kids could introduce more HH tasks, we continued to examine whether the SWB outcomes across behavior groups were affected by the presence of kids. Figure 5.10 (a) showed all emotional outcomes for Monday to Thursday by behavior groups and family types. We found that people living with their own or foster kids had higher net affects for all six behavior groups. Specifically, all the positive emotions became much stronger with the presence of kids, which mitigated the more intense negative emotions.

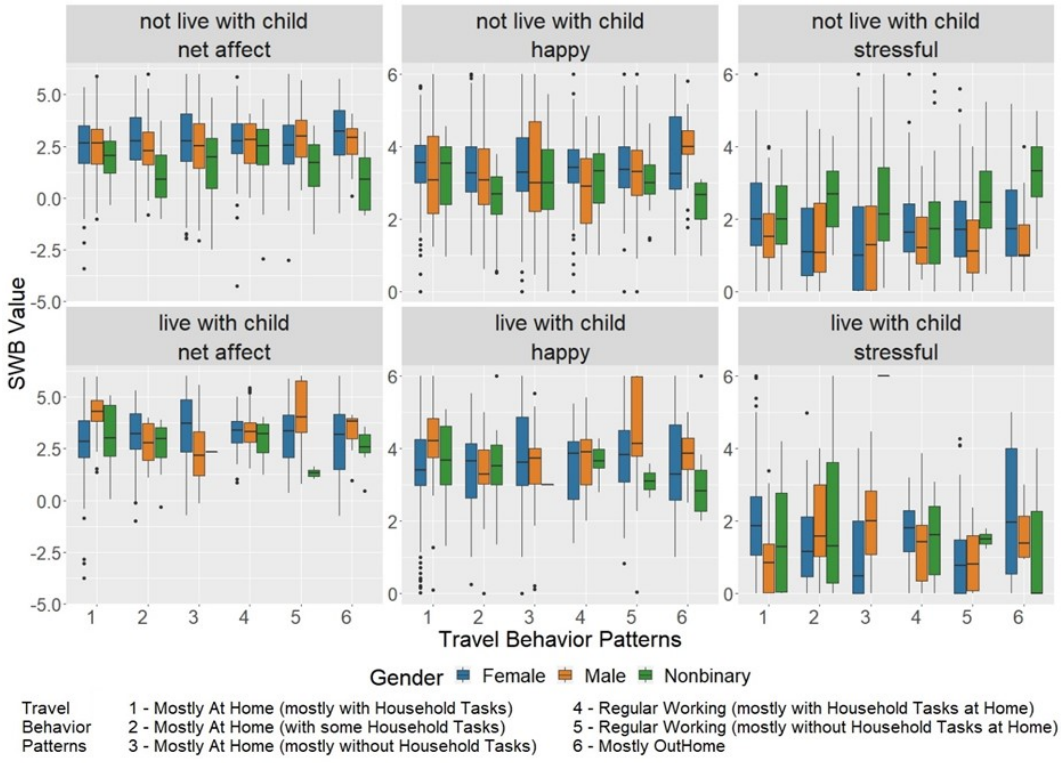
To further examine whether such patterns are consistent across gender groups, we chose happy as the positive emotion, stressful as the negative emotion, and the net affect as the overall SWB outcome. And we visualized how they varied across behavior groups, gender identities, and family types (see Figure 5.10 (b)). We found that living with kids had a stronger impact on males than females and non-binary

people. This difference was most obvious for males in Group 1 (stay at home mostly and share HH tasks). For them, living with kids made them feel much happier and less stressed than without kids.

(a) By Behavior Groups and Family Types



(b) By Behavior Groups, Family Types, and Gender Identities

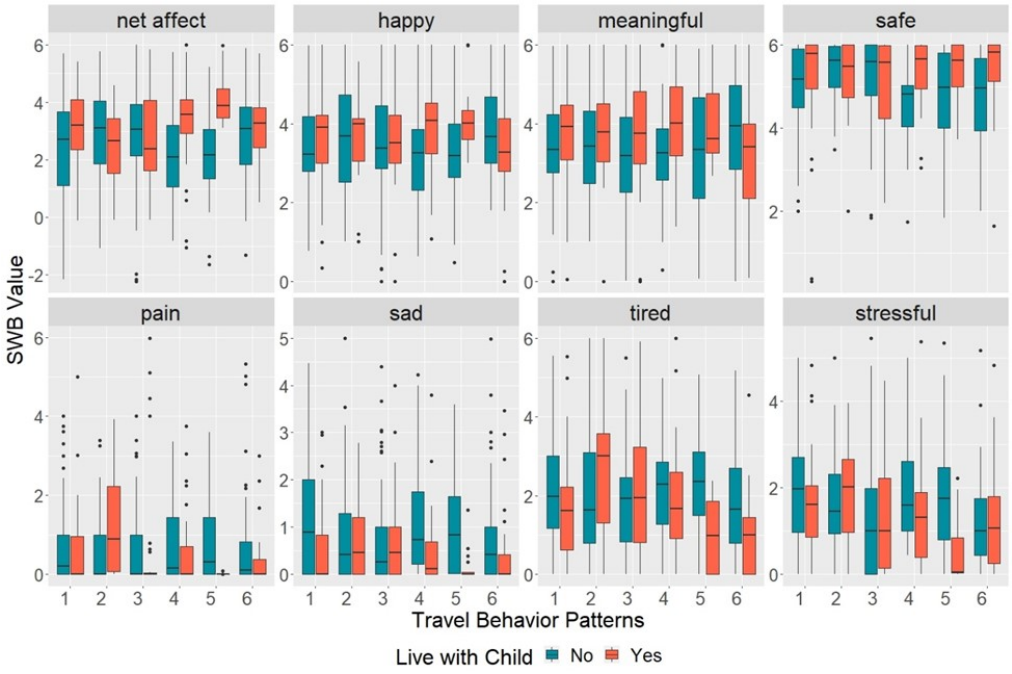


Travel Behavior Patterns
1 - Mostly At Home (mostly with Household Tasks)
2 - Mostly At Home (with some Household Tasks)
3 - Mostly At Home (mostly without Household Tasks)
4 - Regular Working (mostly with Household Tasks at Home)
5 - Regular Working (mostly without Household Tasks at Home)
6 - Mostly OutHome

Figure 5.10 SWB outcomes across behavior groups, family types, and genders (Monday-Thursday)

As shown in Figure 5.11, Friday had slightly different patterns from Monday to Thursday. Groups 2 and 3 who stayed at home but shared few or no HH tasks experience more pain, tiredness, and stress if they lived with kids. This could be because, while living with kids, people were less likely to have out-of-home activities on Friday nights, leading to more intense negative emotions after an entire week of work.

(a) By Behavior Groups and Family Types



(b) By Behavior Groups, Family Types, and Gender Identities

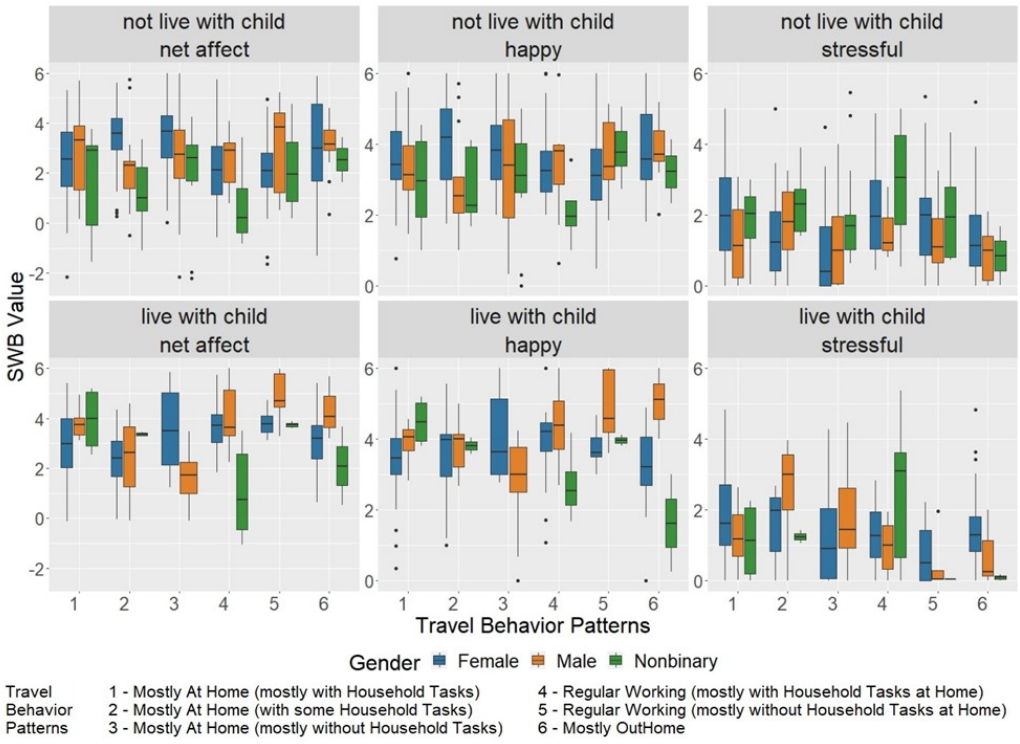


Figure 5.11 SWB outcomes across behavior groups, family types, and genders (Friday)

5.4 STATISTICAL ANALYSIS OF SWB OUTCOMES

The team continued to examine whether SWB outcomes significantly differed across behavioral and social groups. We started by examining a single socio-demographic attribute at a time using ANOVA and F-Test. Then, we conducted statistical regression analyses to associate behavior patterns with socio-demographic attributes that were selected based on CHAID results in Section 4.3 and visual explorations in Section 5.3.

5.4.1 Cross Group Comparison

There were more than two groups for each variable (e.g., gender groups included females, males, and non-binary). Therefore, the team used the one-way analysis of variance (One-Way ANOVA) to compare the SWB outcomes of these groups and determined whether there was statistical evidence that the group means were significantly different (Bewick et al. 2004). The One-Way ANOVA requires that the variable meets three criteria: (1) observations are independent, (2) data follow normality, and (3) the variance of the sample is equal. For some of our selected variables, the last two criteria were violated according to statistical tests such as Bartlett's test and Levene's test. In such cases, we used Welch's F-test instead of the standard One-Way ANOVA for these variables. The F-test is an alternative to the ANOVA and can be used even if the data violate the equal variance criteria (Delbosc and Curries 2011).

Table 5.1 showed analysis results for Monday to Thursday, Friday, and Saturday to Sunday:

- As shown in Table 5.1 for Monday to Thursday, the mean net affects varied significantly[3] across subgroups for almost all variables, which indicated that all selected variables in the table could potentially have significant impacts on the emotional outcomes of participants.
- As shown in Table 5.2 for Friday, the mean net affects varied significantly across subgroups for all variables, and gender differences were significant for all emotions. However, some of the seven emotions did not vary significantly for certain variables. For instance, the happiness levels across family types were different but not significant, which indicated that family types have an impact on happiness levels, but such an impact was not significant.
- As shown in Table 5.3 for Saturday to Sunday, the mean net affects also varied significantly across subgroups for most variables, and gender differences were significant for all emotions.

[3] Note: The team considered the differences across groups as significant if the p value is smaller than 0.05, that is, the difference is statistically significant at the 95% confidence level.

Table 5.1 Comparing Means across Groups using ANOVA and Welch's F-test (Monday-Thursday)

	Net Affect	Happy	Meaningful	Safe	Pain	Sad	Tired	Stressful
1. Gender								
Female	2.807	3.492	3.562	5.178	0.637	0.796	1.965	1.683
Male	2.919	3.545	3.694	5.134	0.660	0.793	1.758	1.415
Non-binary	1.972	3.143	3.067	4.742	0.999	1.071	2.545	2.168
F-value	**41.01*****	**14.25**^{c}	**19.43**^{c}	**24.41*****	**11.78**^{c}	**7.39**^{c}	**30.22**^{c}	**34.34**^{c}
2. Family Type								
Partner	2.675	3.482	3.483	5.126	0.785	0.885	2.071	1.679
Parent	3.214	3.645	3.795	5.386	0.610	0.487	1.680	1.470
Single Parent	2.481	3.437	3.856	5.082	1.226	1.185	2.102	2.063
Other	2.568	3.501	3.432	4.833	0.525	1.068	2.068	1.756
Live Alone	2.408	3.142	3.166	5.088	0.801	0.831	2.154	1.775
F-value	**21.62**^{c}	**11.62**^{c}	**16.01**^{c}	**23.25**^{c}	**8.48**^{c}	**27.34**^{c}	**9.07**^{c}	**6.58**^{c}
3. Race								
White	2.686	3.430	3.407	5.116	0.744	0.794	1.962	1.691
Black	2.696	3.894	3.057	4.569	0.694	0.995	1.650	1.240
Hispanic	3.406	4.256	4.236	5.400	0.770	0.849	1.820	1.460
Other	2.830	3.398	3.701	5.027	0.409	0.788	2.016	1.639
Mixed	2.405	3.226	3.715	5.214	0.790	1.308	2.507	1.984
F-value	**5.67**^{c}	**18.92**^{c}	**14.87**^{c}	**8.65**^{c}	**10.67**^{c}	**3.67**^{c}	**5.28**^{c}	**4.69*****
4. Employment								
Fulltime OutHome	2.991	3.544	3.696	5.255	0.509	0.671	3.033	1.448
Fulltime AtHome	2.885	3.442	3.590	5.158	0.529	0.695	2.652	1.705
Part-time	2.369	3.363	3.177	4.820	0.679	1.004	3.001	1.830
Self-employed	3.230	4.032	3.897	5.831	1.166	0.627	3.249	1.495
Not employed	2.457	3.406	3.418	5.057	1.108	1.093	3.000	1.724
F-value	**14.805**^{c}	**3.81**^{b}	**11.52**^{c}	**67.02**^{c}	**17.50**^{c}	**13.39**^{c}	**7.24**^{c}	**6.40**^{c}
5. Student Status								
Full-time	2.220	3.273	3.142	4.973	0.575	1.195	2.467	2.065
Part-time	2.326	3.138	3.041	4.931	0.595	0.964	2.130	1.820
Not a student	2.881	3.534	3.629	5.155	0.734	0.732	1.861	1.572
F-value	**36.22**^{c}	**14.83**^{c}	**34.02**^{c}	**8.07*****	**4.87**^{b}	**21.9**^{c}	**31.35*****	**26.22*****
6. Education								
High school -	2.152	3.550	3.483	4.824	1.265	1.357	2.585	1.996
Bachlor +	2.733	3.432	3.478	5.121	0.655	0.817	1.948	1.690
Other	2.995	3.717	3.755	5.118	0.768	0.636	2.114	1.288
F-value	**6.35**^{b}	**3.73**^{a}	**2.64**	**4.24**^{a}	**7.28**^{c}	**13.48**^{c}	**9.07**^{c}	**10.52**^{c}
7. Age								
18-24	2.409	3.463	3.190	4.863	0.435	1.110	2.383	1.791
25-34	2.344	3.216	3.232	4.969	0.783	0.986	2.191	1.886
35-44	2.871	3.482	3.659	5.234	0.759	0.695	1.992	1.572
45-54	3.556	3.733	4.113	5.645	0.539	0.475	1.201	1.549
55-64	3.085	3.771	3.907	5.075	0.780	0.703	1.642	1.541
65+	3.013	3.669	3.364	5.124	0.759	0.664	1.503	1.229
F-vlaue	**24.99**^{c}	**10.99*****	**23.05*****	**39.50**^{c}	**8.61**^{c}	**14.27**^{c}	**27.03*****	**9.17**^{c}

For classic one-way anova test, * p-value <0.05; ** p-value <0.01; *** p <0.001.
For Welch's F-test, ^{a} p-value <0.05; ^{b} p-value <0.01; ^{c} p <0.001.

Table 5.2 Comparing Means across Groups using ANOVA and Welch's F-test (Friday)

	Net Affect	Happy	Meaningful	Safe	Pain	Sad	Tired	Stressful
1. Gender								
Female	2.930	3.646	3.584	5.157	0.602	0.732	1.903	1.558
Male	2.943	3.620	3.581	5.033	0.625	0.879	1.715	1.319
Non-binary	2.023	3.099	3.062	4.805	1.111	1.106	2.427	1.887
F-value	**10.22*****	**6.01****	**5.71**^{b}	**3.80***	**5.26**^{b}	**3.95***	**6.51****	**5.41****
2. Household Type								
Partner	2.838	3.607	3.472	5.142	0.782	0.811	1.907	1.440
Parent	3.256	3.715	3.831	5.362	0.558	0.533	1.709	1.386
Single Parent	2.747	3.513	3.819	5.224	0.999	0.847	2.119	1.787
Other	2.614	3.626	3.430	4.728	0.535	1.091	2.000	1.630
Live Alone	2.493	3.274	3.206	5.044	0.788	0.849	2.071	1.687
F-value	**4.58**^{b}	**2.22**	**3.71****	**7.52**^{c}	**2.19**	**5.18**^{c}	**1.43**	**1.52**
3. Race								
White	2.756	3.540	3.442	5.076	0.725	0.818	1.935	1.575
Black	2.922	4.072	3.497	4.564	0.798	0.916	1.461	1.313
Hispanic	3.971	4.438	4.4799	5.478	0.565	0.529	1.274	0.942
Other	2.924	3.519	3.566	5.0473	0.416	0.769	1.851	1.445
Mixed	2.617	3.357	3.684	5.190	0.700	1.010	2.400	1.727
F-value	**3.01***	**3.60****	**2.84***	**1.96**	**1.53**	**0.78**	**2.88***	**1.80**
4. Employment								
Fulltime OutHome	3.177	3.721	3.798	5.276	0.525	0.666	1.899	1.264
Fulltime AtHome	2.900	3.514	3.581	5.091	0.525	0.717	1.823	1.583
Part-time	2.487	3.461	3.178	4.830	0.701	0.960	2.019	1.666
Self-employed	3.469	4.269	3.950	5.904	0.871	0.758	2.046	1.281
Not employed	2.639	3.561	3.472	5.048	0.999	0.982	1.985	1.585
F-value	**3.46**^{a}	**2.01**	**3.14**^{a}	**27.41**^{c}	**2.95**^{a}	**2.22**	**0.49**	**1.90**
5. Student Status								
Full-time	2.456	3.516	3.179	4.950	0.595	1.127	2.190	1.792
Part-time	2.439	3.346	3.117	4.768	0.535	0.997	2.038	1.649
Not a student	2.945	3.607	3.639	5.144	0.705	0.727	1.845	1.466
F-value	**5.08****	**1.04**	**6.38****	**3.84***	**0.79**	**5.08**^{b}	**2.64**	**3.05***
6. Education								
High school -	2.603	3.843	3.794	4.905	1.237	1.278	2.210	1.585
Bachlor +	2.810	3.535	3.488	5.088	0.633	0.805	1.911	1.560
Other	3.131	3.810	3.681	5.117	0.719	0.590	1.795	1.181
F-value	**0.96**	**1.63**	**0.95**	**0.50**	**1.57**	**3.74***	**0.84**	**1.64**
7. Age								
18-24	2.562	3.642	3.180	4.807	0.434	1.126	2.172	1.525
25-34	2.484	3.303	3.255	4.954	0.766	0.889	2.045	1.713
35-44	2.918	3.640	3.685	5.194	0.748	0.724	2.029	1.520
45-54	3.603	3.771	4.188	5.600	0.461	0.526	1.285	1.396
55-64	2.993	3.647	3.714	5.052	0.763	0.791	1.577	1.447
65+	3.173	3.913	3.484	5.086	0.645	0.588	1.595	1.122
F-vlaue	**5.04*****	**2.50***	**5.47*****	**9.62**^{c}	**1.76**	**2.86**^{a}	**4.40*****	**1.59**

For classic one-way anova test, * p-value <0.05; ** p-value <0.01; *** p <0.001.
For Welch's F-test, ^{a} p-value <0.05; ^{b} p-value <0.01; ^{c} p <0.001.

Table 5.3 Comparing Means across Groups using ANOVA and Welch's F-test (Saturday)

	Net Affect	Happy	Meaningful	Safe	Pain	Sad	Tired	Stressful
1. Gender								
Female	3.026	3.754	3.671	5.232	0.676	0.732	1.921	1.441
Male	3.001	3.724	3.503	5.140	0.740	0.845	1.745	1.157
Non-binary	2.022	3.242	3.170	4.705	1.051	1.202	2.420	2.060
F-value	**19.97^{c}**	**10.40*****	**9.59^{c}**	**12.13^{c}**	**5.70^{b}**	**8.6^{c}**	**11.61*****	**23.55^{c}**
2. Household Type								
Partner	2.924	3.779	3.462	5.217	0.815	0.826	1.941	1.332
Parent	3.307	3.765	3.905	5.425	0.668	0.577	1.712	1.277
Single Parent	2.723	3.602	3.744	5.068	1.160	0.856	1.919	1.725
Other	2.738	3.689	3.543	4.826	0.575	1.031	1.958	1.562
Live Alone	2.529	3.438	3.234	5.086	0.872	0.867	2.211	1.614
F-value	**7.98^{c}**	**2.82***	**7.90^{c}**	**13.08^{c}**	**3.71^{b}**	**6.72^{c}**	**3.56^{b}**	**3.78^{b}**
3. Race								
White	2.859	3.661	3.487	5.179	0.752	0.801	1.967	1.480
Black	2.721	4.068	3.316	4.587	1.167	1.082	1.480	1.348
Hispanic	3.764	4.417	4.341	5.444	0.725	0.533	1.567	1.053
Other	2.894	3.573	3.692	4.961	0.496	0.935	1.862	1.433
Mixed	2.665	3.478	3.656	5.128	1.060	0.911	2.267	1.450
F-value	**3.53****	**6.35^{c}**	**4.29****	**4.41^{b}**	**3.94^{b}**	**2.36**	**2.75***	**1.24**
4. Employment								
Fulltime OutHome	3.208	3.836	3.657	5.340	0.572	0.608	1.882	1.216
Fulltime AtHome	3.037	3.665	3.698	5.175	0.623	0.772	1.773	1.404
Part-time	2.486	2.563	3.308	4.764	0.790	0.972	2.130	1.679
Self-employed	3.088	4.055	4.093	5.879	1.009	0.867	2.651	1.823
Not employed	2.724	3.619	3.419	5.178	1.019	0.953	1.980	1.439
F-value	**7.01^{c}**	**1.82**	**4.05^{b}**	**40.10^{c}**	**4.69^{b}**	**4.76^{b}**	**3.60^{b}**	**4.27^{b}**
5. Student Status								
Full-time	2.439	3.526	3.186	5.000	0.614	1.105	2.315	1.826
Part-time	2.617	3.550	3.227	4.910	0.619	0.903	1.999	1.595
Not a student	3.016	3.726	3.681	5.193	0.787	0.752	1.848	1.346
F-value	**10.84*****	**2.42**	**11.63*****	**4.97****	**2.28**	**7.20^{c}**	**8.66*****	**12.11*****
6. Education								
High school -	2.650	3.831	3.869	4.916	1.174	1.227	2.168	1.653
Bachlor +	2.889	3.659	3.540	5.151	0.708	0.817	1.929	1.456
Other	3.010	3.779	3.539	5.132	0.846	0.599	1.914	1.200
F-value	**0.57**	**0.79**	**1.14**	**1.17**	**2.20**	**6.16^{b}**	**0.84**	**2.22**
7. Age								
18-24	2.656	3.658	3.260	4.881	0.370	1.094	2.106	1.537
25-34	2.493	3.456	3.302	4.987	0.904	0.989	2.180	1.613
35-44	2.974	3.746	3.750	5.254	0.878	0.741	2.074	1.414
45-54	3.754	3.866	4.126	5.674	0.483	0.437	1.035	1.249
55-64	3.187	3.880	3.898	5.142	0.758	0.669	1.697	1.356
65+	3.158	3.845	3.186	5.168	0.677	0.544	1.403	1.009
F-vlaue	**12.97^{c}**	**3.44****	**10.00^{c}**	**20.96^{c}**	**10.58^{c}**	**8.38^{c}**	**21.20^{c}**	**4.63^{c}**

For classic one-way anova test, * p-value <0.05; ** p-value <0.01; *** p <0.001.
For Welch's F-test, ^{a} p-value <0.05; ^{b} p-value <0.01; ^{c} p <0.001.

In addition to daily SWB outcomes, we also compared the emotion experienced during all trips among gender groups. As shown in Table 4, the emotions experienced during trips were statistically different across genders for Monday to Thursday, Friday, and Saturday and Sunday. Non-binary people had the lowest net affects throughout the week than males and females, which was attributed to their lower levels of positive emotions (happy, meaningful, and safe) and higher levels of negative emotions (pain, sad, tired, and stressful). Moreover, compared to males, females consistently felt more stressed and tired during trips. Considering that tiredness and stress may lead to more potential traffic crashes (e.g., Mattews 2002), such difference suggested that females who tended to heavily rely on driving personal vehicles may have a higher risk of having crashes than males due to the tiredness.

Table 5.4 Comparing emotions during trips across genders using ANOVA and Welch's F-test

	Net Affect	Happy	Meaningful	Safe	Pain	Sad	Tired	Stressful
1. Mon – Thu.								
Female	2.84	4.45	4.45	5.72	1.55	1.59	2.55	2.45
Male	2.86	4.46	4.52	5.52	1.64	1.59	2.40	2.27
Non-binary	1.86	3.95	3.78	5.13	1.73	1.90	3.19	2.91
F-value	**40.97*****	**643.17**^{c}	**22.75**^{c}	**647.08**^{c}	**607.36**^{a}	**610.2**^{c}	**615.6**^{c}	**621.51**^{c}
2. Fri.								
Female	2.97	4.63	4.50	5.73	1.51	1.54	2.53	2.36
Male	2.97	4.60	4.57	5.67	1.60	1.67	2.41	2.25
Non-binary	1.91	3.95	3.78	5.16	2.01	1.85	2.91	2.78
F-value	**10.6*****	**6.609****	**5.982****	**6.051****	**128.9**^{b}	**2.768**	**2.80**	**3.957***
3. Sat. – Sun.								
Female	3.18	4.83	4.68	5.79	1.57	1.51	2.40	2.20
Male	3.10	4.73	4.63	5.68	1.58	1.68	2.32	2.09
Non-binary	2.21	4.49	4.11	5.19	1.85	2.06	2.86	2.79
F-value	**17.52*****	**3.587***	**7.553*****	**12.54*****	**271.62**	**247.88**^{c}	**6.978*****	**267.93**^{c}

Since the ANOVA and F-test analysis accounted for only one variable to define groups and compared their mean SWB outcomes, these two methods cannot capture the interactions (or correlations) between variables. Hence, we conducted regression analyses in the next subsection.

5.4.2 Regression Analysis

In this subsection, we further examined the potential associations between mobility patterns, social groups, and SWB outcomes via regression analysis. We selected socio-demographic variables used in the regression analysis based on CHAID results in Section 4.3. By selecting socio-demographic variables that were most relevant to the extracted behavior patterns, we implicitly incorporated behavior patterns into the regression model.

We used Monday to Thursday as an example to demonstrate the variable selection process. As shown in Figure 5.2, employment status (node 1) played a key role in determining activity-trip patterns. Thus, we included employment status as one variable. And we combined full-time employees who WFH (*Fulltime*

AtHome) and self-employed people as one group because they together determined a subgroup (node) in CHAID results. Using a similar way, for family types (node 2), people in groups *Partner* and *Live Alone* were grouped and apart from other family types, and subgroups under *Parent* were separated from subgroups under *Single Parent* groups. After regrouping, we got two hyper family types: (1) living with kids and (2) living with partners. We adopted a similar way to reclassify (1) the educational attainment (nodes 12 and 18) based on whether participants had at least a bachelor's degree, and (2) age (nodes 3 and 25) as young adults (18-24), adults (25-54), and older adults (55+). We also included gender identity (node 4), race (nodes 13 and 20), and student status (node 19) and kept the original categories for these three variables.

Using similar methods, we selected and reclassified variables for Friday and Saturday-Sunday based on the CHAID analysis results in Figures 5.4 and 5.6 respectively. For Friday, we included gender identity, race, employment status, living with partners, living with kids, and student status as variables. For Saturday to Sunday, we included the same set of variables as those for Monday to Thursday.

After selecting and reclassifying variables, we conducted regression analysis. The outcome variable was the daily net affect. Considering that the net affect was a continuous variable, linear regression models were applied to associate it with the selected variables (Weisberg 2005, Bergstad et al. 2011):

$$Y = \beta_0 + \beta_1 x_1 + \cdots + \beta_n x_n \quad (3)$$

where Y was the net affect for a person in one day, x_i was the value for one of the selected variables for that person (e.g., gender, race), and β_i showed a positive or negative association between each variable and the net affect. The team included the p-values to show the significance level of the association.

Table 5.5 presented the analysis results for Monday to Thursday, Friday, and Saturday to Sunday. By holding constant all other variables, we found that:

- Non-binary people had lower net affects throughout the week. This was consistent with findings in Figure 5.8 that non-binary people usually felt less happy, meaningful, and safe than females and males across all behavior groups.
- Living with partners was positively related to the net affect throughout the entire week. Living with kids was positively related to the net affect on weekdays, but not on Saturday and Sunday.
- Compared to white people, Hispanic people had significantly higher net affects throughout the week. Black people also had higher net affects than white people, but such difference was only significant for Monday to Thursday.
- For employment status, part-time and unemployed people had lower net affects compared to people who worked full-time outside the home (e.g., in the office).
- Compared to people aged 18-24, people aged 25-55 were likely to have significantly lower net affects on Monday-Thursday, and people aged 25-34 tended to have significantly lower net affects on weekends.

Table 5.5 Regression analysis results of subjective well-being

Monday – Thursday		Friday		Saturday – Sunday	
Variable	Coefficient	Variable	Coefficient	Variable	Coefficient
Gender (ref: Female)		*Gender (ref: Female)*		*Gender (ref: Female)*	
Male	0.062	Male	0.026	Male	-0.094
Non-binary	**-0.762*****	**Non-binary**	**-0.798*****	**Non-binary**	**-0.882*****
Live with Partner (ref: No)		*Live with Partner (ref: No)*		*Live with Partner (ref: No)*	
Yes	**0.365*****	**Yes**	**0.270.**	**Yes**	**0.477*****
Live with Child (ref: No)		*Live with Child (ref: No)*		*Live with Child (ref: No)*	
Yes	**0.467*****	**Yes**	**0.299.**	Yes	-0.024
Race (ref: White)		*Race (ref: White)*		*Race (ref: White)*	
Black	**0.551***	Black	0.457	Black	0.174
Hispanic	**0.799*****	**Hispanic**	**1.223*****	**Hispanic**	**0.927*****
Other/Mixed	0.083	Other/Mixed	0.070	Other/Mixed	0.074
Employment Status (ref: Fulltime OutHome)		*Employment Status (ref: Fulltime OutHome)*		*Employment Status (ref: Fulltime OutHome)*	
Fulltime AtHome	-0.044	Fulltime AtHome	-0.249	Fulltime AtHome	-0.212
Part-time employed	**-0.349****	Part-time employed	-0.422.	**Part-time employed**	**-0.559*****
Not employed	**-0.693*****	**Not employed**	**-0.569****	**Not employed**	**-0.764*****
Student Status (ref: Full-time student)		*Student Status (ref: Is a student)*		*Student Status (ref: Full-time student)*	
Part-time student	-0.143	Not a student	0.071	Part-time student	-0.054
Not a student	0.115			Not a student	0.012
Education (ref: Bachelor-)				*Education (ref: Bachelor-)*	
Bachelor+	0.004			Bachelor+	-0.038
Age (ref: 18-24)				*Age (ref: 18-24)*	
25-54	**-0.414*****			**25-34**	**-0.737*****
55+	0.174			35-44	-0.232
				45-54	0.363
				55-64	0.068
				65+	0.153
Intercept	2.795***	Intercept	2.838***	Intercept	3.332***

Notes: Bold indicates significance at least the 0.1 level.

. p-value < 0.1; * p-value < 0.05; ** p-value < 0.01; *** p < 0.001

To further examine the effect of activity-trip patterns on SWB outcomes, the team conducted regression analysis for each behavior group. Table 5.6 showed the results for Monday to Thursday:

- Compared to females, males had higher net affects if they mostly stayed at home and shared HH tasks while at home. But if males did not share HH tasks, they had lower net affect values. Such differences were significant and consistent with the visual exploration results in Figure 5.8 (a).
- Compared to females, non-binary people had lower net affect values across all behavior groups and most of them were significant (Groups 2 to 6).
- Living with partners was positively associated with net affects for most behavior groups, especially for people who mostly stay at home (Groups 1 to 3).
- Living with children was associated with higher net affects for most behavior groups, especially for people who shared HH tasks while at home (Groups 1 and 4).
- Employment status did not show a significant effect on net affects across most subgroups. This was because the employment status of participants in each subgroup were quite similar.

Table 5.6 Regression analysis results of subjective well-being by behavior groups (Monday – Thursday)

Variable	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Gender (ref: Female)						
Male	**0.879*****	-0.278	**-0.422***	0.219	**0.309.**	-0.170
Non-binary	-0.023	**-1.205*****	**-0.708****	**-0.341.**	**-1.222*****	**-1.065***
Live with Partner (ref: No)						
Yes	**0.586****	**0.455***	**0.516****	-0.081	**0.307.**	**1.442*****
Live with Child (ref: No)						
Yes	**0.847*****	**0.656****	**0.435***	**0.481****	**0.447***	0.353
Race (ref: White)						
Black	**3.767*****	0.777	-0.199	NA	-0.490	-1.098
Hispanic	0.504	**1.301****	**0.807***	0.225	**1.158***	NA
Other/Mixed	**-0.428***	0.237	**0.373***	0.140	0.158	-0.635
Employment Status (ref: Fulltime OutHome)						
Fulltime AtHome	-0.367	0.171	0.369	0.079	0.105	-0.344
Part-time employed	-0.498	0.459	-0.209	0.082	**-0.469***	-0.724
Not employed	**-0.729***	-0.339	-0.415	0.612.	**-1.364*****	-1.185
Student Status (ref: Full-time student)						
Part-time student	-0.309	**-0.616.**	0.092	0.479	0.217	0.037
Not a student	-0.046	-0.394	**0.707****	0.137	**0.467***	-0.951
Education (ref: Bachelor-)						
Bachelor+	-0.141	0.013	**0.360.**	**1.272****	**-0.587****	**-1.928****
Age (ref: 18-24)						
25-54	**-0.570.**	-0.058	**-0.860*****	0.365	**-0.898*****	-1.058
55+	**0.690.**	**1.029****	-0.327	0.066	0.010	-0.513
Intercept	2.822***	2.345***	2.130***	1.008*	3.405***	5.915***

Notes: Bold indicates significance at at least the 0.1 level.

. p-value < 0.1; * p-value < 0.05; ** p-value < 0.01; *** p < 0.001

Table 5.7 presented regression analysis results for Saturday to Sunday, which had different patterns from results for Monday to Thursday:

- Compared to females, male and non-binary people tended to have lower net affects, but many of these differences were not significant.
- Living with partners and living with kids were both positively associated with net affects for those who stayed at home mostly and share some HH tasks.
- People who were not employed show more negative outcomes during the weekends, especially those who did not have many out-of-home activities and trips.

Table 5.7 Regression analysis results of subjective well-being by behavior groups (Saturday - Sunday)

Variable	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Gender (ref: Female)						
Male	-0.002	-0.096	**-0.415.**	**-1.172***	-0.079	**-5.500****
Non-binary	-0.349	**-1.996*****	-0.103	**-1.517***	-1.990.	**-3.438*****
Live with Partner (ref: No)						
Yes	-0.068	**0.618****	**0.429.**	-0.479	1.277	-0.300
Live with Child (ref: No)						
Yes	**0.665****	0.010	0.220	-0.689	1.134	1.290
Race (ref: White)						
Black	**2.621****	NA	-0.074	NA	-3.003	NA
Hispanic	0.055	**0.900.**	**1.278***	0.375	NA	NA
Other/Mixed	-0.181	-0.370	**0.707****	-0.171	0.035	**-2.290****
Employment Status (ref: Fulltime OutHome)						
Fulltime AtHome	-0.316	-0.397	-0.099	-0.030	-0.233	**-1.242.**
Part-time employed	-0.403	-0.361	**-1.206*****	0.532	-1.966	NA
Not employed	**-0.833****	**-0.681***	**-1.548*****	**1.056.**	**-3.762.**	NA
Student Status (ref: Full-time student)						
Part-time student	0.315	**-0.757.**	0.274	-0.773	**-4.179***	NA
Not a student	0.269	-0.455	0.227	0.462	**-2.002***	0.125
Education (ref: Bachelor-)						
Bachelor+	0.276	**-0.506.**	0.437	-0.807	-2.060	**-5.175****
Age (ref: 18-24)						
25-34	**-0.668.**	0.468	**-1.352*****	0.947	-2.550	NA
35-44	-0.301	**0.896***	**-1.190****	0.541	-1.285	-1.239
45-54	0.026	**1.263***	-0.046	2.042	-2.622	NA
55-64	-0.465	**1.083***	0.430	0.713	-3.170	NA
65+	-0.455	**1.293***	0.101	-0.576	2.180	0.979
Intercept	2.933*****	3.345*****	3.285*****	3.252****	7.963****	9.447*****

Notes: Bold indicates significance at at least the 0.1 level.
*. p-value < 0.1; * p-value < 0.05; ** p-value < 0.01; *** p < 0.001*

In sum, the team found that socio-demographic characteristics showed different associations with the net affects across the six behavior groups and between weekdays and weekends. The significances of those associations also varied across subgroups and attributes.

5.5 SUMMARY OF FINDINGS

To summarize, both visual explorations and statistical analyses showed complex relationships between behavior patterns, social identities, and SWB outcomes. Key findings included:

- Non-binary people had less positive and more negative experiences in their daily activities and trips. Therefore, their overall SWB outcomes (net affects) were the worst among all gender groups.
- Living with kids and sharing HH tasks at home can bring more positive emotions for males during the weekdays than for females. This was probably due to the different types of HH tasks shared by females and males as discussed in Section 4: females shared more child care, cooking, and tasks that distracted them from their tasks constantly, while males shared more lawn care and tasks that often occurred just once or twice a day, which may even allow them to take a break from work or study.
- Hispanic people in all behavior groups had better emotional outcomes than white people in the same behavior group throughout the entire week. Black people and people of mixed races had emotional outcomes that varied among behavior groups or days across the week.
- Although employment status played a key role in determining behavior patterns, it did not directly determine the SWB outcomes itself. Instead, it often interacted with other social identities such as gender, age, and student status to create distinct patterns of SWB outcomes.
- Age had mixed impacts on SWB outcomes. One consistent pattern across behavior groups was that people aged 25-34 tend to have worse SWB outcomes (lower net affects) than people aged 18-24 and aged 55+. This was likely due to the newly arising overlapping responsibility and various stressors during this stage of life, including completing higher education, starting to build careers, purchasing homes, and adapting to a life shared with partners, spouses, or children.

CHAPTER 6: CONCLUSION

Gender can have a significant influence on people's behaviors and experiences. Hence, excluding gender diversity in transportation research and practices could result in biased or incomplete understanding of issues and perceptions about transportation and quality of life. This study used survey data collected at the personal level to examine whether and how gender, in a broad sense, can lead to distinctly different activity-travel patterns. In this chapter, we summarized key findings and benefits from a literature review, survey data collection, and survey data analysis. And we concluded our study by identifying key action items for future transportation planning and policymaking.

6.1 KEY BENEFITS FROM LITERATURE REVIEW

The literature review on the definitions of gender and gender-typical behaviors provided references for studying gender-related topics in transportation. Key lessons learned in the literature review included:

- Gender is not binary. Using women and men to define gender excludes and marginalizes the gender non-conforming group (a.k.a. non-binary people).
- Only a few recent studies in gender and travel have recognized the gender non-conforming group. These studies provide initial evidence of the unique needs and experiences of gender non-conforming people.
- Gender intersects with other social identities of a person (e.g., family types, employment, life stage) and creates unique needs, behaviors, and experiences. Therefore, it is vital to adopt an intersectionality view to avoid, or at least mitigate, biased conclusions regarding travel needs and experiences among and within different gender groups.
- Existing gender and travel studies have not adequately addressed the intersectionality nature of gender, with only a few exceptions that investigate the intersections between gender and race and ethnicity, family members (young children in particular), employment status, and age (to recognize life stage).
- Gender is a social construct. It reflects the social environment in which people are living, and it may change over time and location. Thus, directly using conclusions and findings from other times or locations ignores the importance of local contexts for effective policymaking.
- Existing data often do not fulfill the requirements to study the intersectionality of gender and other social identities and their impacts on travel. Data that are collected locally and updated regularly are needed to identify issues and support policymaking.
- Study cases on gender and travel reveal some common dissimilarities of travel patterns between women and men in the U.S. These patterns can be used to describe gender-typical travel behaviors that reflect the social norms in the U.S. And local data and evidence are needed to develop an accurate and comprehensive view on the local situation.

The main benefits of the literature review included:

- The definitions of gender, gender identity, and intersectionality provided valuable references for future research and practices to develop more appropriate languages regarding gender and gain a more accurate understanding of the different transportation needs and experiences of women, men, and non-binary people.
- Findings regarding gender-typical behaviors and experiences provided evidence of persistent differences in gender roles in the modern world and the need to continue advancing gender equity in transportation.
- Findings from existing literature regarding gender-typical behaviors and experiences in other regions and during other times can be compared to local situations in Minnesota and provide valuable lessons for future planning and management practices.
- Some resources such as websites and organizations regarding gender, gender identity, and intersectionality can be used to inform women and non-binary people about their rights.

6.2 KEY BENEFITS FROM NEW SURVEY DATA

The research team used the Daynamica smartphone application to collect 14 days of participants' diaries and well-being status. The final data contained 781 participants who completed the in-take survey with no missing or artificial data, and 278 participants who completed the 14-day smartphone diaries with good quality. Despite the small sample size, participants who completed the 14-day diaries were well distributed across gender, race, age, and family type. Regarding the spatial distribution, 51 out of 278 participants were outside the seven-county metropolitan area even though most participants were from Hennepin and Ramsey counties. Key benefits of collecting the new survey data included:

- The survey included additional questions about gender, gender identity, and gender roles to capture the complex nature of gender.
- The survey data contained activity-travel diaries with detailed spatial, temporal, and thematic information about participants' everyday life. Specifically, the additional questions regarding gender identities and shares of household-supporting tasks can provide more accurate views on different gender roles among females, males, and non-binary people and their impacts on everyday schedules and activity-travel patterns.
- The survey data contained participants' experienced emotions during trips and activities that can be used to investigate how gender, in a broader sense, may affect travel experiences and potentially reveal social groups that suffered from worse SWB outcomes.
- The survey included questions about safety and transit use, which can provide novel insights to understand safety and security beyond reported cases. Specifically, we can assess perceived or potential safety and security issues and their variations across gender identities. For example, we observed some significant gender differences regarding transit barriers, such as females and non-binary were more likely to "travel with bags/carts/stroller" and "not feel safe on transit and on the way to transit" than males.

- The recruitment outcome revealed potential gender and racial inequity in new technology adoption since we used a smartphone application to collect survey data. In general, participants who completed the 14-day survey entry were well distributed across gender, race, age, and family type in general. However, non-white people were more likely to withdraw or become inactive after completing the in-take survey and did not advance to the smartphone data entry. We also found that non-binary people had a higher completion rate of the 14-day diary data than other genders, even though it required more effort by the team to persuade non-binary people to participate in the study.

6.3 KEY BENEFITS FROM SURVEY DATA ANALYSIS

The team applied various visual and statistical methods to study gender-typical behaviors and identify disparities among gender groups. We analyzed the 2019 TBI data and the Daynamica data that were collected before and after the outbreak of COVID-19, respectively. The main benefits of behavior analysis were discussed below with the corresponding findings from the analyses:

- The behavior analysis provided novel insights into gender differences in travel behaviors by addressing the interdependency between activities and trips in daily schedules. For example, we found that female, full-time employees had little after-work personal time if living with kids and typically had return home trips during afternoon traffic peak hours. In contrast, male, full-time employees may also have trips for non-HH tasks after afternoon peak hours in addition to the occasional trips for HH tasks. This revealed the gender difference in the timing of trips and its potential association with gender roles, which may not be captured by studying the mobility indicators or using an existing survey dataset.
- The CHAID analysis can address the intersectional nature of social identity and revealed how the intersectionality of gender and other social identities may lead to distinct behavior patterns. The analysis can provide novel insights regarding the distinct behavior patterns and needs of an intersectional group that is significantly different from other groups. For instance, we found that employment status remained the key determinant for activity-travel patterns on weekdays. However, with the same employment status of working from home, females made more trips than males after the outbreak of COVID, which were mostly for household-supporting tasks in the late afternoon. This example of gender differences may not have been found if we compared travel patterns independently among employment statuses or gender groups.
- The visual and statistical analyses provided evidence of gender differences in travel behaviors locally in Minnesota. Many of our findings were in accord with findings from other cities in our literature review such as Los Angeles (LA Metro 2019), especially regarding household-supporting trips and transit usage.
- The comparison of findings from the TBI survey data collected before the pandemic and the Daynamica data collected after the outbreak of COVID-19 revealed some potential impacts of the pandemic on behavior patterns. A key lesson was to the need to account for working from home status while defining employment status considering its significant impacts on travel

needs, travel times, and trip purposes. An example of gender difference is that, during the pandemic, females made more trips than males and non-binary people, and they relied more on household vehicles for travel and rarely used transit. And such differences in trip frequencies and auto-dependency were more significant for Black females within the female gender group.

We applied visual and statistical methods to identify potential disparities in SWB outcomes across social groups using the newly collected Daynamica survey data. The benefits of well-being analysis include:

- The analysis accounted for subjective well-being outcomes to study users' well-being benefits (happy, meaningful, and safe) and burdens (sad, stressed, pain, tired) in transportation studies. The analysis findings can support future transportation decision-making to identify potential underserved social groups and continue promoting users' well-being outcomes.
- The analysis results revealed disparities in transportation users' SWB outcomes across genders and intersectional groups. For example, we found that non-binary people have less positive and more negative experiences with their daily activities and trips. Therefore, they have the worst SWB outcomes among all genders. This suggests the need for in-depth qualitative studies to understand the reasons for more negative emotions experienced by non-binary people.

6.4 KEY ACTION ITEMS

This project identifies several key action items that transportation and local agencies can implement in future research and practice:

- Recognize the complex nature of gender. Gender is a concept broader than the male-female binary. It is crucial to capture the complex nature of gender and adopt appropriate language around gender and gender identity for future survey design and data collection. For instance, survey questions need to be explicit and specify which aspects of gender are asked, such as sex at birth, self-identified gender, and gender pronoun. The survey languages also should be inclusive. For instance, instead of using male, female, and other genders for gender, we could use man, woman, and non-binary for self-identified gender (or gender identity) and include the options for prefer not to answer and self-described (free text entry).
- Recognize the persistent existence of gender differences in time allocations, transportation needs, and subjective well-being outcomes. Findings from the study can support continuous efforts and investments to advance gender equity in transportation and beyond. Methods and findings from this study can also provide a reference for future research in other study areas or data collected during other times. Findings from this study and future research can support policymakers in making more informed decisions to provide more accessible and healthier transportation options for all genders.
- Recognize the specific needs of non-binary people. Non-binary people have worse subjective well-being outcomes than females and males and are more sensitive to safety during their use of transit services, even though their gender identity does not significantly impact their travel

patterns in general. More in-depth qualitative surveys are needed to confirm and uncover the reasons for their bad emotional experiences beyond perceived safety.

- Recognize the importance of community engagement. Participant recruitment outcomes suggest that it is necessary to keep engaging with community-based organizations to reach out to hard-to-reach social groups, such as African Americans. By communicating with community-based organizations, we can avoid marginalizing those hard-to-reach populations and more effectively collect feedback from them, likely through means of a paper-based survey or in-person interviews, to identify key issues and specific concerns related to mobility needs and experiences.
- Recognize the need for future studies in gender and travel. Analysis results indicate obvious changes in activity participations and travel needs before and after the outbreak of COVID-19. It would be valuable to conduct similar research in the post-pandemic setting and examine the possible long-term impacts the pandemic has had on behavior and wellbeing patterns among genders.

In sum, this study proved the persistent existences of gender differences in everyday task scheduling, travel choices, and wellbeing outcomes using existing and newly collected survey data in Minnesota. Findings from the literature review and data analysis and lessons learned from data collection suggested the importance of capturing the complex, intersectional nature of gender and supporting continuous efforts and investments to advance gender equity in transportation.

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APPENDIX A
LITERATURE ON GENDER AND TRAVEL BEHAVIORS

Author	Data	Study Area	Data Analysis	Gender	Intersectionality	Findings
Binary of Women and Men						
McGuckin & Nakamoto 2005	Nationwide Personal Transportation Survey; National Household Travel Survey (NHTS)	U.S.	Descriptive analysis	• Male/female	• Gender • Race	(*Gender*) Women tend to: • work closer to home, especially for women in two-adult families with children • make household-related stops during commutes (e.g., drop off, pick up, shop, family errands); whereas men stop to get a meal or coffee • make drop-off trips before 9 am (*Gender, Race*) African American women are more likely to stop for shopping along commuting trips; whereas Hispanic men are the least likely to stop.
Zhou 2005	Attitude-based Household Surveys	San Diego & San Mateo, U.S	Descriptive analysis	• Male/female	NA	(*Gender*) Women tend to: • feel less safe walking at night/certain region • be more sensitive to time • be more sensitive to stress • have a more fixed schedule
Crane 2007	American Housing Survey (AHS)	U.S.	Descriptive analysis	• Single/couple • Parenthood • Male/female	NA	(*Gender*) Women generally have shorter commutes. The gender gap in commute distance is the smallest among single women and men and the largest among married coup with children.
Kato & Matsumoto 2007	Activity Diary Survey	Toyama City, Japan	Nonlinear Tobit model to estimate time allocation	• Male/female couple	NA	(*Gender*) The more children a household has, the wife is less likely to have individual out-of-home leisure time on a weekday, whereas it does not affect the husband.
Schwanen et al 2007	AMADEUS Activity Diary	Amsterdam - Utrecht Netherlands	Descriptive analysis and path model to estimate activity frequency	• Male/female couple	NA	(*Gender*) Women have more household activity (e.g., chauffeuring and grocery shopping) The distribution of household tasks between men and women is more equal in higher density, more diverse neighborhoods.

Author	Data	Study Area	Data Analysis	Gender	Intersectionality	Findings
Crane & Takahashi 2009	American Housing Survey (AHS)	U.S.	Descriptive analysis	• Male/female	• Gender • Race • Age	(*Gender*) Women have shorter distances and durations of trips to work (*Gender, Race*) Black women have longer commute time by bus than black men; Hispanic women have similar time to Hispanic men; White women have shorter time than White men. (*Gender, Age*) The gender gap in commute time falls between women and men as the age increases
Ettema & Lippe 2009	Time Competition Survey	Dutch, Netherlands	Regression analysis to estimate time allocation	• Male/female couple	NA	(*Gender*) Women spend more time on childcare. Women with traditional role expectations take less responsibility to get paid work and take a larger part of household tasks.
Boarnet & Hsu 2015	Southern California Household Travel Survey	Southern CA, U.S.	Descriptive analysis and negative binomial regression to estimate trip number	• Single/couple • Parenthood • Male/female	• Gender • Employment • Income	(*Gender*) Women have more household serving trips, especially, women living with spouse/partner and child have more chauffeuring trips (*Gender, Employment*) Women working part-time, or unemployed women have more chauffeuring trips (*Gender, Income*) Women in high-income households have more chauffeuring trips
Elias et al. 2015	Travel Survey of Residents in Arab Community	Arab, Israel	Descriptive analysis and structural equation model for commuting decision process	• Male/female	NA	(*Gender*) Women tend to: • make fewer tours and fewer trips • spend less time on travel and out-of-home activity • work within their communities with less time • include child-serving stops • drive less but ride as car passenger and walk more

Author	Data	Study Area	Data Analysis	Gender	Intersectionality	Findings
Taylor et al. 2015	American Time Use Survey (ATUS)	U.S.	Descriptive analysis	• Single/couple • Parenthood • Male/female	• Age • Employment	(*Gender*) Women in all household types tend to make more household-serving trips and travel with children, especially with the presence of partner and children (*Gender, Age*) Gender gaps are more pronounced between couples in their 20s (*Gender, Employment*) Gender gaps are more pronounced in male breadwinner household or women working part-time
Matsuo 2016	NHTS	U.S.	Descriptive & regression analysis to estimate driver status and driving mileage	• Male/female	• Gender • Race • Immigration	(*Gender, Race, Immigration*) Hispanic female immigrants tend to remain non-drivers compared to other race or natives, particularly with low-income Once Hispanic female immigrants becomes drives, their driving mileages become larger
Colley 2017	Transportation Tomorrow Survey	Greater Toronto, Hamilton Area, Canada.	Descriptive analysis	• Male/female	• Gender • Race	(*Gender*) Women tend to: • rely on alternative modes of travel • travel shorter distances to employment • complete more household responsibilities (*Gender, Age*) Women in younger age are more likely to use public transit
Fan 2017	ATUS	U.S.	Pooled log-linear regression to estimate travel time	• Single/couple • Parenthood • Breadwinner • Male/female	NA	(*Gender*) Women in couple households with kids spend less time on work trips and women spend more time on household supporting trips. Partner/Spouse presence and breadwinner status does not mitigate gender differences in travel time

Author	Data	Study Area	Data Analysis	Gender	Intersectionality	Findings
Scheiner & Holz-Rau 2017	German Mobility Panel	Germany	Descriptive & regression analysis to estimate travel complexity	• Single/couple • Parenthood • Male/female	• Gender • Employment • Age	(*Gender*) Women tend to have more complex travel patterns (higher activity entropy & more trips per tour), especially with the presence of children (*Gender, Employment*) Non-employed women have more complex travel patterns than their male counterparts; while employed individuals make more complex tours may be explained by seeking efficiency (*Gender, Age*) Middle-age women have higher levels of travel complexity
Ji et al. 2018	Travel Survey of Residents in Kunming	Kunming China	Multinomial logistic regression to estimate travel mode use	• Male/female	NA	(*Gender*) Females are less willing to travel far from home because of their household responsibilities. With the increase of commuting constraints, females are more likely to transfer to car use.
Chakrabarti & Joh 2019	California Household Travel Survey	urban California, U.S.	Descriptive & regression analysis to estimate auto travel distance, active travel, transit use	• Parenthood (children by age groups) • Dual-earner male/female couple	NA	(*Gender*) Women tend to: • make fewer miles of auto travel • not spend substantial time in active travel • have smaller gender gaps in active travel as the presence of children • drive longer distance with school-aged children but the gender gaps remain the same

Author	Data	Study Area	Data Analysis	Gender	Intersectionality	Findings
LA Metro 2019	NHTS; LA Metro Surveys	Los Angeles, U.S.	Descriptive analysis	• Male/female	• Gender • Employment	(*Gender*) Women tend to: • make more trips OR not make any trips • have more varied destinations and make shorter trips, more chained trips, and multiple stops • make more trips for household errands, care, transporting others, and travel with kids, strollers, and grocery bags • travel during mid-day hours/off-peak hour • get priority use of the car because of their complicated trip patterns (*Gender, Employment*) Women working part-time are more likely to have trip chains.
Chidambaram & Scheiner 2020	German Time Use Survey	Germany	Descriptive analysis	• Single/couple • Parenthood • Male/female	• Gender • Employment	(*Gender*) The gender gaps in commute distance, time spent on paid and unpaid work are larger with the presence of small children The presence of small children increases unpaid activities (e.g., household chores and school volunteer works.) for both males and females, except for single earning mom. (*Gender, Employment*) Gender gaps become smaller in the dual-earner households
Hu 2021	NHTS	U.S.	Multi-level regression models to estimate commute distance and automobile use	• Single/couple • Parenthood • Breadwinner • Male/female	• Gender • Race	(*Gender*) Women tend to: • have shorter commute distances • have greater usage of automobile • have smaller gender gaps in one-adult households (*Gender, Race*) Household structure affects gender gaps differently across racial groups where Black people tend to have smaller gender gaps

Author	Data	Study Area	Data Analysis	Gender	Intersectionality	Findings
Kim & Ulfarsson 2021	NHTS	U.S.	Descriptive & regression analysis	• Female/male	• Gender • Race • Age	(*Gender, Race, Age*) Older minority women tend to have fewer trips, short trip distance, make no trips in a day, not drive cars.
Olivieri & Fageda 2021	Household Mobility Survey	Metro Area of Montevideo, Uruguay	Multi-level regression models	• Parenthood • Breadwinner • Male/female	NA	(*Gender*) Women tend to: • travel shorter distance and not travel by car • have shorter commute time and increased trip frequency with the presence of children • have similar patterns in dual-earner and male breadwinner household
No-binary Gender						
Kurdek 2007	Small Sample Surveys	U.S.	Descriptive analysis	• Gay and lesbian couples	NA	(*Gender*) Compared to gay partners, lesbian partners reported a more equal division of household tasks between partners.
Rapino & Cooke 2011	Public Use Microdata Sample	U.S.	log-linear regression to estimate commute time	• Single/couple • Parenthood • Heterosexual/ homosexual • Male/female	NA	(*Gender*) Married/cohabiting women have shorter commuting times, whereas same-sex female partners have longer commuting times which may be because they divide household tasks more equally.
Smart & Klein 2013	NHTS	U.S.	OLS regression to estimate travel distance	• Gay/lesbian/ straight	NA	(*Gender*) Partnered gay men living in gay and lesbian neighborhoods make shorter non-work trips than straight or lesbian couples, which may be because they are more likely to live in large metropolitan areas with clustered LGBT-oriented activity sites.
Klein & Smart 2016	American Community Survey; NHTS	U.S.	Nested logistic regression to estimate travel mode use	• Gay/lesbian/ straight couple	NA	(*Gender*) Same-sex partner tend to use alternative modes of travel, such as shared mode (carpool, transit) and non-motorized mode (walk, bicycle)

APPENDIX B
SURVEY QUESTIONS USED FOR DAYNAMICA DATA COLLECTION

PART ONE: INTAKE SURVEY

Thank you for your interest in the Gender & Travel Study (GTS). We appreciate your help to the Minnesota Department of Transportation and the University of Minnesota to understand the impacts of gender and identity on travel behaviors and wellbeing. Please complete this enrollment survey. The survey will take 15-20 minutes to finish.

These questions will be used to determine your eligibility:

Q1. Are you over 18 years old? (Y/N)

If No, Skip Logic to end survey because eligibility criteria not met

Q2. Do you live in Minnesota? (Y/N)

If No, Skip Logic to end survey because eligibility criteria not met

Q3. Do you have a smartphone and a data plan? (Y/N)

If No, Skip Logic to end survey because eligibility criteria not met

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The research team seeks your consent to install a survey application named Daynamica on your smartphone to collect your activity-travel diaries. You will receive a $40 Amazon gift card for your completion of 14-day data collection. The consent form provides details about data collection procedures and the gift card reward.

Our data collection and management protocol has been reviewed and approved by the University of Minnesota Institutional Review Board (IRB) to adequately protect your confidentiality and privacy. If you have any concerns regarding this study and would like to talk to someone other than the researcher(s), you are encouraged to call the University's Research Participants' Advocate Line: 612-625-1650 (toll-free: 1-888-224-8636).

Please read the consent form below. [Insert the contents of the consent form here.]

If you wish to participate, please check 'I accept the terms of the Consent Form'. Please feel free to contact Yaxuan Zhang at gts@umn.edu if you have any questions. If you would like to keep a copy of the consent form for your record, you can use this link (link to the consent form in PDF) to download the consent form in PDF.

Checkbox 'I have read the consent form'

Checkbox 'I would like to participate and accept the terms in the consent form'.

Thank you for choosing to participate! Please provide your contact information for us to get connected with you during your participation. We will use email to support your participation and send you the gift card. So, please make sure to provide a valid email address.

Q4. Please provide your preferred name for future communications

Q5. Please provide your preferred email address for the research team to contact you.

Q6. Please confirm your email address.

Q7. What type of phone do you use?
[Apple] / [Android] / [Other: Please specify]

1.Background Information
These questions ask about your basic background information.

Q1.1. What year were you born? (slider from 1900 to 2005)

Q1.2. What best describes your Race or Ethnicity? (Select all that apply)
[American Indian or Alaska Native] / [Asian] / [Black or African American] / [Hispanic, Latino, or Spanish Origin] / [Middle Eastern or North African] / [Native Hawaiian or other Pacific Islander] / [White] / [Other race, ethnicity or origin]

Q1.3. As of today, what is your employment status?
[Employed Full Time] / [Employed Part Time] / [Unemployed] / [Primarily Self-Employed] / [Unpaid Volunteer or Intern] / [Homemaker or Stay at Home] / [Retired]

Q1.4. Are you currently enrolled as a student?
[Full Time Student] / [Part Time Student] / [Not a student]

Q1.5. What is your highest level of education degree?
[Less than a High School Diploma] / [Highschool Diploma] / [Some College] / [Vocational/Technical Training] / [Associate Degree] / [Bachelor's Degree] / [Graduate/Professional Degree]

Q1.6 Do you have a valid driver's license/permit?
[Yes] / [No]

Q1.7 Where do you live?
[Twin Cities] / [Other Urban Areas] / [Suburbs] / [Rural Areas] / [Other: Please specify]

Q1.8. What zip code do you live in?
[Free Text entry]

These questions ask about your gender and gender identity. We are committed to your privacy, and you can always choose "prefer not to answer". Our website includes some useful resources about gender and identity for your references: gts.umn.edu.

Q1.9. What best describes your current gender identity?
[Female] / [Male] / [Non-binary/ Non-conforming] / [Prefer Self Describe: (Text Entry)] / [Prefer Not to Answer]

Q1.10. Do you consider yourself as transgender?
[Yes] / [No] / [Prefer Not to Answer]

Q1.11. What are your gender pronouns? (Select all that apply)
[She/Her/Hers] / [He/Him/His] / [They/Them/Theirs] / [Avoid Pronouns] / [Prefer Self Describe: (Text Entry)] / [Prefer Not to Answer]

Q1.12. What is your gender on your legal documents? (e.g., driver's license, state ID) (Select all that apply)
[Female] / [Male] / [Non-binary/X] / [Other: (Text Entry)] / [Prefer Not to Answer]

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2. Household Member:
These questions ask about people living in your household.

Q2.1. As of today, how many people are living in your household (including yourself)?
(Slider 1-20)

Q2.2. `Ask if Q2.1 >1` Who lives in your household with you? *Checkboxes for [Yes]/[No]*

- Spouse / Partner
- Own / Foster Children
- Grandchildren
- Parents (or parent-in-law)
- Grandparents
- Other relatives (e.g., sibling, cousin)
- Roommates/friends
- Household helpers
- Other

Q2.3. `Ask if Q2.2 Own / Foster Children /Grandchildren is checked` As of today, how many children live with you? (Please only consider your own/foster children and grandchildren) (Slider 0-10 for each age group)
[less than 1 year old] / [1-3 years old] / [3-5 years old] / [5-15 years old] / [15-18 with valid driver's permit] / [15-18 without valid driver's permit]

Q2.4. `Ask if Q2.2 Spouse / Partner / Parent / Grandparents / Other Relatives / Roommates / Friends / other is checked ` Other than children, are there people living in your household who need special care? (such as disabled people)
[Yes] / [No]

Q2.5. `Ask if Q2.2 [Spouse / Partner] == Yes` Could you provide some information about your spouse/partner?
[Yes]/ [No, prefer not to provide]

`Ask if Q2.5 == Yes`
The following questions focus on your spouse's/partner's basic background information. Please answer those questions to your best knowledge.

Q2.6. What year was your spouse/partner born? (slider from 1900 to 2010)

Q2.7. What best describes your spouse's/partner's Race or Ethnicity? (Select all that apply)
[American Indian or Alaska Native] / [Asian] / [Black or African American] / [Hispanic, Latino, or Spanish Origin] / [Middle Eastern or North African] / [Native Hawaiian or other Pacific Islander] / [White] / [Other Race, Ethnicity or Origin] / [Not Sure]

Q2.8. As of today, what is your spouse's/partner's employment status?
[Employed Full Time] / [Employed Part Time] / [Unemployed] / [Primarily Self-Employed] / [Unpaid Volunteer or Intern] / [Homemaker or Stay at Home] / [Retired] / [Not Sure]

Q2.9. Is your spouse/partner currently enrolled as a student?
[Full Time Student] / [Part Time Student] / [Not a student] / [Not Sure]

Q2.10. What is your spouse's/partner's highest level of education?
[Less than a High School Diploma] / [Highschool Diploma] / [Some College] / [Vocational/Technical Training] / [Associate Degree] / [Bachelor's Degree] / [Graduate/Professional Degree] / [Not Sure]

Q2.11. Does your spouse/partner have a valid driver's license/permit?
[Yes] / [No] / [Not Sure]

Q2.12. Would you say that the money that you earn is more than what your spouse/partner earns (or less, or roughly the same)?
[More] / [Less] / [Roughly the Same] / [Not Sure] / [Prefer Not to Answer]

Q2.13. Would you say that you work more hours for the paid work than your spouse/partner (or less, or roughly the same)?
[More] / [Less] / [Roughly the Same] / [Not Sure] / [Prefer Not to Answer]

Q2.14. What best describes your spouse's/partner's current gender identity?
[Female] / [Male] / [Non-binary/ Non-conforming] / [Prefer Self Describe: (Text Entry)] / [Not Sure] / [Prefer Not to Answer]

Q2.15. Does your spouse/partner identify self as transgender?
[Yes] / [No] / [Not Sure] / [Prefer Not to Answer]

Q2.16. What are your spouse's/partner's gender pronouns? (Select all that apply)
[She/Her/Hers] / [He/Him/His] / [They/Them/Theirs] / [Avoid Pronouns] / [Prefer Self Describe: (Text Entry)] / [Not Sure] / [Prefer Not to Answer]

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3. Gender Role:

These questions ask about your thoughts on gender roles in terms of household tasks and responsibility. There are no right or wrong answers, so please respond to these questions that best describe your situations and attitudes.

Q3.1. 'Ask if Q2.2 [Spouse / Partner] is checked'
How much household responsibility do you currently share with your spouse/partner?

[I do it all] 0 10 20 30 40 50 60 70 80 90 100% [My Spouse/Partner does it all] [Other persons do/Not Applicable]

- Cooking and Serving Meals
- Cleaning
- Laundry
- Lawn and Garden Care
- Decoration, Repair, and Household Management
- Caring for Household Member (Children, all kinds)
- Caring for Household Member (Adults who need special care)
- Grocery Shopping
- Bringing in the Household Income

Q3.2. 'Ask if Q2.2 [Spouse / Partner] is checked' In your opinion, how much household responsibility do you think you SHOULD share with your spouse/partner?

[I do it all] 0 10 20 30 40 50 60 70 80 90 100% [My Spouse/Partner does it all] [Other persons do/Not Applicable]

- Cooking and Serving Meals
- Cleaning
- Laundry
- Lawn and Garden Care
- Decoration, Repair, and Household Management
- Caring for Household Member (Children)
- Caring for Household Member (Adults who need special care)
- Grocery Shopping
- Bringing in the Household Income

Q3.3. 'Ask if Q2.2 [Spouse / Partner] is not checked' Imagine that you will live with your spouse/partner in the future, how much household responsibility do you think you SHOULD share with your spouse/partner?

[I do it all] 0 10 20 30 40 50 60 70 80 90 100% [My Spouse/Partner does it all] [Other persons do/Not Applicable]

- Cooking and Serving Meals
- Cleaning
- Laundry
- Lawn and Garden Care
- Decoration, Repair, and Household Management
- Caring for Household Member (Children)
- Caring for Household Member (Adults need special care)
- Grocery Shopping
- Bringing in the Household Income

4. Residence:
These questions ask about your residence information.

Q4.1. In 2020, what was your household's total annual income (from all sources before taxes/deductions from pay)?

[Under $15,000] / [$15,000-$24,999] / [$25,000-$34,999] / [$35,000 - $49,999] / [$50,000 - $74,999] / [$75,000 - $99,999] / [$100,000 - $149,999] / [$150,000 - $199,999] / [$200,000-$249,999] / [$250,000 or more] / [Prefer Not to Answer]

Q4.2. As of today, which of the following best describes where you live?

[I live in one home location all the time] / [I have multiple home locations but live in one most of the time] / [I have multiple home locations and regularly live in several of them] / [My home location is not fixed (e.g., living in mobile home/trailer)]

Q4.3. What type of place is your current home? (use the primary one if you have multiple homes)

[Single family house] / [Townhouse] / [Building with 2-4 units] / [Building with 5 or more apartments or condos] / [Senior or age-restricted apartments or condos] / [Dorm, group quarters, or institutional facility] / [Manufactured home/ mobile home / trailer] / [Other]

Q4.4. Do you own or rent your current home? (use the primary one if you have multiple homes)

[Rent] / [Own] / [Housing provided by job or military] / [Other (free text entry)]

Q4.5. How long have you lived in your current home? (use the primary one if you have multiple homes)

[Less than 1 year] / [Between 1 and 2 Years] / [Between 2 and 5 Years] / [Between 5 and 9 Years] / [10 + Years]

5. Employment/Student:
These questions ask about your current employment/student status.

Q5.1. `Ask if Q1.3 != Unemployed, or Homemaker, or Retired` As of today, which of the following best describes your current work location?

[Work ONLY from home (self-employed or only telework)] / [Telework some days and travel to work location(s) for the remainder] / [Only one work location (outside of home)] / [Work location is outside of home and regularly varies (e.g., different offices/job sites)] / [Drive/bike/travel for work (e.g., driver, sales, deliveries)]

Q5.2. `Ask if Q5.1 == Telework some days and travel to a work location for the remainder. How often do you typically work from home? (primary job if you have multiple jobs)

[6-7 days a week] / [5 days a week] / [4 days a week] / [2-3 days a week] / [1 day a week] / [1-3 days a month] / [Less than monthly]

Q5.3. `Ask if Q5.1 != Work only from home` As of today, how are you typically traveling to and from work?

[In a household vehicle (or motorcycle)] / [In other personal vehicle (e.g., rental, carshare, work car)] / [Taxi or ride service (e.g., Uber/Lyft)] / [Bus or shuttle (e.g., local bus, work bus, van pool)] / [Rail transportation (e.g., Green Line, Blue Line, NorthStar Commuter Rail, Amtrak)] / [Bicycle] / [Walk, jog, or roll using a mobility device such as a wheelchair] / [Other]

Q5.4. . `Ask if Q1.3 != Unemployed, or Homemaker, or Retired` How flexible is your current work schedule/time?

[Extremely fixed, and I must schedule other activities based on it]
1 2 3 4 5 6 7
[Extremely flexible, and I can easily adjust it for other activities]

Q5.5. `Ask if Q1.4 != Not a student ` As of today, which of the following best describes your current school location?

[Attend Class ONLY from home (online class)] / [Online class some days and travel to school location(s) for the remainder] / [Only one school location (outside of home)] / [School location is outside of home and regularly varies (e.g., different campus)]

Q5.6. ` Ask if Q5.5 == Online class some days and travel to a school location for the remainder. How often do you typically attend class from home?

[6-7 days a week] / [5 days a week] / [4 days a week] / [2-3 days a week] / [1 day a week] / [1-3 days a month] / [Less than monthly]

Q5.7. `Ask if Q5.5 != Attend Class ONLY from home ` As of today, how are you typically traveling to and from school?

[In a household vehicle (or motorcycle)] / In other personal vehicle (e.g., rental, carshare, work car)] / [Taxi or ride service (e.g., Uber/Lyft)] / [Bus or shuttle (e.g., local bus, work bus, van pool)] / [Rail transportation (e.g., Green Line, Blue Line, NorthStar Commuter Rail, Amtrak)] / [Bicycle] / [Walk, jog, or roll using a mobility device such as a wheelchair] / [Other]

Q5.8. `Ask if Q1.4 != Not a student ` How flexible is your current school schedule/time?

[Extremely fixed, and I must schedule other activities based on it]
1 2 3 4 5 6 7
[Extremely flexible, and I can easily adjust it for other activities]

---

6. Transportation:

These questions ask about your daily travel situations and your opinions on local transit.

Q6.1. How many licensed drivers are there in your household? (slider 0-20)

Q6.2. How many working vehicles (including cars, pickup trucks, SUVs and vans, and motorcycles) are there available to your household? (slider 0-10)

Q6.3. (if Q6.2. >0) Who in your household uses these working vehicles most frequently?

[Myself] / [Spouse/Partner] / [Other person(s) in my household] / [Equally use the vehicles] / [Other]

Q6.4. For your daily travel, what travel mode do you use most frequently?

[In a household vehicle (or motorcycle)] / In other personal vehicle (e.g., rental, carshare, work car)] / [Taxi or ride service (e.g., Uber/Lyft)] / [Bus or shuttle (e.g., local bus, work bus, van pool)] / [Rail transportation (e.g., Green Line, Blue Line, NorthStar Commuter Rail, Amtrak)] / [Walk, jog, or roll using a mobility device such as a wheelchair] / [Bicycle] / [Other]

Q6.5. How much do your household tasks (such as escorting kids, shopping for food) affect your choice of travel modes?

Not at all 1 2 3 4 5 6 7 Very

Q6.6. How convenient do you feel public transit is to suit your needs?

Not at all 1 2 3 4 5 6 7 Very

Q6.7. What made it difficult for you to use public transit? Check all that apply

- I travel with children
- I travel with an individual who needs assistance
- I travel with bags, carts, and/or stroller
- I don't feel safe on my way to the public transit
- I don't feel safe on the public transit
- I don't feel comfortable in the public space
- It doesn't go where I need to go
- I have to make too many transfers
- It is difficult for me to make multiple trips in a row
- Service is not available when I need to travel
- Real-time arrival info in unpredictable/unreliable
- Service is not frequent enough
- Public transit is slow
- Public transit is expensive
- It doesn't feel comfortable and clean

---

7. Gender and Wellbeing:

These questions ask details about how your gender identity and gender roles may affect your emotions and subjective wellbeing.

Q7.1. To what degree are you satisfied with your overall life?

Dissatisfied 1 2 3 4 5 6 7 Satisfied

Q7.2. How do you feel when you are doing the following household tasks? (Select all that apply)
[Happy], [Meaningful], [Sad], [Tired], [Stressed], [Painful], [Not applicable]

- Cooking and Serving Meals
- Cleaning
- Laundry
- Lawn and Garden Care
- Decoration, Repair, and Household Management
- Caring for Household Member (Children)
- Caring for Household Member (Adults who need special care)
- Grocery Shopping
- Bringing in the Household Income

Q7.3. Your experiences and emotions may be affected by your gender identity. To which degree do you agree with each statement below? [Strongly Agree] / [Agree] / [Neutral] / [Disagree] / [Strongly Disagree]

- I don't feel comfortable presenting in public spaces because of my gender identity
- I don't feel comfortable when people talk about my gender identity
- I don't feel welcomed/included because of my gender identity
- I have experienced discrimination/abuse because of my gender identity

Q7.4. Do you agree with the following statements about how your life has changed because of Coronavirus? (Check all that apply)

[I do not leave the house as frequently as I did before Coronavirus] / [I do not eat out as frequently as I did before Coronavirus] / [I do not engage in personal business activities as frequently as I did before Coronavirus] / [I do not engage in Leisure and Recreation activities as frequently as I did before Coronavirus] / [I work from home more frequently than before Coronavirus] / [I engage in trips by myself more frequently than I did before Coronavirus]

Q7.5. What else would you like to share with us about this study? (open question)

(Free Text Entry)

Thank you for telling us about your emotions and subjective well-being. If you are struggling and need help, you are not alone. You can text HOME to 74174 to be connected to a crisis counselor, or text 'oSTEM' to +1 (313) 662-8209 to be connected to a qualified LGBTQIA+ crisis responder. You don't have to be in an acute crisis to receive help. It's always free, and available 24/7.

Thanks for completing the survey. We will contact you by email shortly about how to install and log into the Daynamica smartphone app on your smartphone after checking your eligibility. Please make sure to check messages from gts.umn.edu in the next 3-5 days.

PART TWO: IN APP ACTIVITY-TRAVEL SURVEY

<Every Calendar Item>

- **For Activities (Home, Work, Education, Personal Business, Leisure-Recreation, Eat Out, Shopping, Other)**

1. (All activities) Did this activity involve any household tasks? (e.g., grocery shopping in contrast to shopping for fun, caring for own children while working)
   a. Yes
   b. No

2. (All activities) Who was with you during this activity? (Select all that apply)
   a. No one
   b. Spouse / Partner
   c. Own / Foster children
   d. Grandchildren
   e. Other family members
   f. Colleagues / Co-workers
   g. Friends / Acquaintances
   h. Other

3. (All Activities) How time-sensitive was this activity by itself? It had to be done:
    a. At this time
    b. Around this time
    c. Today
    d. This week
    e. This month
    f. This was not a time-sensitive activity

4. 4. (All Activities) How meaningful did you consider what you were doing?
Not meaningful at all 0 1 2 3 4 5 6 Extremely meaningful

5. (All Activities) How **happy** did you feel during this activity?
Not happy at all 0 1 2 3 4 5 6 Extremely happy

6. (All Activities) How **safe** did you feel during this activity?
Not safe at all 0 1 2 3 4 5 6 Extremely safe

7. (All Activities) How **stressed** did you feel during this activity?
Not stressed at all 0 1 2 3 4 5 6 Extremely stressed

8. (All Activities) How **sad** did you feel during this activity?
Not sad at all 0 1 2 3 4 5 6 Extremely sad

9. (All Activities) How **tired** did you feel during this activity?
Not tired at all 0 1 2 3 4 5 6 Extremely tired

10. (All Activities) How much **pain** did you feel during this activity if any?
Not painful at all 0 1 2 3 4 5 6 Extremely painful

- **For Trips (Car, Walk, Bike, Bus, Rail, Wait, Other)**

1. (All trips) Did you make any stops along this trip for household tasks? (e.g., drop-off your partner at the bus stop, curbside pickup groceries)
    a. Yes
    b. No

2. (All trips) Who was with you during this trip (or part of this trip)? (Select all that apply)
    a. No one
    b. Spouse / Partner
    c. Own / Foster children
    d. Grandchildren
    e. Other family members
    f. Colleagues / Co-workers
    g. Friends / Acquaintances
    h. Other

3. (Trips that contain a **car** segment) Were you the driver or passenger during the car section of this trip? (Select all that apply)
    a. Driver
    b. Passenger

4. (Trips that contain a **car** segment) Did you use the taxi, Uber, Lyft, or other ride services during the car section of this trip?
    a. Yes
    b. No

5. (All Trips) How **meaningful** did you consider this trip?
   Not meaningful at all 0 1 2 3 4 5 6 Extremely meaningful

6. (All Trips) How **happy** did you feel during this trip?
   Not happy at all 0 1 2 3 4 5 6 Extremely happy

7. (All Trips) How **safe** did you feel during this trip?
   Not safe at all 0 1 2 3 4 5 6 Extremely safe

8. (All Trips) How **stressed** did you feel during this trip?
   Not stressed at all 0 1 2 3 4 5 6 Extremely stressed

9. (All Trips) How **sad** did you feel during this trip?
   Not sad at all 0 1 2 3 4 5 6 Extremely sad

10. (All Trips) How **tired** did you feel during this trip?
    Not tired at all 0 1 2 3 4 5 6 Extremely tired

11. (All Trips) How much **pain** did you feel during this trip if any?
    Not painful at all 0 1 2 3 4 5 6 Extremely painful

End of Day

1. What time did you go to sleep yesterday (or earlier today)?
   Slider before 9pm, 10pm, …, 1am, after 2am. <30 min interval>

2. What time did you get up today?
   Slider before 5am, 6am, …, 9am, after 10 am <30 min interval>

3. When you were at **Home** today, roughly how many hours were spent on work and study?
   Slider 0, 2, 4, 6, 8, 10, 12, 12+ hours

4. When you were at **Home** today, roughly how many hours were spent on caring for household members? (e.g., children, elders with special needs)
   Slider 0, 2, 4, 6, 8, 10, 12, 12+ hours

5. When you were at **Home** today, roughly how many hours were spent on other household tasks? (e.g., cleaning, cooking)
   Slider 0, 2, 4, 6, 8, 10, 12, 12+ hours

.

Your **household tasks** may prevent you from engaging in certain desirable activities or choosing your preferred travel modes

6. Select any activities you could NOT do today mainly because of your household tasks. (Select all that apply)
   a. Work-related
   b. School-related
   c. Personal Business
   d. Leisure-Recreation
   e. Eat Out
   f. Shopping
   g. Other activities
   h. N/A

7. Select any travel modes you could NOT use today mainly because of your household tasks. (Select all that apply)
    i. Personal Car
    j. Taxi or ride service (e.g., Uber, Lyft)
    k. Bus
    l. Transit
    m. Walk
    n. Bike
    o. Other modes
    p. N/A

Your daily **gender expression** (e.g., how you dress and act) may affect your decision on which activities to participate in or to avoid.

8. Select any activities you chose NOT to do today because of your gender expression. (Select all that apply)
    q. Work-related
    r. School-related
    s. Personal Business
    t. Leisure-Recreation
    u. Eat Out
    v. Shopping
    w. Other activities
    x. N/A

9. Select any travel modes you decided NOT to use today because of your gender expression. (Select all that apply)
    y. Personal Car
    z. Taxi or ride service (e.g., Uber, Lyft)
    aa. Bus
    bb. Transit
    cc. Walk
    dd. Bike
    ee. Other modes
    ff. N/A

10. How many **unexpected/unusual** events have greatly influenced your emotions today? (e.g., good news that made you much happier; fell while running and felt painful)
    Slider 0, 1, 2, 3, 4, 5, 6, 7+

PART THREE: IN APP EXIT SURVEY

Prompted to receive in app exit survey if:
[Valid Participants Criteria]

1. To what degree do you think your travel and schedules during your participation are typical (like most of the other times)? (slider)
    Not my typical Very Typical
    0 1 2 3 4 5 6

To what extent do you agree or disagree with the statement in question 2 to 5?

2. This survey has made me more aware of my travel and activity behaviors
    Strongly Disagree Strongly Agree
    0 1 2 3 4 5 6

3. This survey has made me more aware of my gender identity
   Strongly Disagree Strongly Agree
   0 1 2 3 4 5 6

4. This survey has made me more aware of my gender expression
   Strongly Disagree Strongly Agree
   0 1 2 3 4 5 6

5. This survey has made me more aware of gender roles in everyday life
   Strongly Disagree Strongly Agree
   0 1 2 3 4 5 6

6. Can University of Minnesota researchers contact you about participating in future Daynamica research projects?
   [Yes] / [No]

7. Do you have any comments about this Gender & Travel Study or the Daynamica smartphone application you would like to share with us? (Free Text Entry)

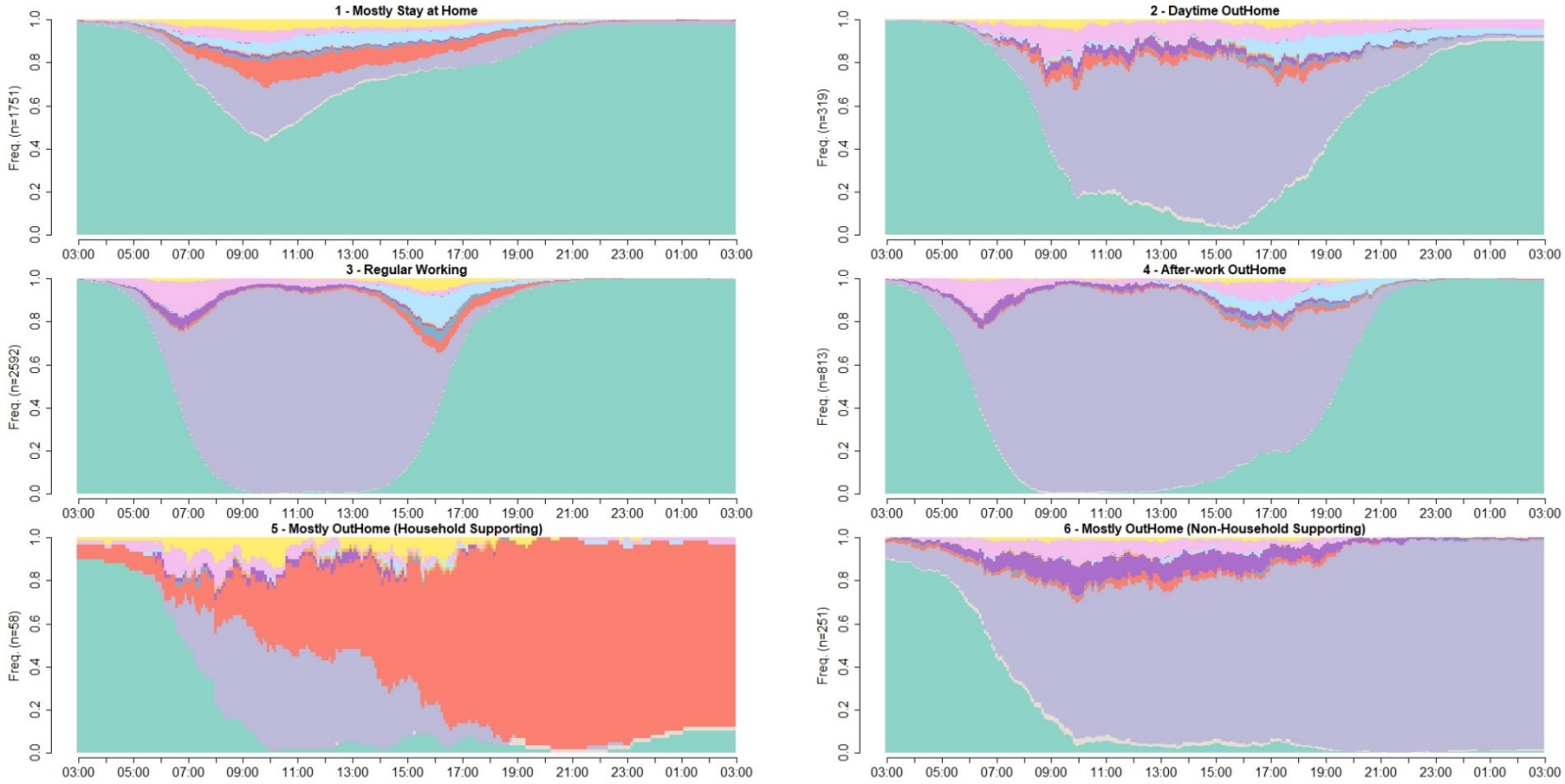
APPENDIX C
IMPUTED ACTIVITY TYPES FROM TRIP PURPOSES

ACTIVITY TYPE (IMPUTED)	TRIP PURPOSE (RECORDED IN TBI SURVEY)	HOUSEHOLD TASKS LABEL
HOME	Went home	HOME
WORK	Primary workplace	nHH
WORK-RELATED	Other work-related	nHH
WORK-RELATED	Traveling for work (e.g., going to airport)	nHH
WORK-RELATED	Volunteering	nHH
WORK-RELATED	Work-related activity (e.g., meeting, delivery, worksite)	nHH
SCHOOL	College/university	nHH
SCHOOL	Daycare or preschool	nHH
SCHOOL	K-12 school	nHH
SCHOOL	Other education-related (e.g., field trip)	nHH
SCHOOL	Other type of class (e.g., cooking class)	nHH
SCHOOL	Vocational education	nHH
SCHOOL-RELATED	College/university	nHH
SCHOOL-RELATED	K-12 school	nHH
SCHOOL-RELATED	Other education-related (e.g., field trip)	nHH
SCHOOL-RELATED	Other type of class (e.g., cooking class)	nHH
SCHOOL-RELATED	Vocational education	nHH
MEAL	Dine out/get coffee or take-out	nHH
SOCIAL/RECREATION	Exercise (e.g., gym, jog, bike, walk dog)	nHH
SOCIAL/RECREATION	Family activity (e.g., watch child's game)	HH
SOCIAL/RECREATION	Leisure/entertain/cultural (e.g., cinema, museum)	nHH
SOCIAL/RECREATION	Other social/leisure/vacation activity	nHH
SOCIAL/RECREATION	Religious/civic/volunteer activity	nHH
SOCIAL/RECREATION	Social (e.g., visit friends/relatives)	nHH
SOCIAL/RECREATION	Vacation/traveling	nHH
ESCORT	Other place to pick-up/drop-off	HH
ESCORT	Pick-up/drop-off to/from childcare/preschool/adult care	HH
ESCORT	Pick-up/drop-off to/from K-12 school or college	HH
ESCORT	Pick-up/drop-off to/from other person's workplace	HH
ESCORT	Pick-up/drop-off to/from other person's scheduled activity (e.g., lesson, appointment)	HH
ESCORT	To/from other person's home	HH
SHOP	Get gas	HH
SHOP	Grocery shopping	HH
SHOP	Other routine shopping (e.g., pharmacy)	HH
SHOP	Shopping for major item (e.g., furniture, car)	HH
ERRAND/OTHER	Errand with appointment (e.g., haircut, accountant)	nHH
ERRAND/OTHER	Errand without appointment (e.g., post office, dry cleaning)	HH

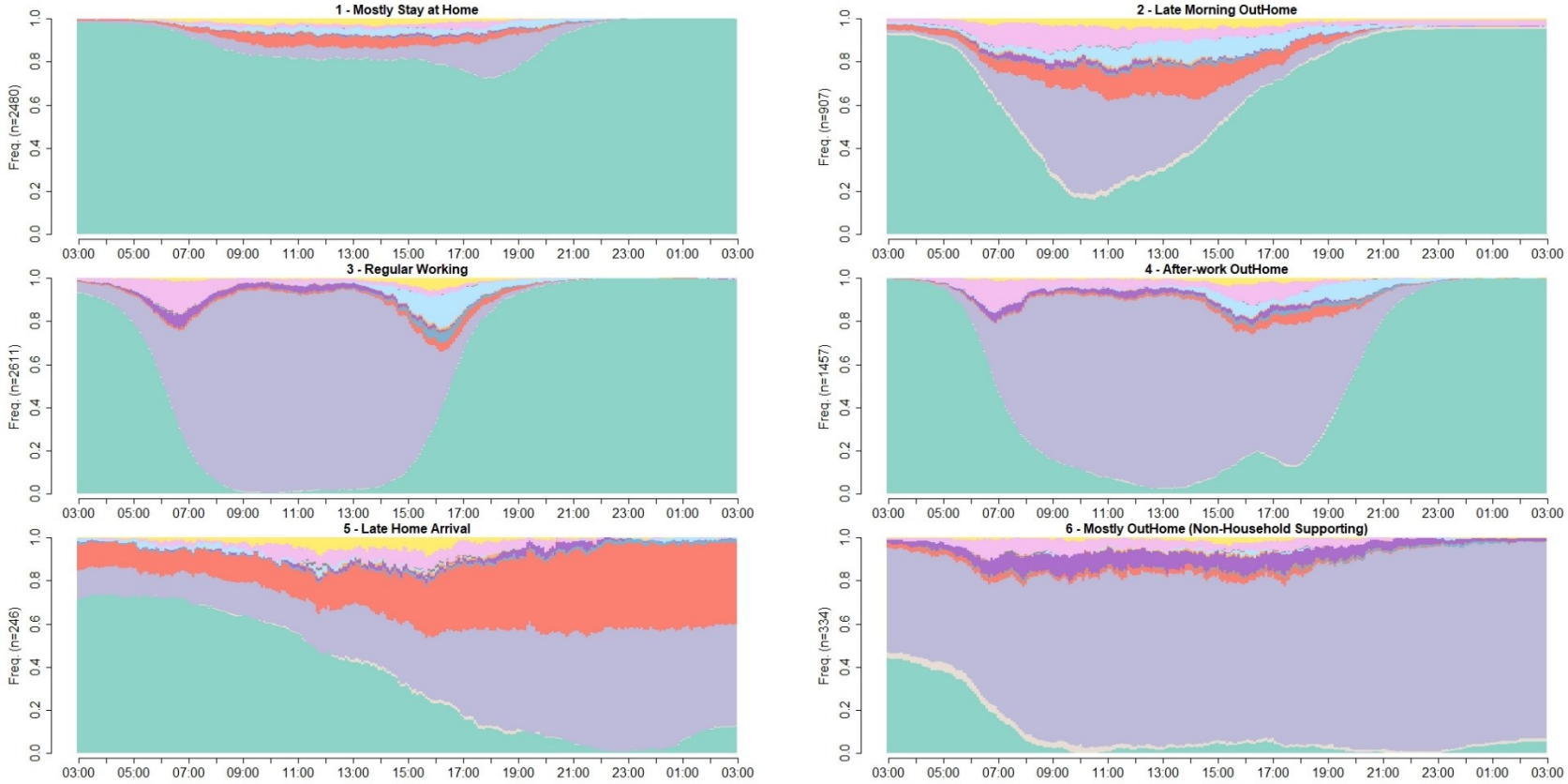
ACTIVITY TYPE (IMPUTED)	TRIP PURPOSE (RECORDED IN TBI SURVEY)	HOUSEHOLD TASKS LABEL
ERRAND/OTHER	Medical visit (e.g., doctor, dentist)	HH
ERRAND/OTHER	Other errand	nHH
ERRAND/OTHER	Other purpose	nHH
SPENT THE NIGHT AT NON-HOME LOCATION	Spent the night at non-home location in region	HOME
SPENT THE NIGHT AT NON-HOME LOCATION	Spent the night at non-home location out of region	HOME
CHANGE MODE	Change/transfer mode (e.g., wait for bus, change planes)	TRIP
MISSING: NON-IMPUTABLE	Missing: Non-imputable	MISSING
ERRAND/OTHER	Split loop trip	TRIP

APPENDIX D
STATE DISTRIBUTIONS OF DISTINCT PATTERNS BY DAYS OF THE WEEK – TBI DATA

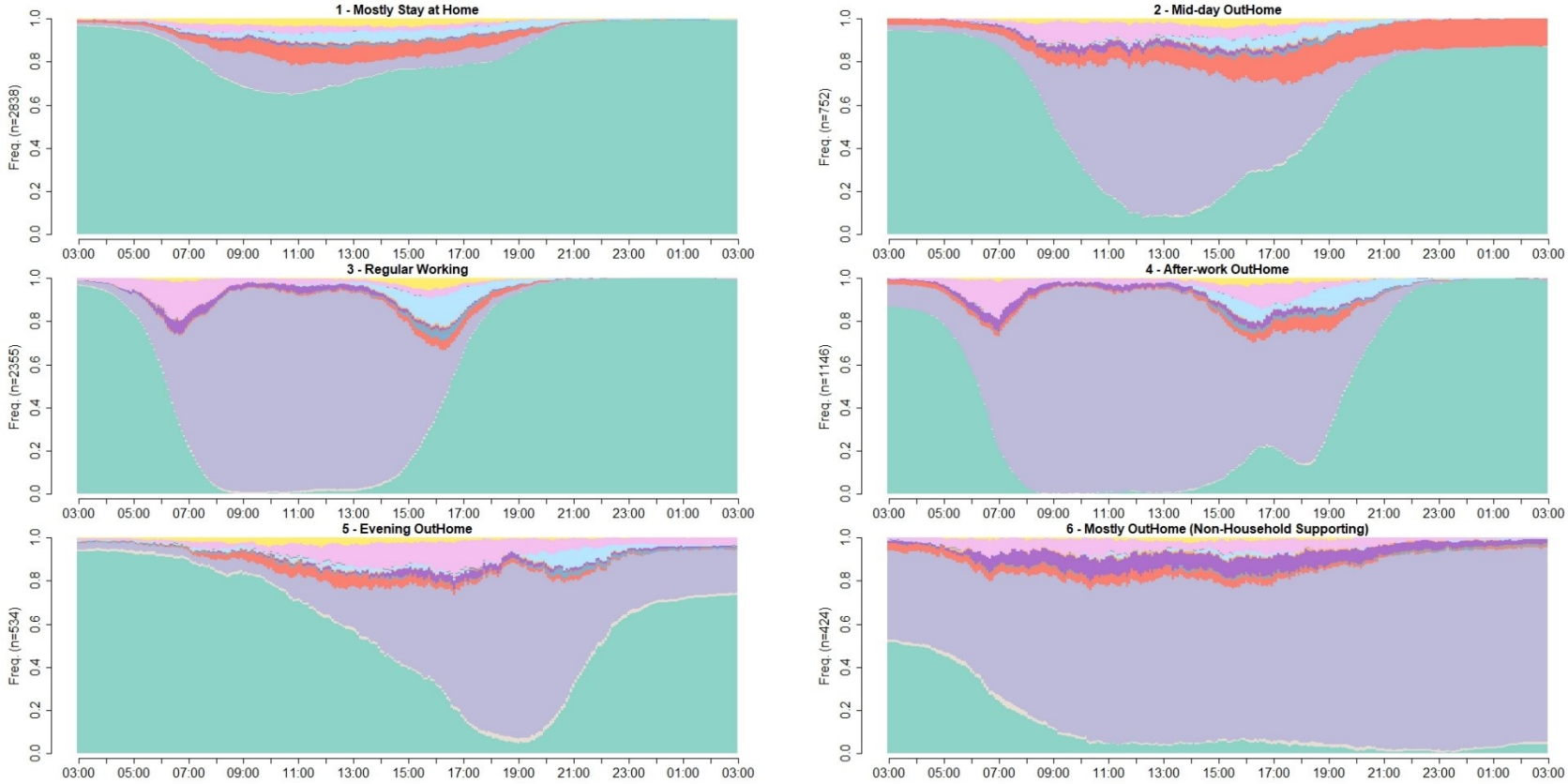
(a) State distributions of distinct activity-travel patterns (TBI Data, Monday)



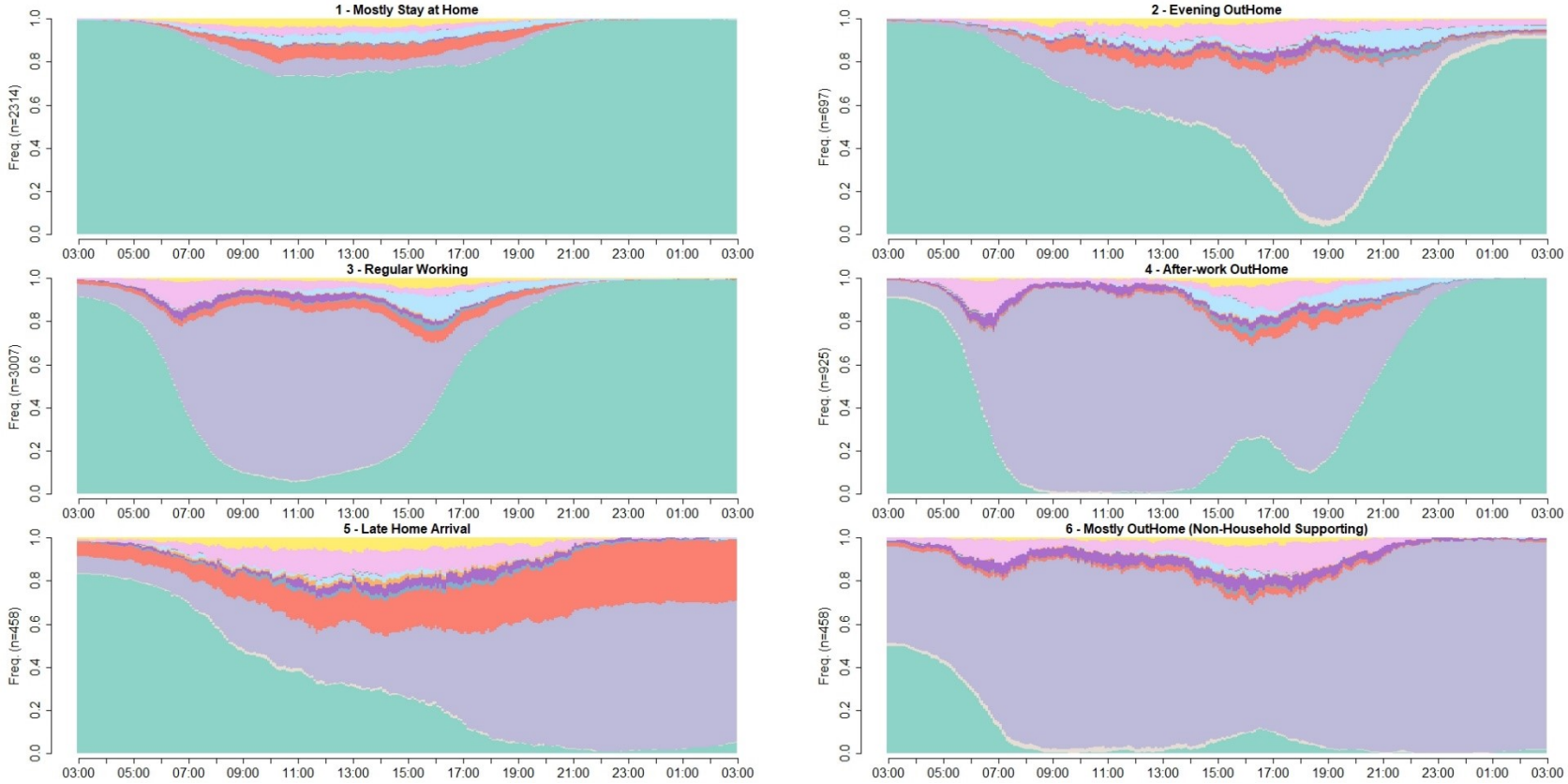
(b) State distributions of distinct activity-travel patterns (TBI Data, Wednesday)



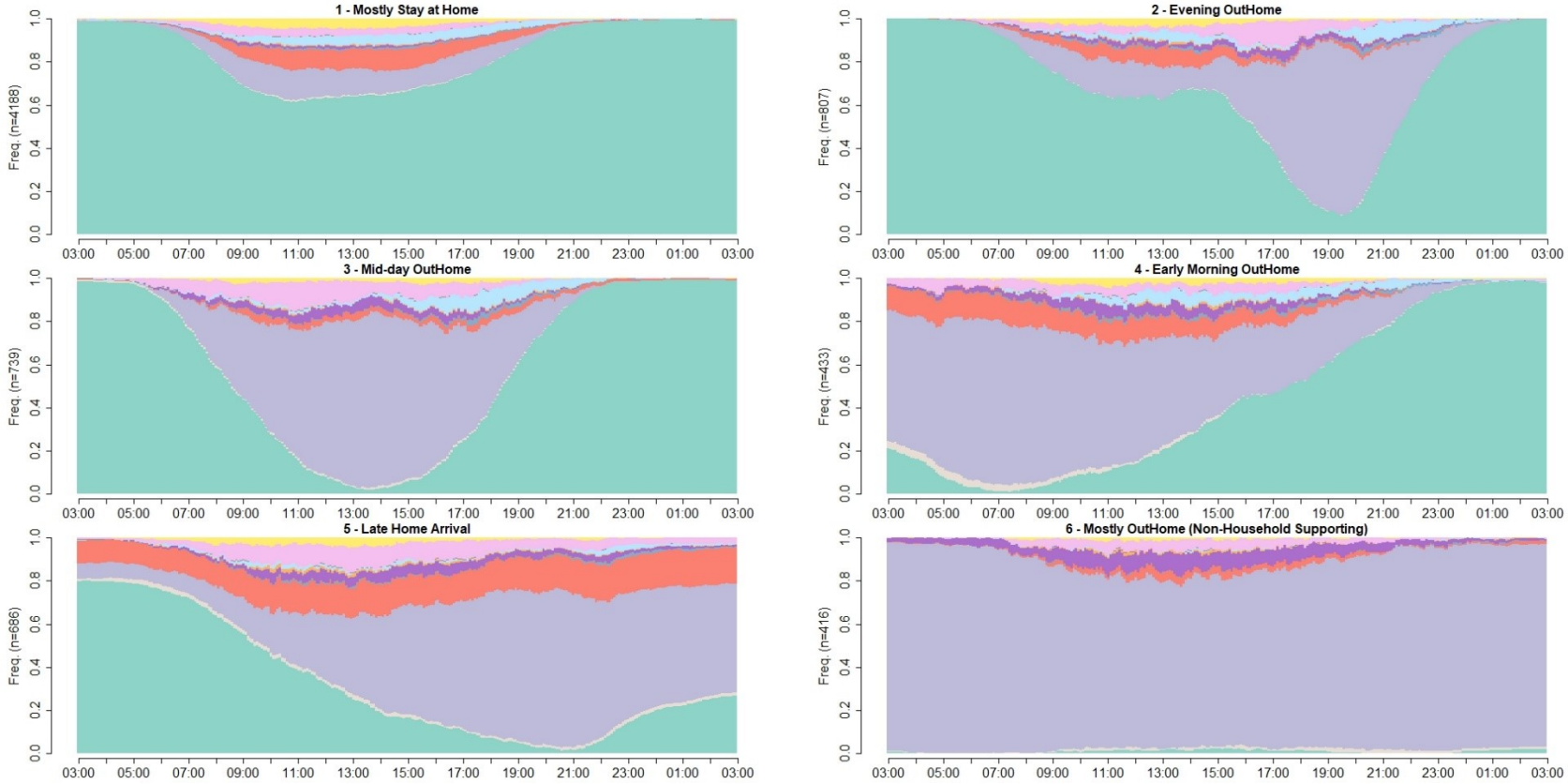
(c) State distributions of distinct activity-travel patterns (TBI Data, Thursday)



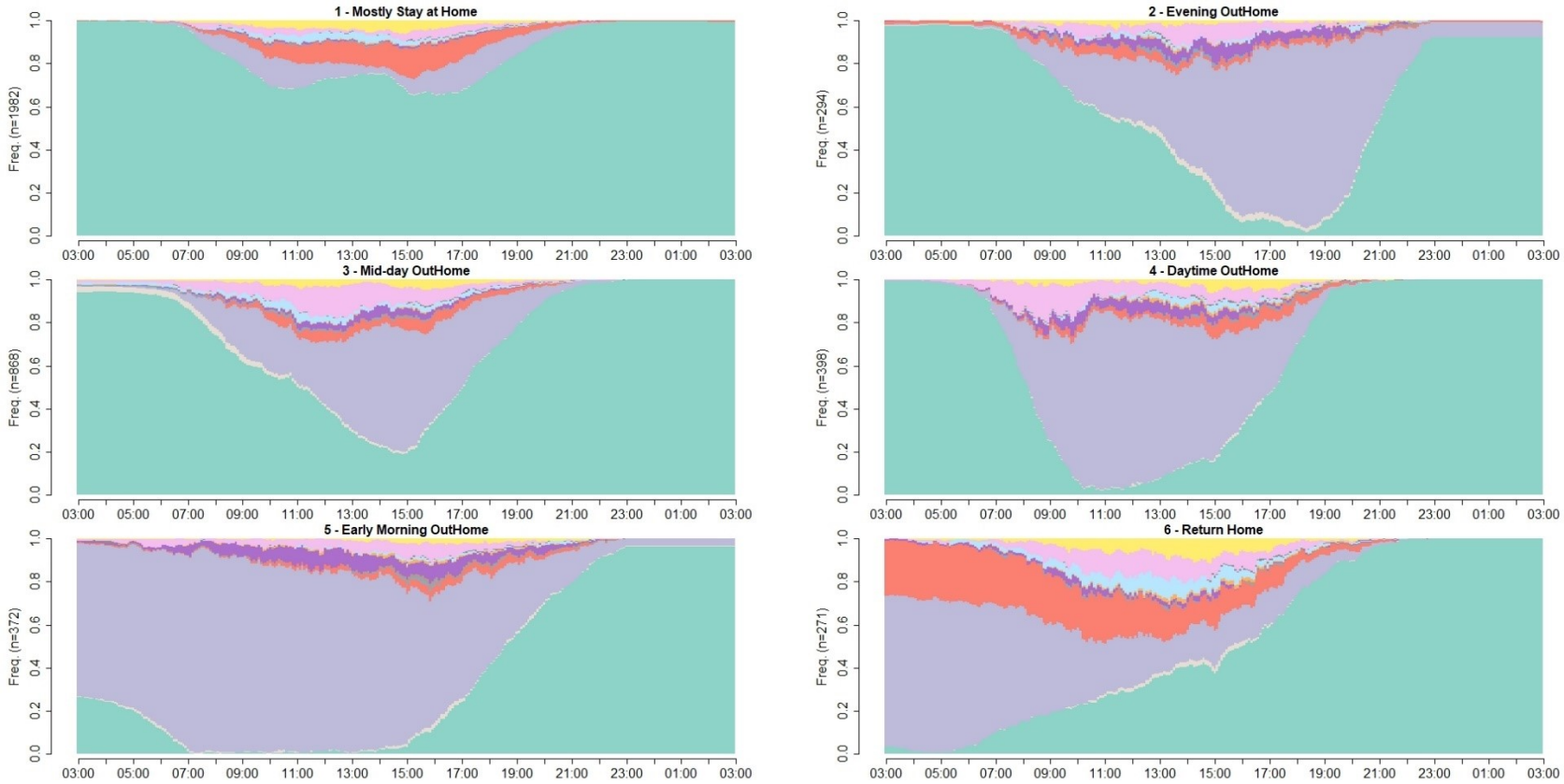
(d) State distributions of distinct activity-travel patterns (TBI Data, Friday)



(e) State distributions of distinct activity-travel patterns (TBI Data, Saturday)

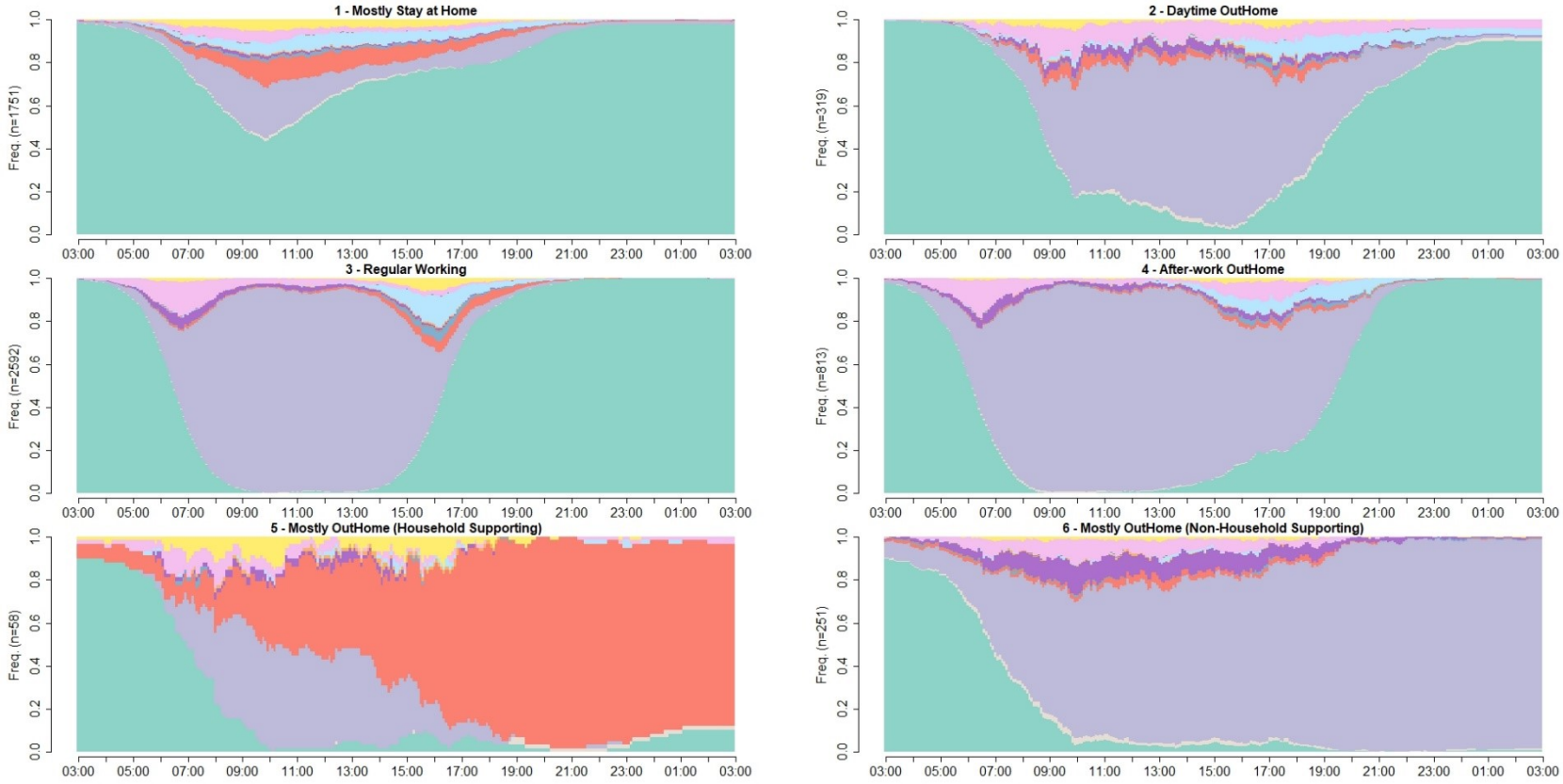


(f) State distributions of distinct activity-travel patterns (TBI Data, Sunday)

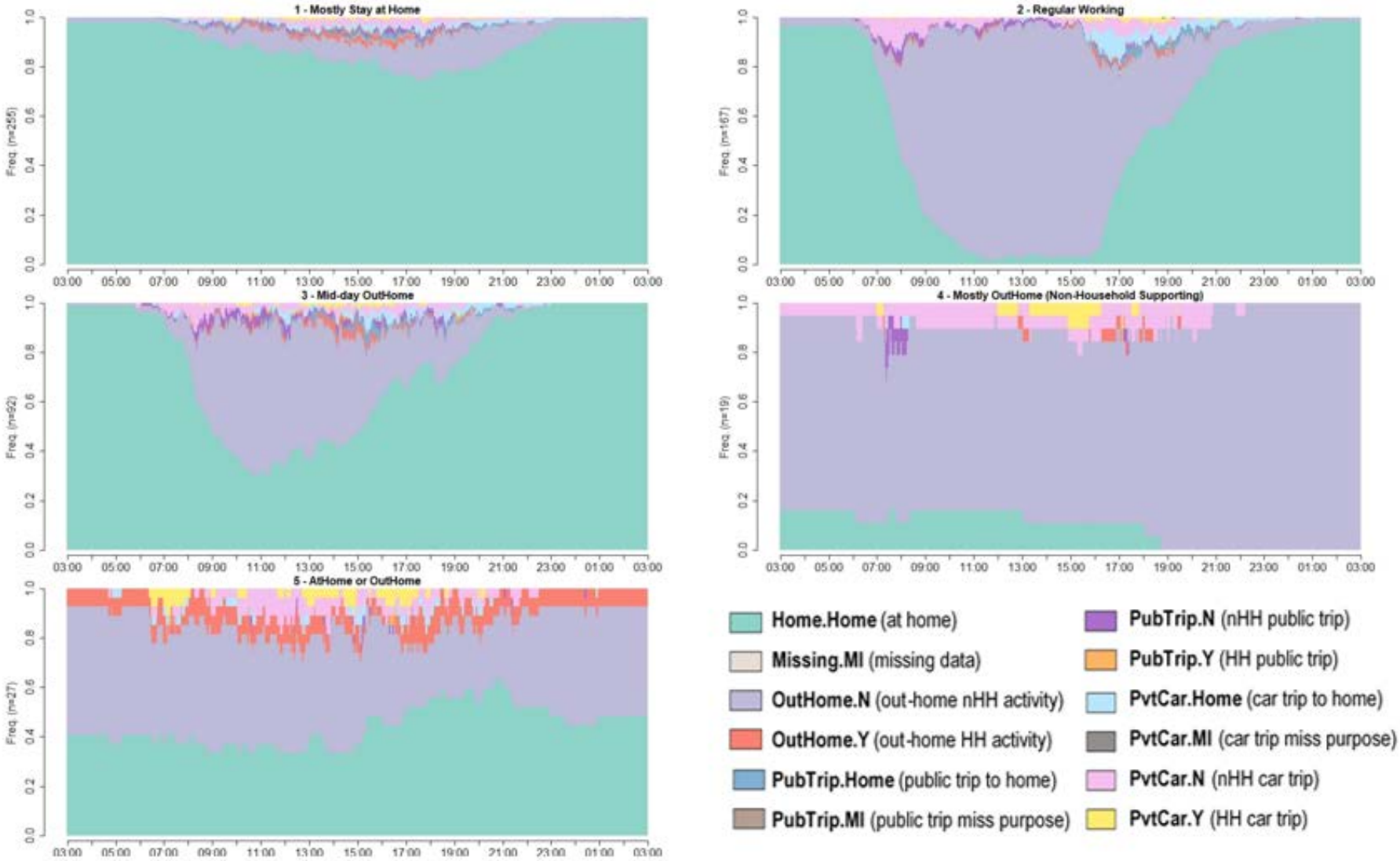


APPENDIX E
STATE DISTRIBUTIONS OF DISTINCT PATTERNS BY DAYS OF THE WEEK – DAYNAMICA DATA, FIRST METRIC

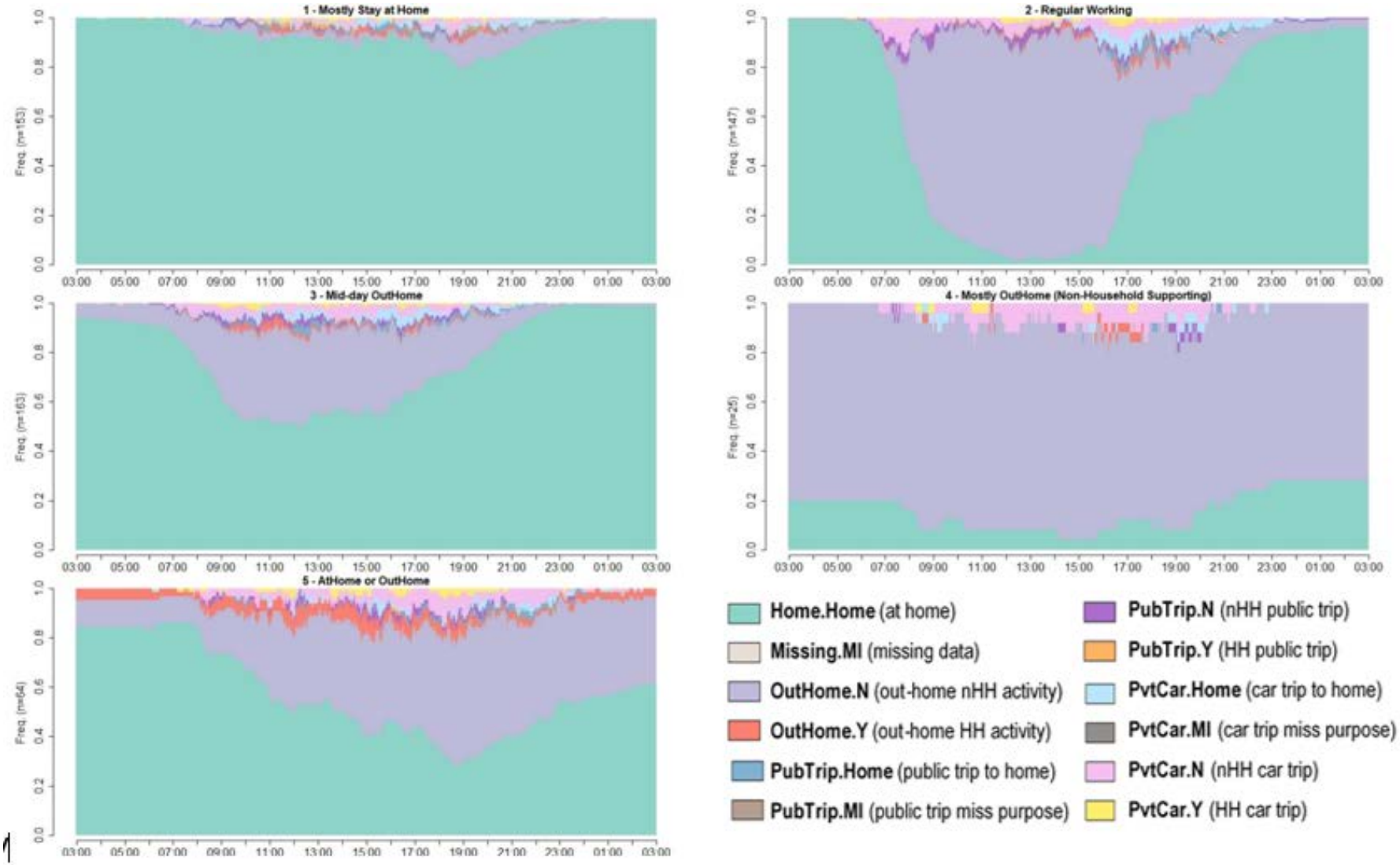
(a) State distributions of distinct activity-travel patterns (Daynamica, 1st Metric, Monday)



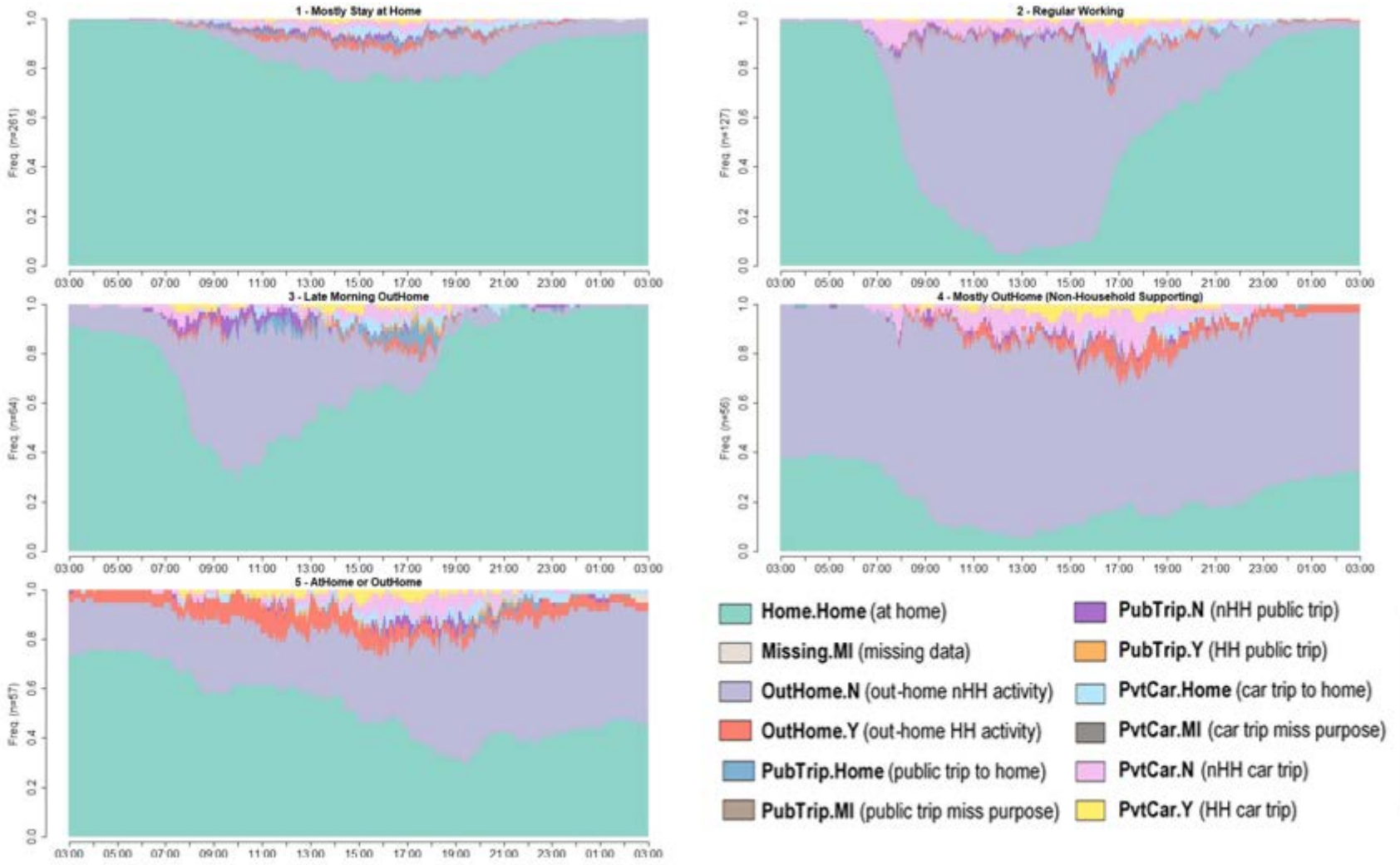
(b) State distributions of distinct activity-travel patterns (Daynamica, 1st Metric, Wednesday)



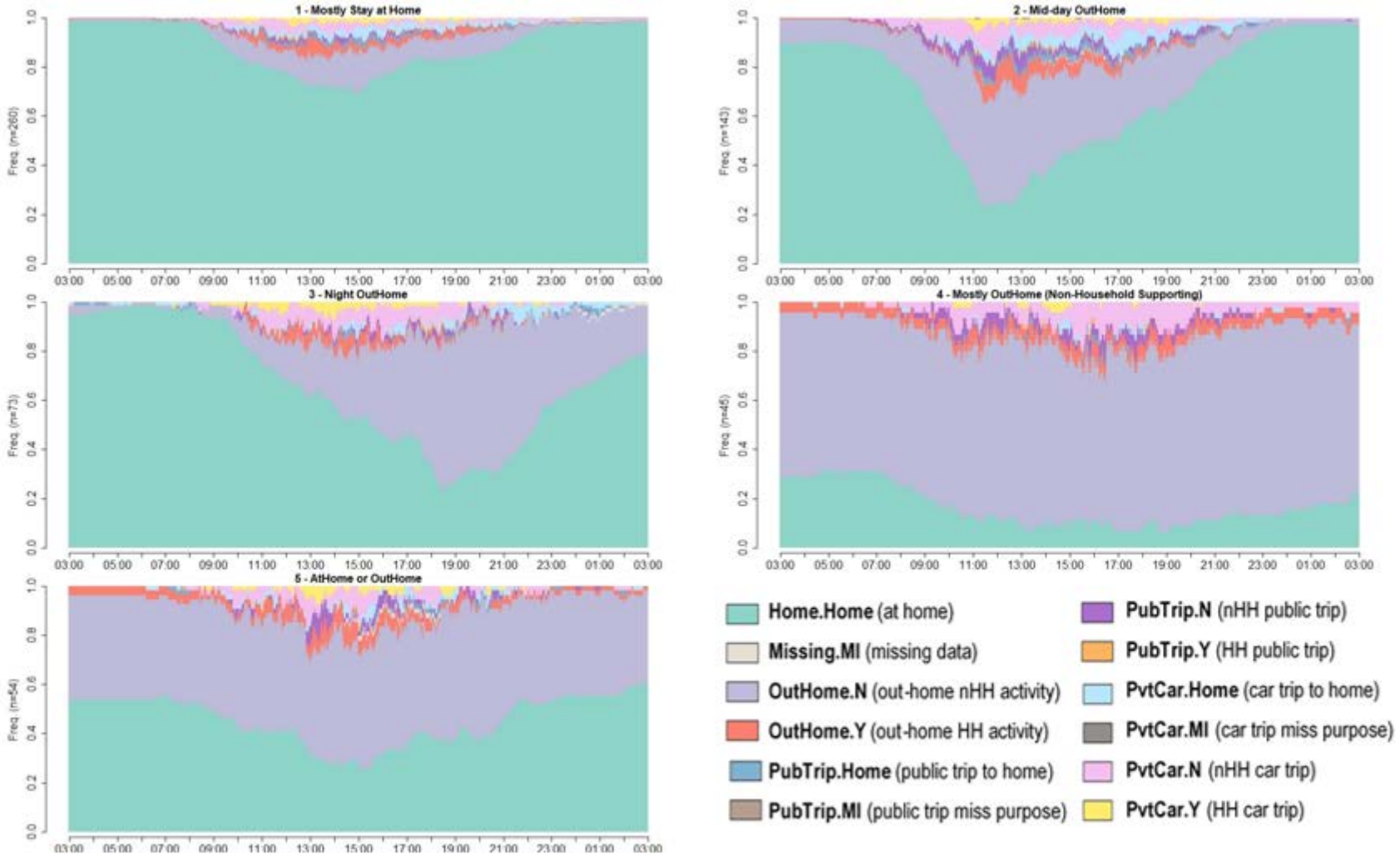
(c) State distributions of distinct activity-travel patterns (Daynamica, 1st Metric, Thursday)



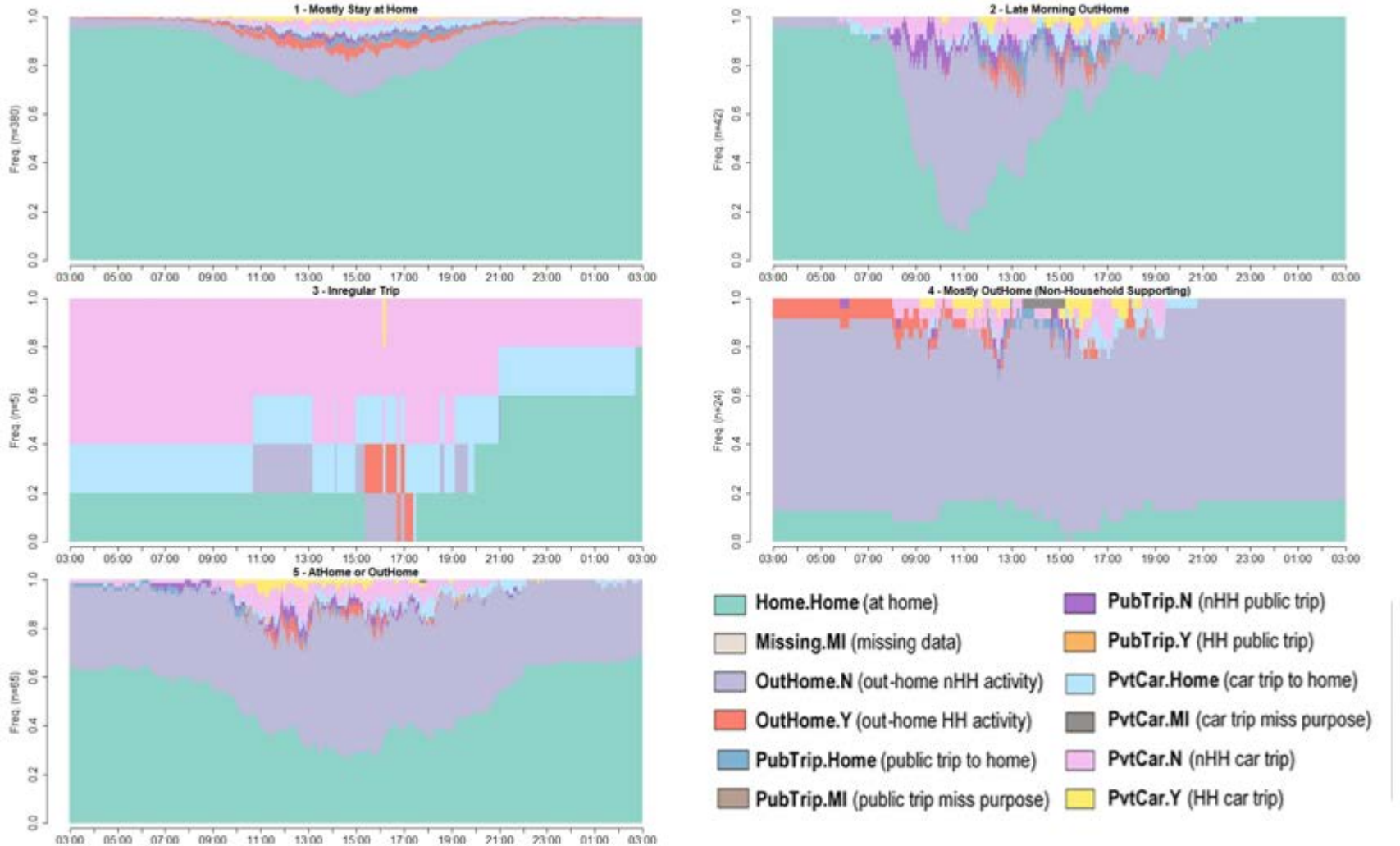
(d) State distributions of distinct activity-travel patterns (Daynamica, 1st Metric, Friday)



(e) State distributions of distinct activity-travel patterns (Daynamica, 1st Metric, Saturday)

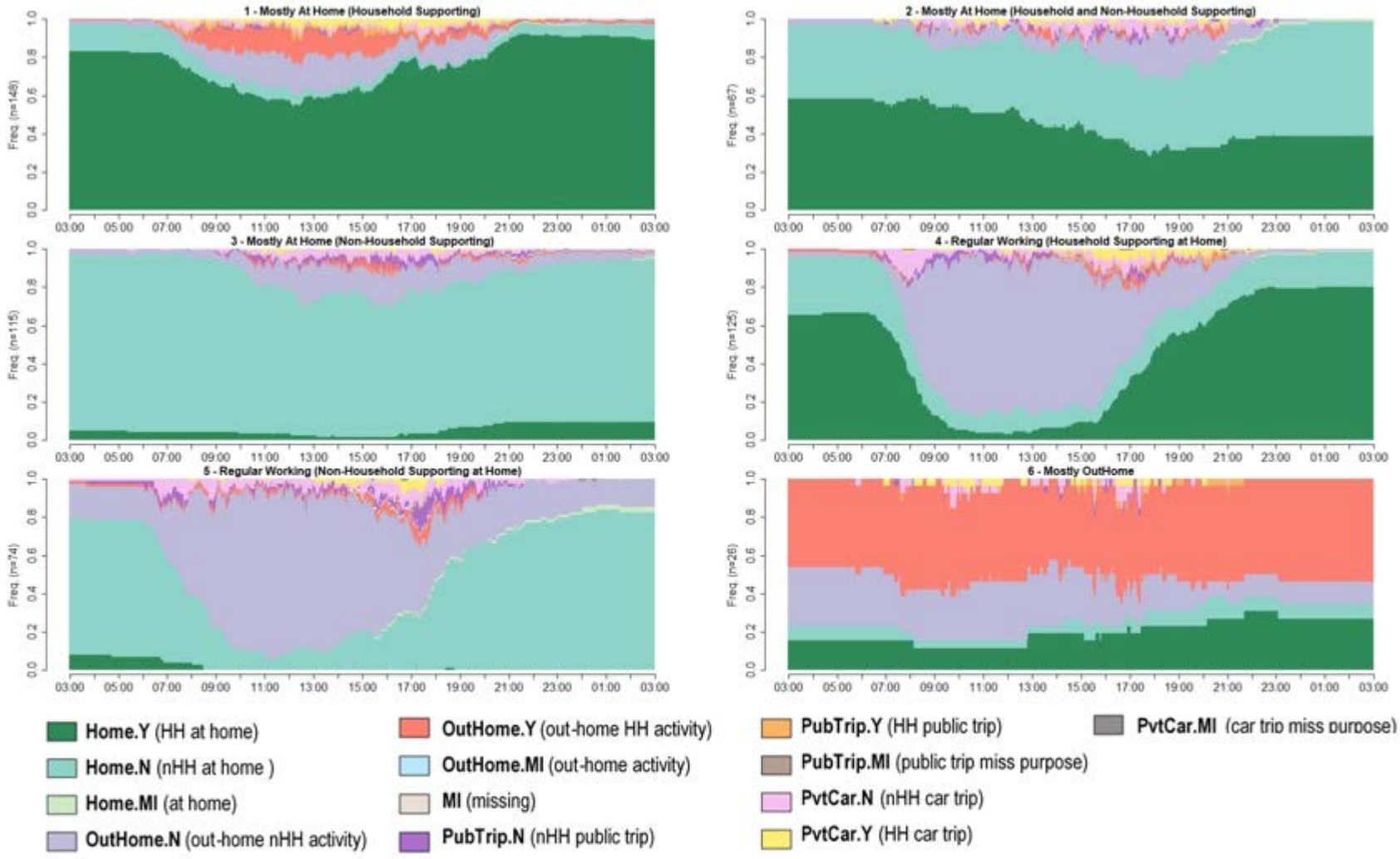


(f) State distributions of distinct activity-travel patterns (Daynamica, 1st Metric, Sunday)

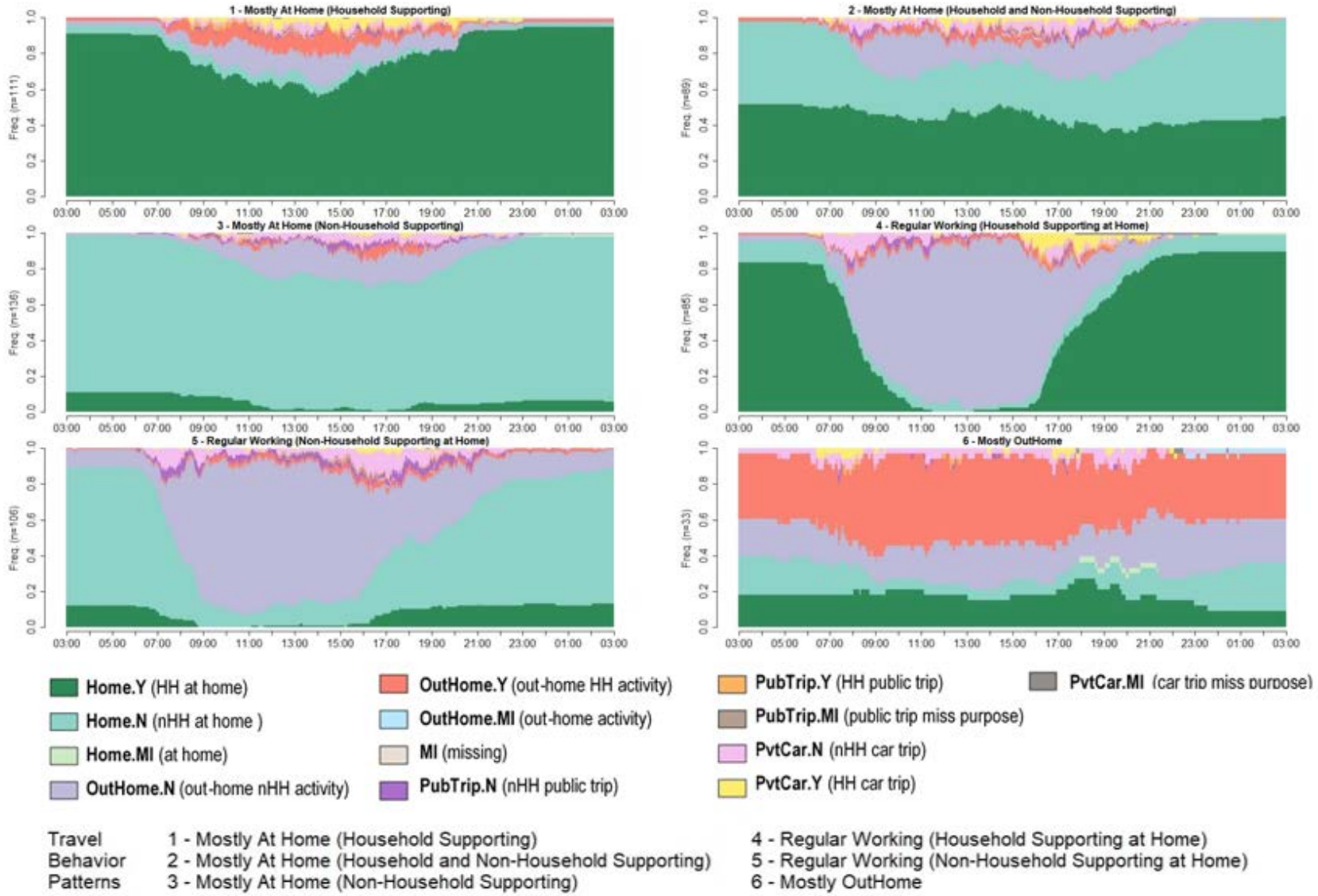


APPENDIX F
STATE DISTRIBUTIONS OF DISTINCT PATTERNS BY DAYS OF THE WEEK OTHER THAN TUESDAY – DAYNAMICA DATA, SECOND METRIC

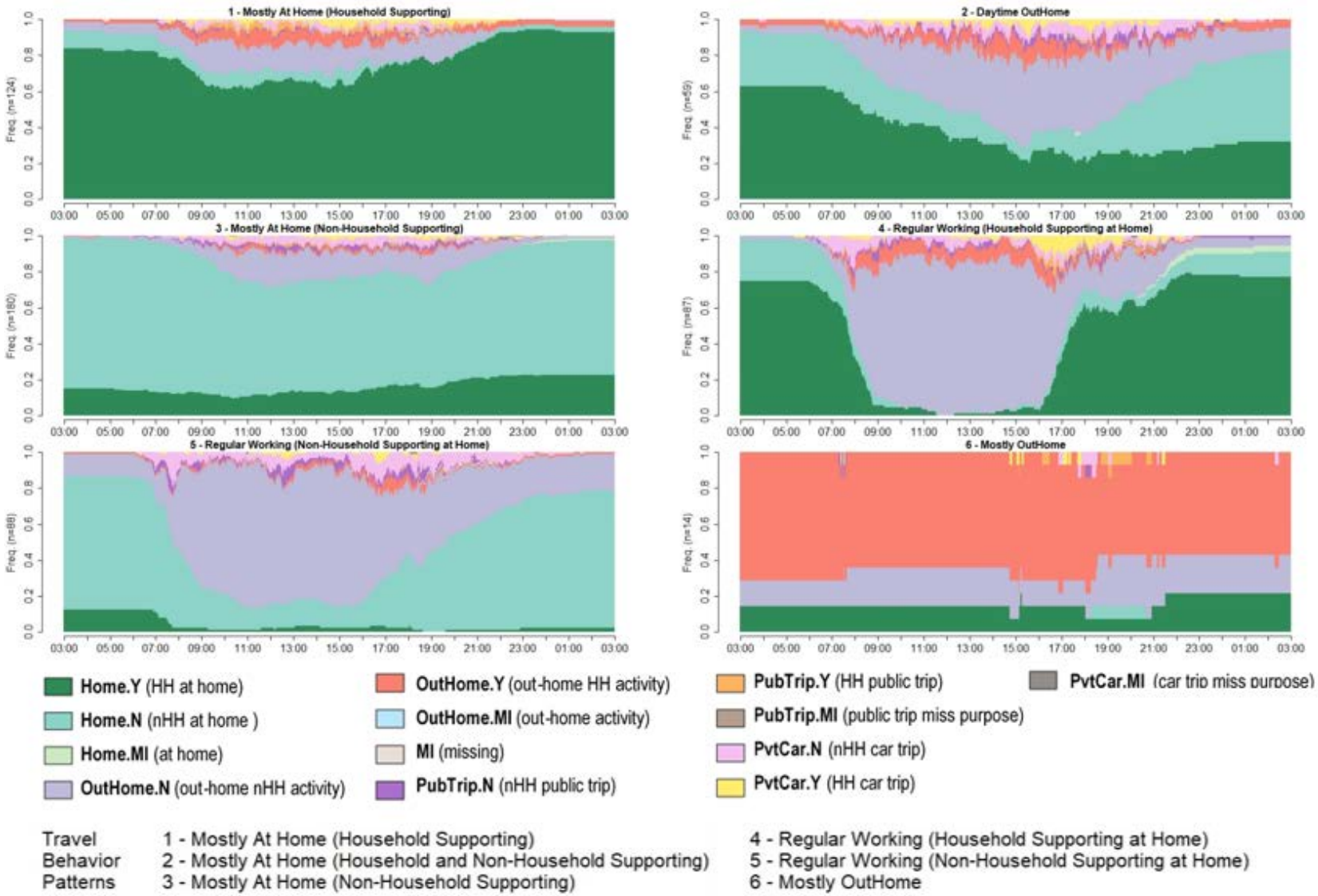
(a) State distributions of distinct activity-travel patterns (Daynamica, 2nd Metric, Monday)



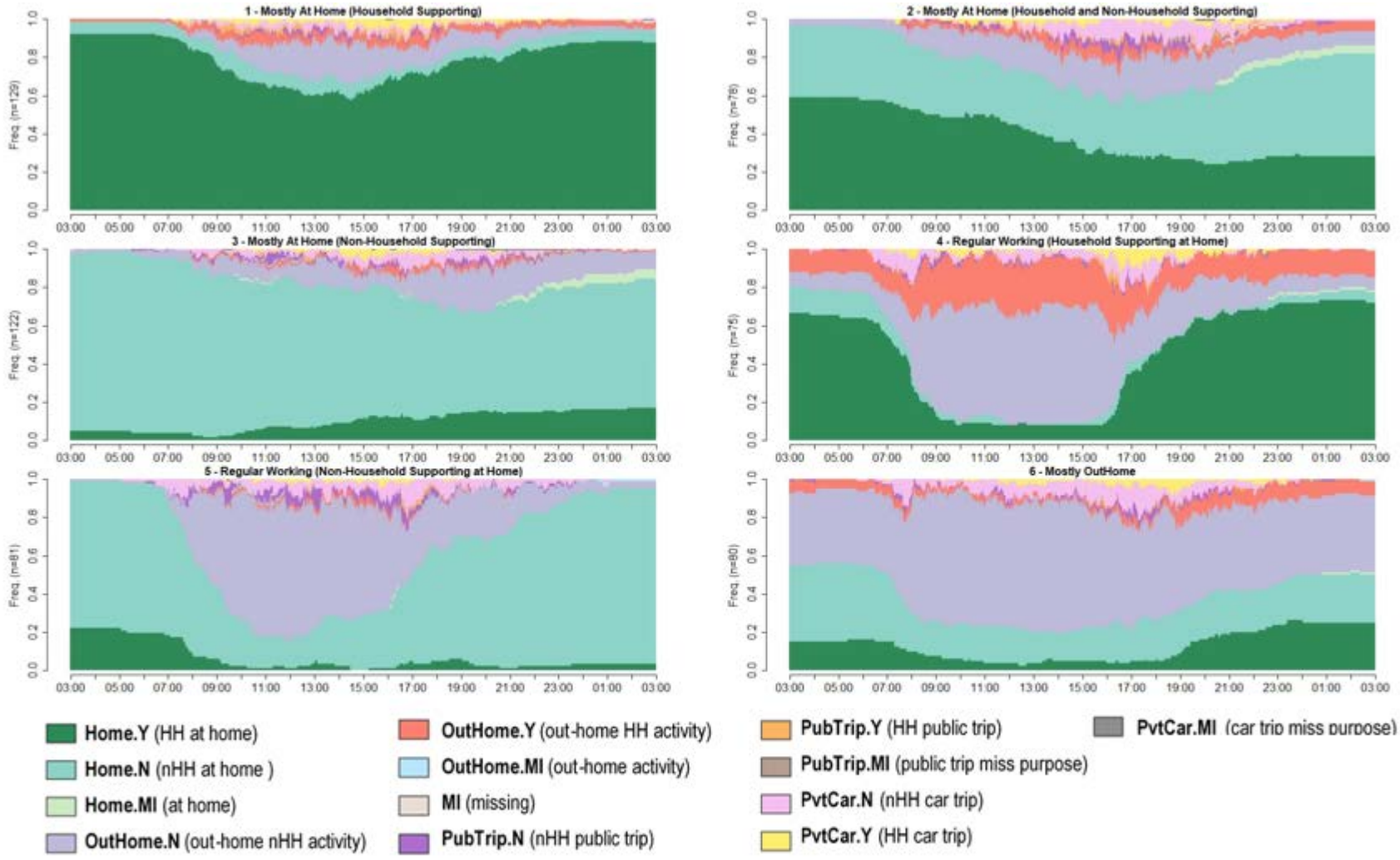
(b) State distributions of distinct activity-travel patterns (Daynamica, 2nd Metric, Wednesday)



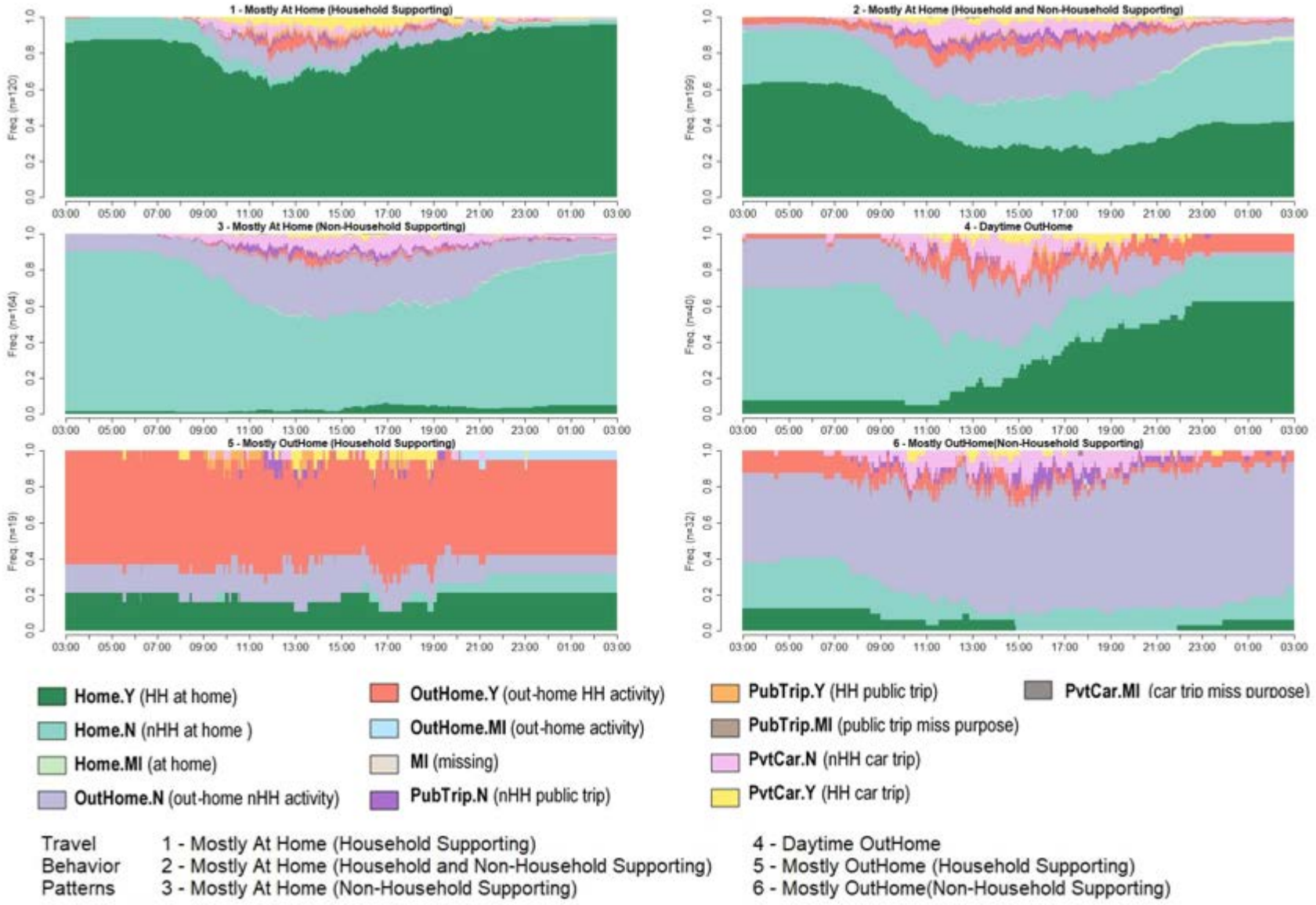
(c) State distributions of distinct activity-travel patterns (Daynamica, 2nd Metric, Thursday)



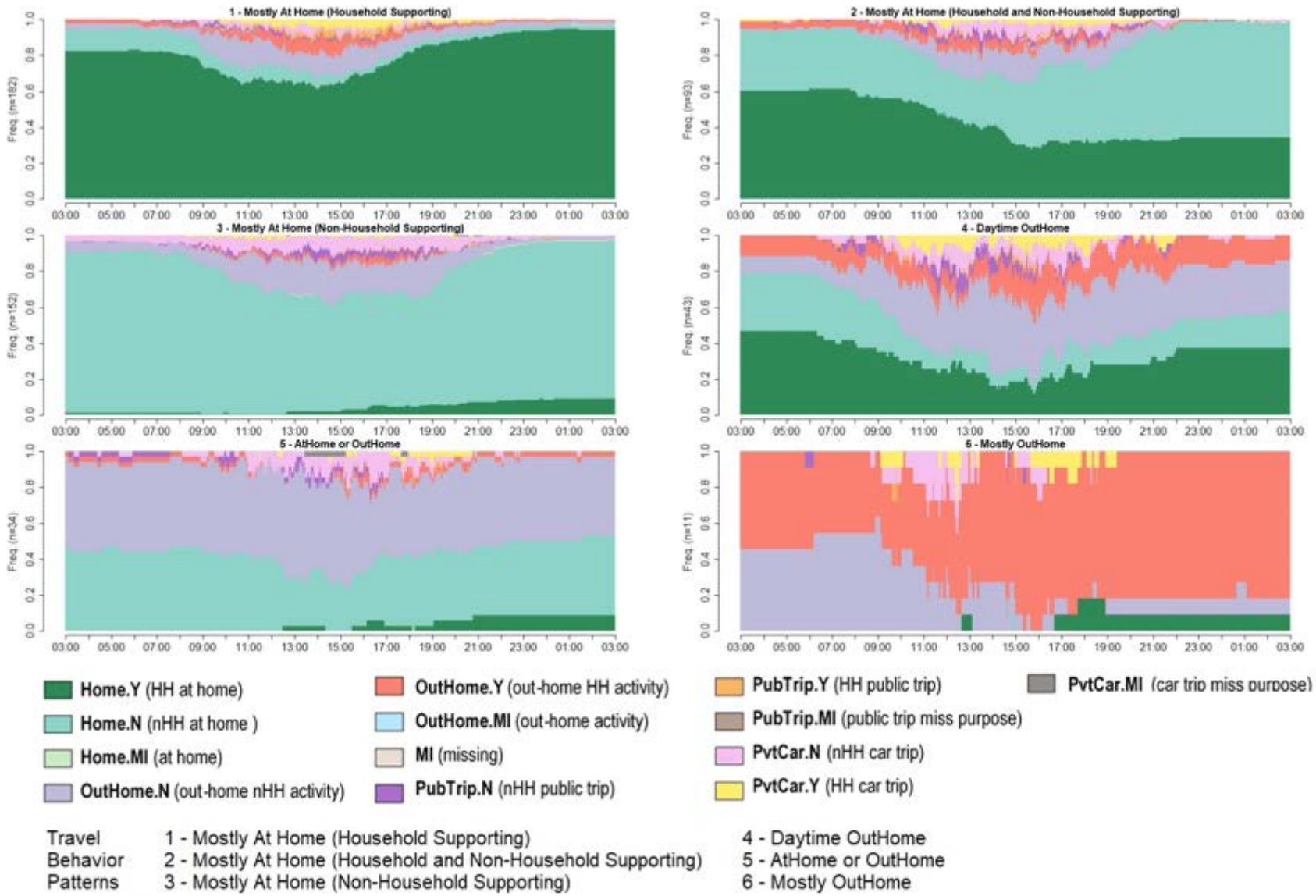
(d) State distributions of distinct activity-travel patterns (Daynamica, 2nd Metric, Friday)



(e) State distributions of distinct activity-travel patterns (Daynamica, 2nd Metric, Saturday)



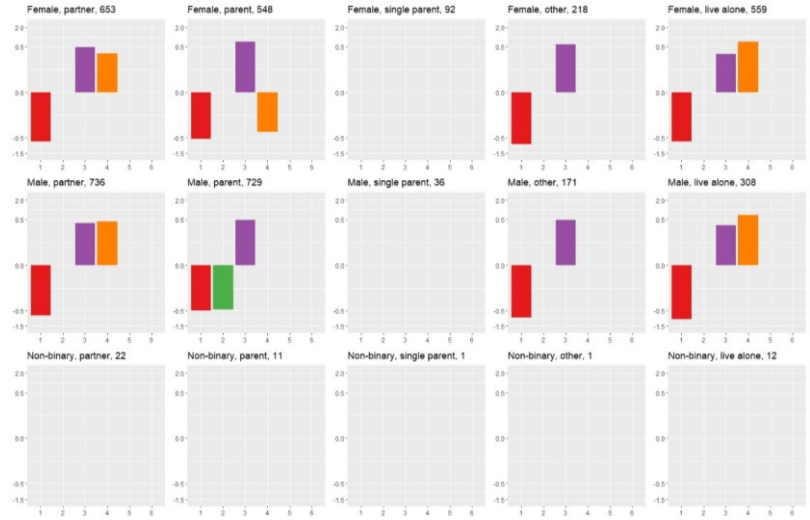
(f) State distributions of distinct activity-travel patterns (Daynamica, 2nd Metric, Sunday)



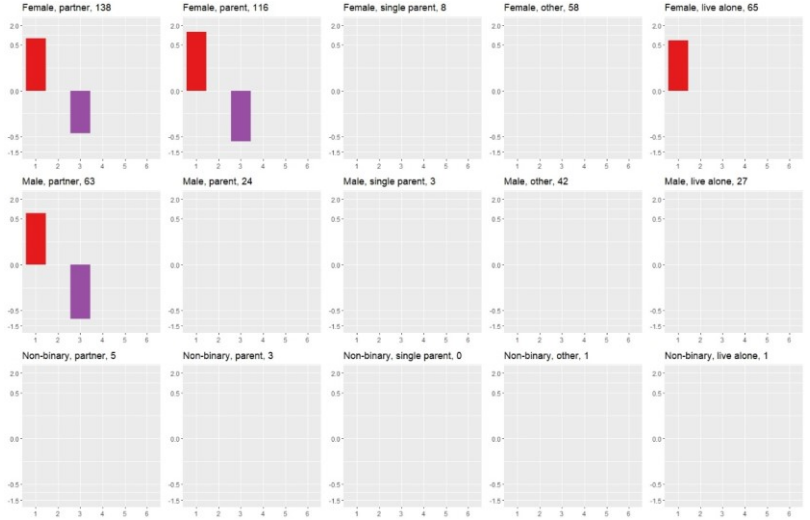
APPENDIX G
PROPOSITIONS FOR 6 PATTERNS AND 60 INTERSECTIONALITY GROUPS - TBI DATA

(a) Propositions for 6 patterns and 60 intersectionality groups (TBI, Monday)

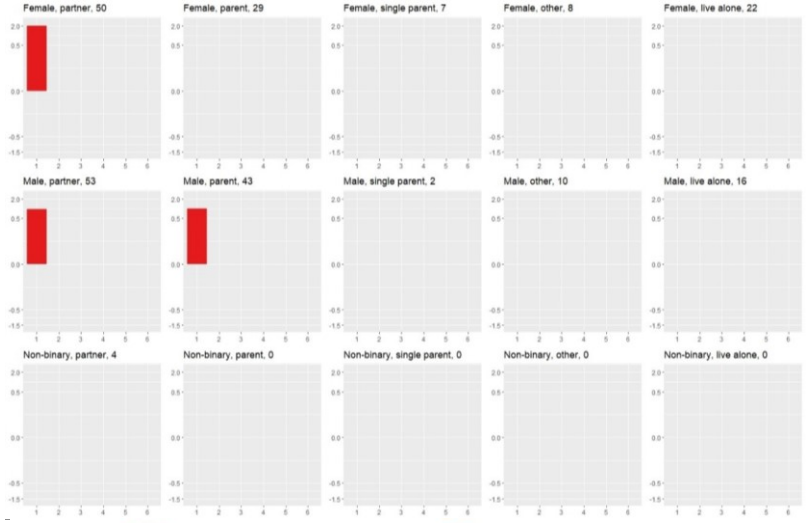
Full-time Employee



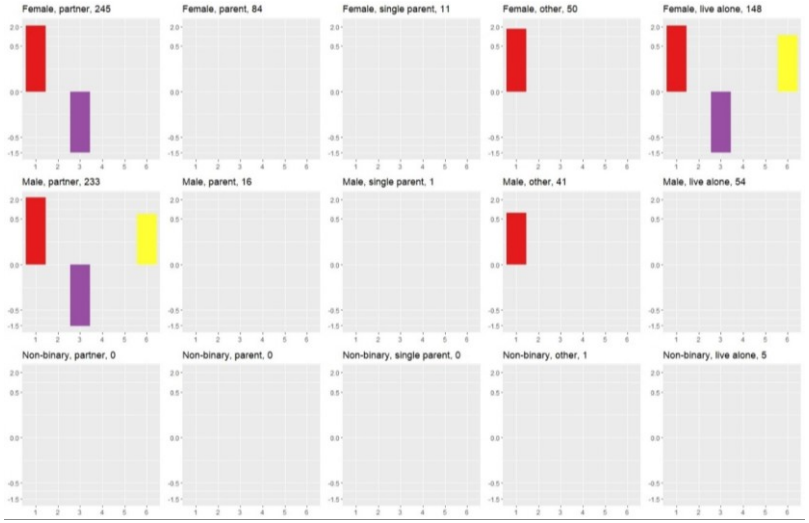
Part-time Employee



Self-Employed



Not Employed

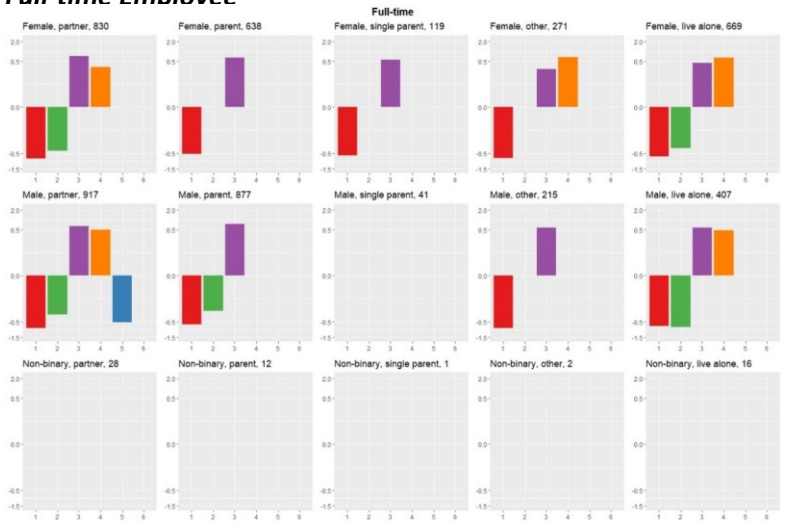


Travel Behavior Patterns

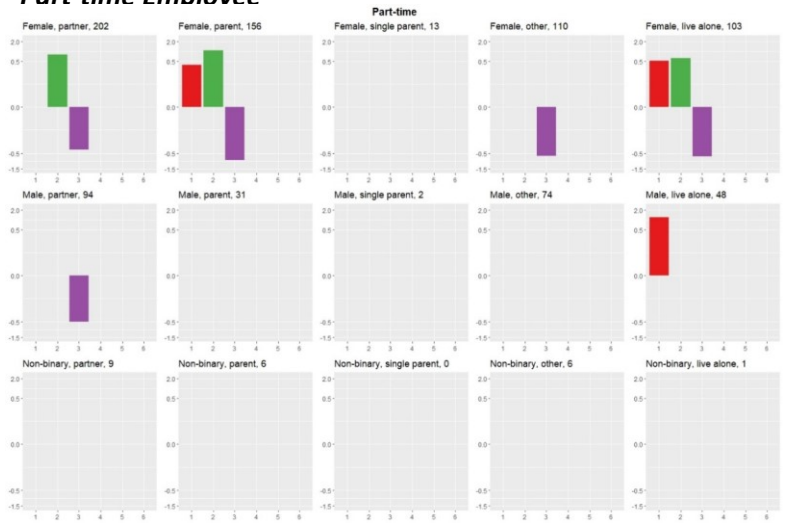
- 1 - Mostly Stay at Home
- 2 - Daytime OutHome
- 3 - Regular Working
- 4 - After-work OutHome
- 5 - Mostly OutHome (Household Supporting)
- 6 - Mostly OutHome (Non-Household Supporting)

(b) Propositions for 6 patterns and 60 intersectionality groups (TBI, Wednesday)

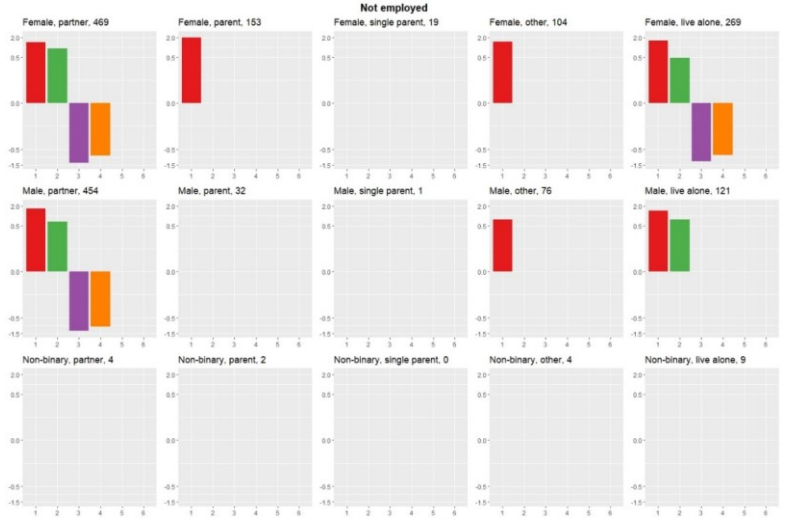
Full-time Employee



Part-time Employee



Self-Employed



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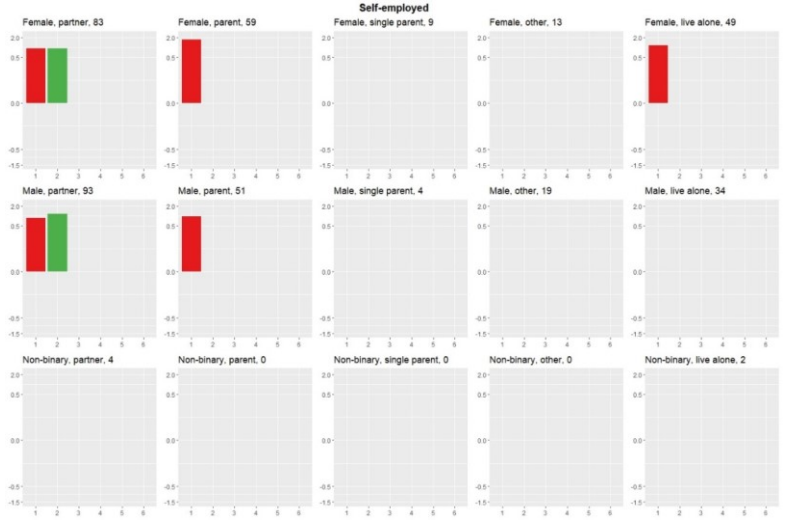
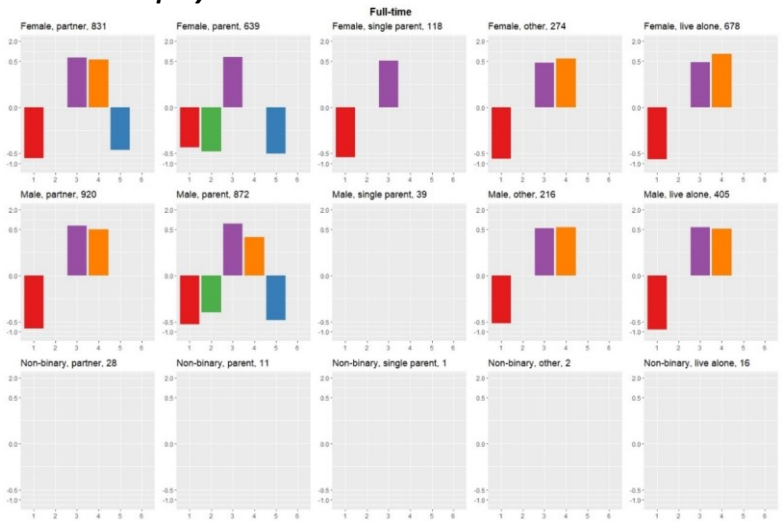
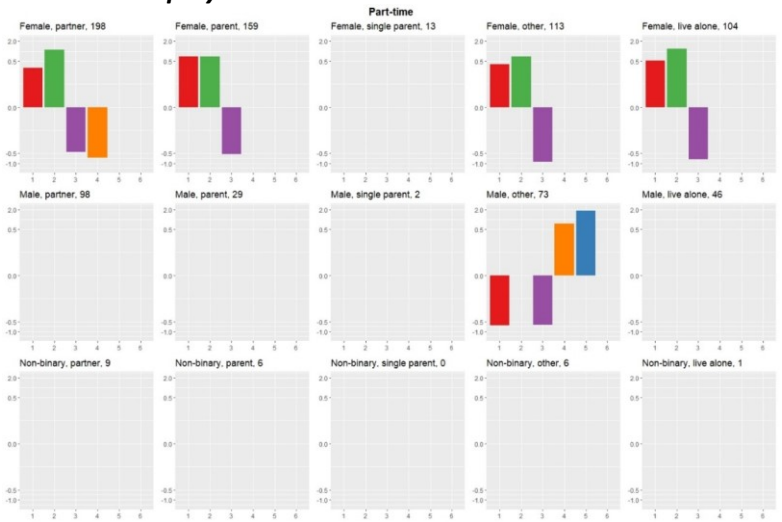


(c) Propositions for 6 patterns and 60 intersectionality groups (TBI, Thursday)

Full-time Employee



Part-time Employee



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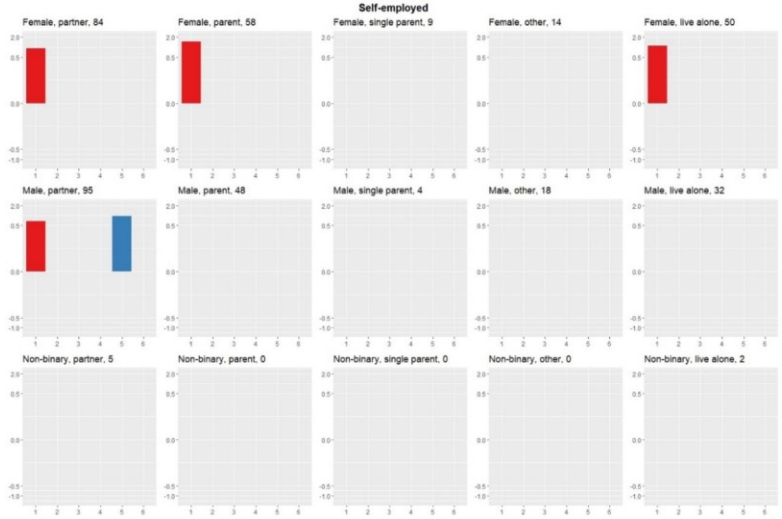
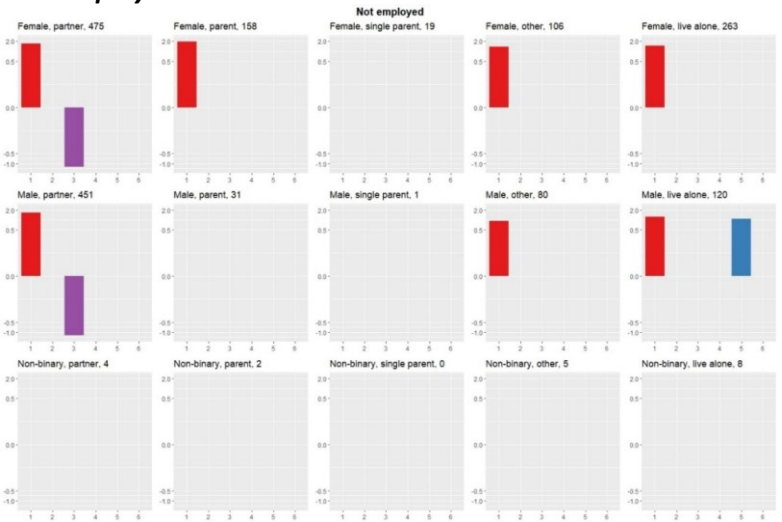
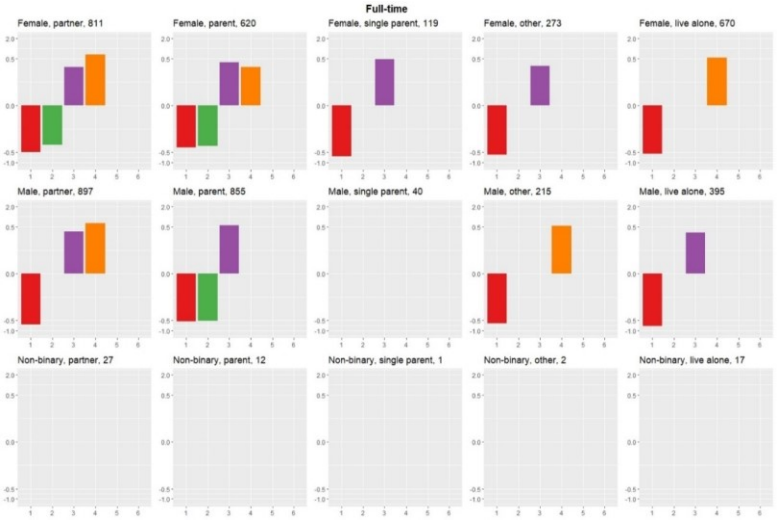


Not Employed

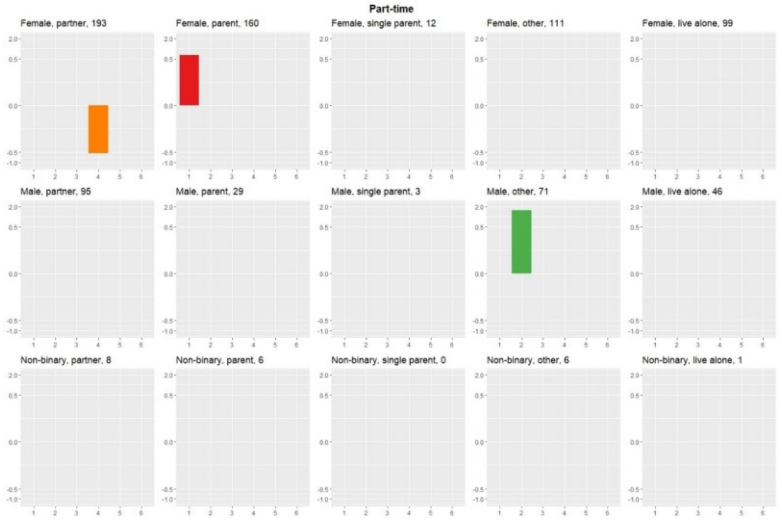


(d) Propositions for 6 patterns and 60 intersectionality groups (TBI, Friday)

Full-time Employee



Part-time Employee



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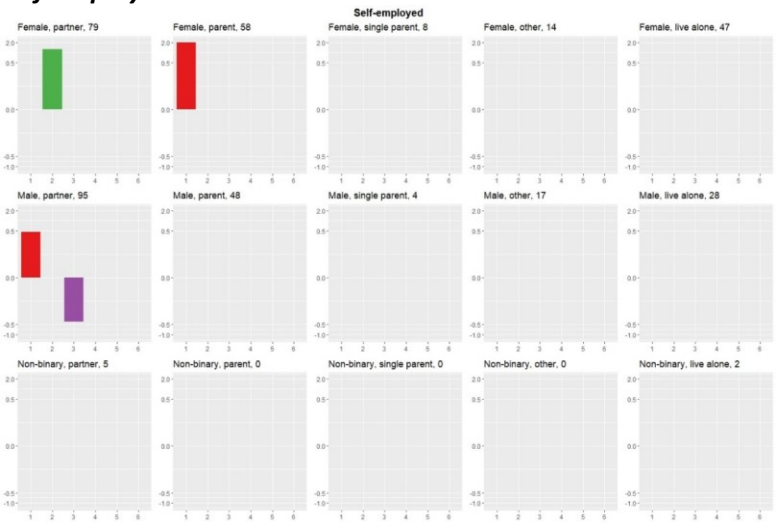

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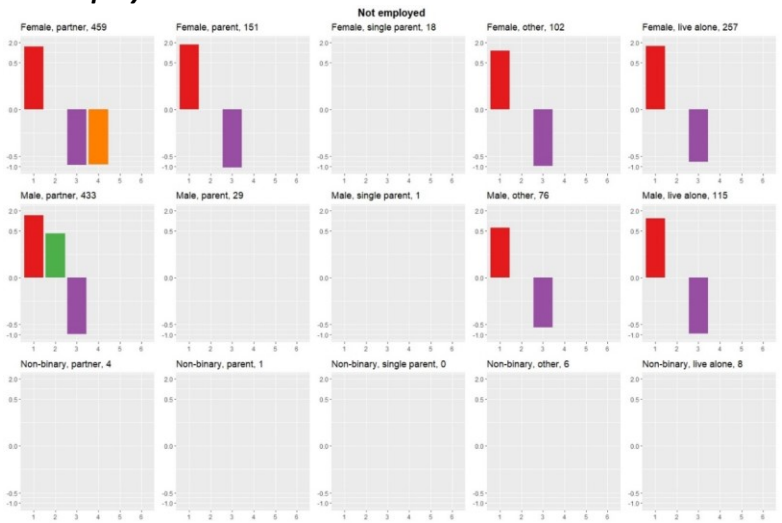
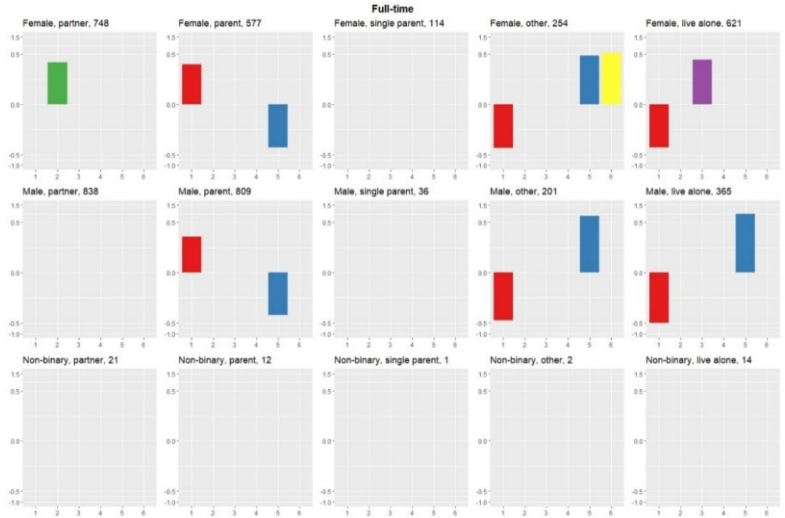
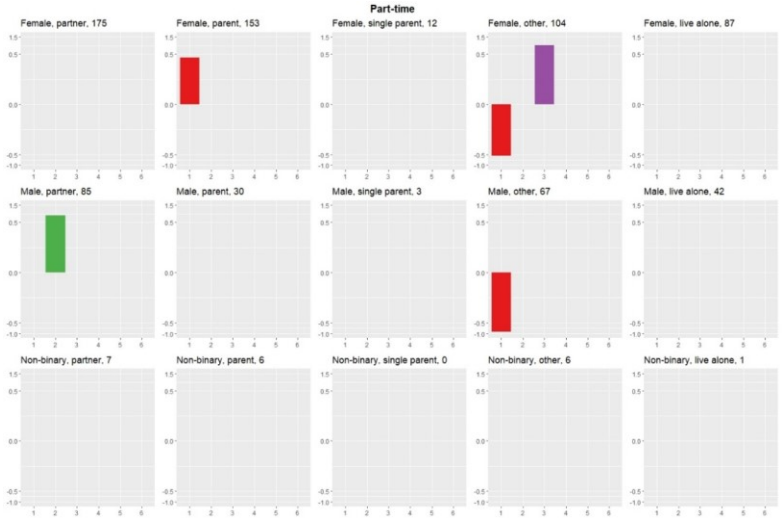


(e) Propositions for 6 patterns and 60 intersectionality groups (TBI, Saturday)

Full-time Employee



Part-time Employee



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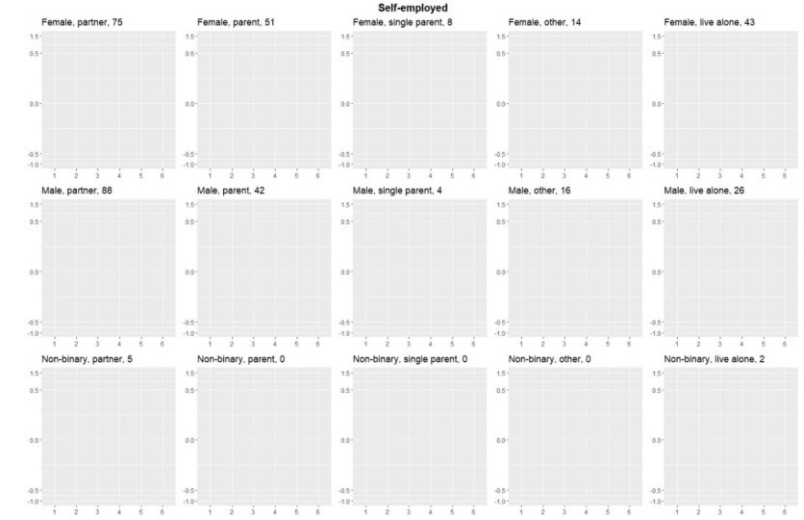

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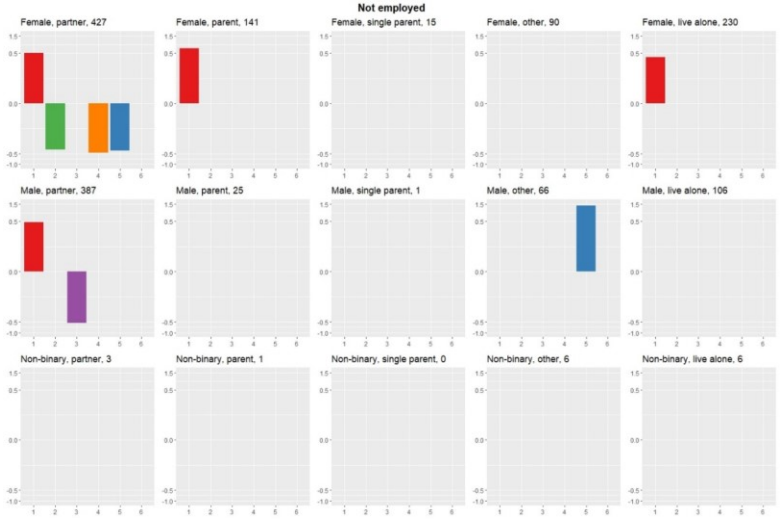
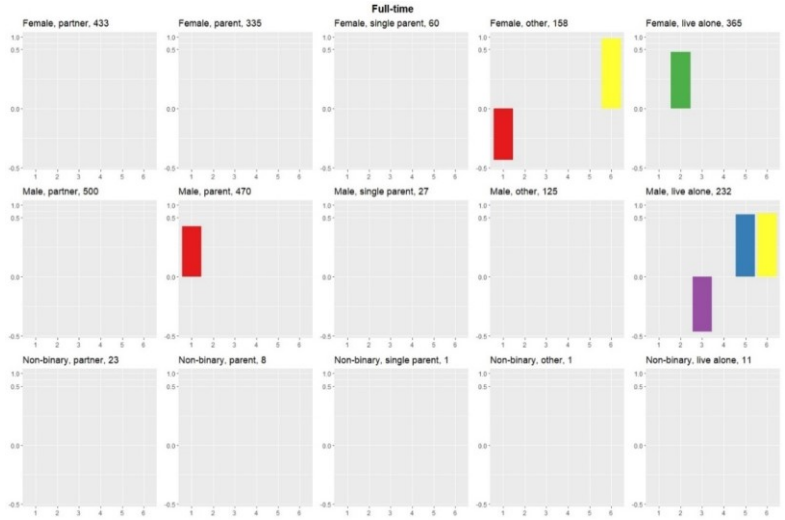


Travel Behavior Patterns

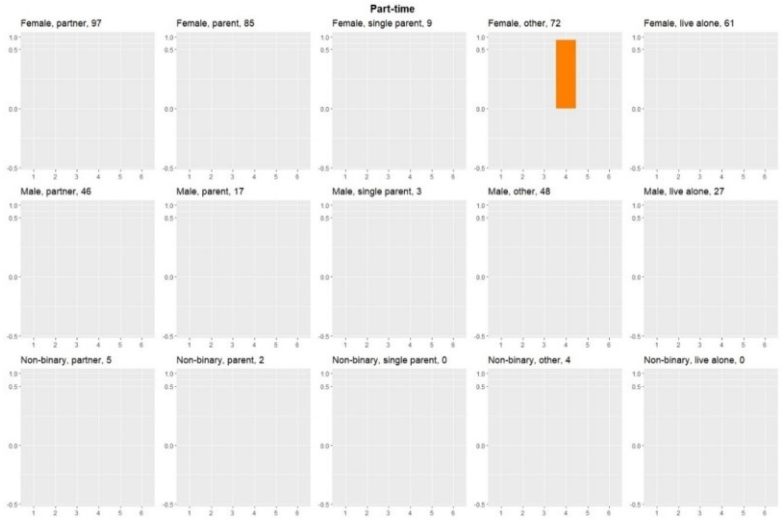
- 1 - Mostly Stay at Home
- 2 - Daytime OutHome
- 3 - Regular Working
- 4 - After-work OutHome
- 5 - Mostly OutHome (Household Supporting)
- 6 - Mostly OutHome (Non-Household Supporting)

(f) Propositions for 6 patterns and 60 intersectionality groups (TBI, Sunday)

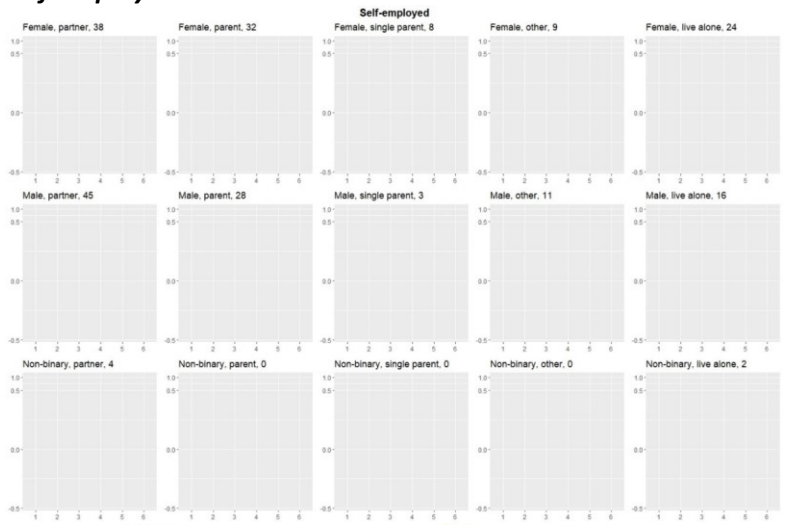
Full-time Employee



Part-time Employee



Self-Employed



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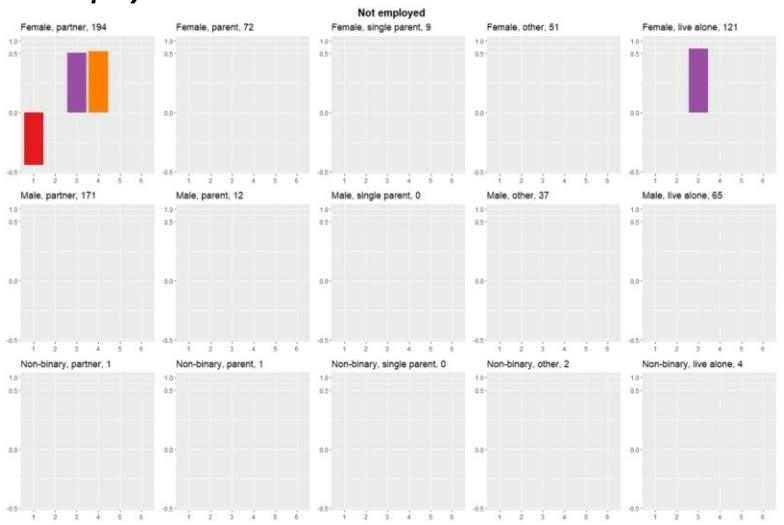


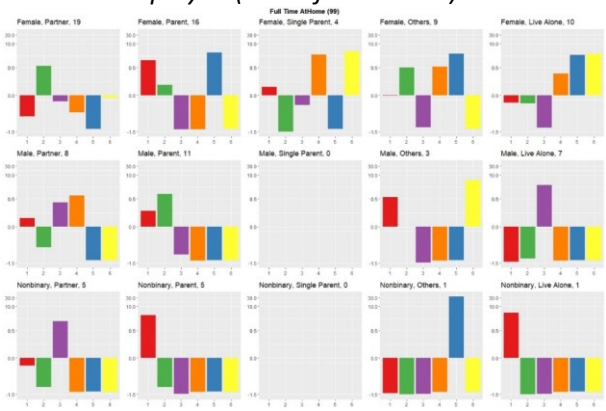
Travel Behavior Patterns

- 1 - Mostly Stay at Home
- 2 - Daytime OutHome
- 3 - Regular Working
- 4 - After-work OutHome
- 5 - Mostly OutHome (Household Supporting)
- 6 - Mostly OutHome (Non-Household Supporting)

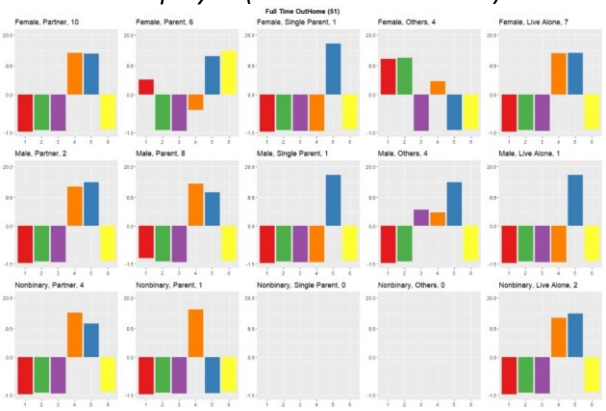
APPENDIX H
PROPOSITIONS FOR 6 PATTERNS AND 75 INTERSECTIONALITY GROUPS - DAYNAMICA DATA

(a) Propositions for 6 patterns and 75 intersectionality groups (Daynamica, Monday)

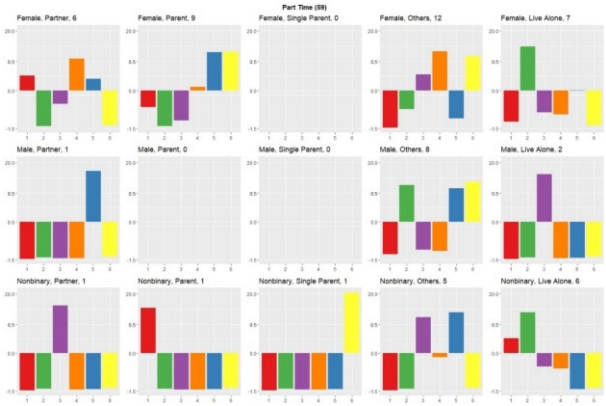
Full-time Employee (Work from Home)



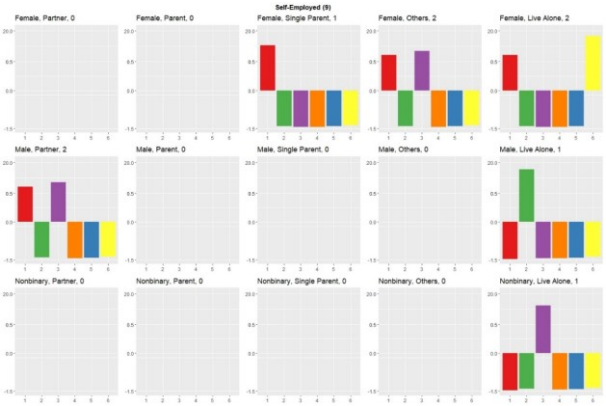
Full-time Employee (Work Outside Home)



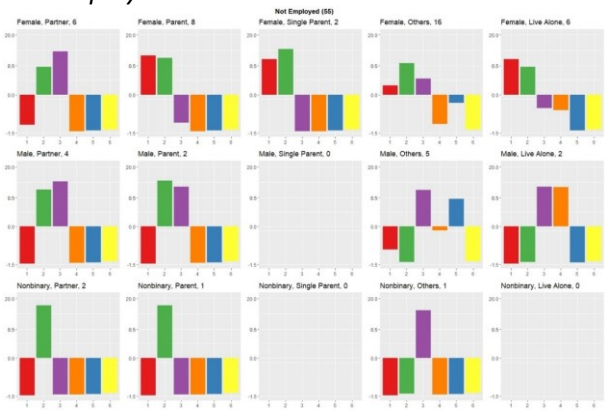
Part-time Employee



Self-Employed



Not Employed

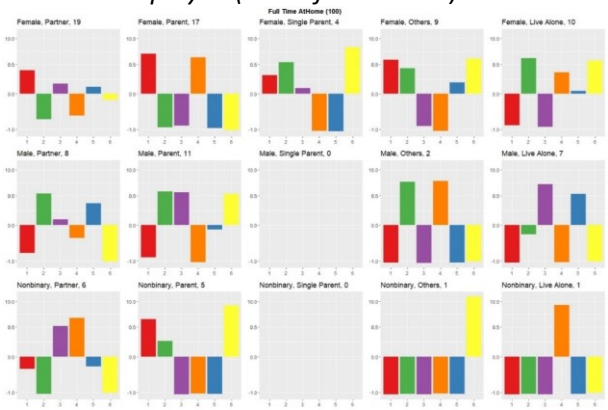


Travel Behavior Patterns

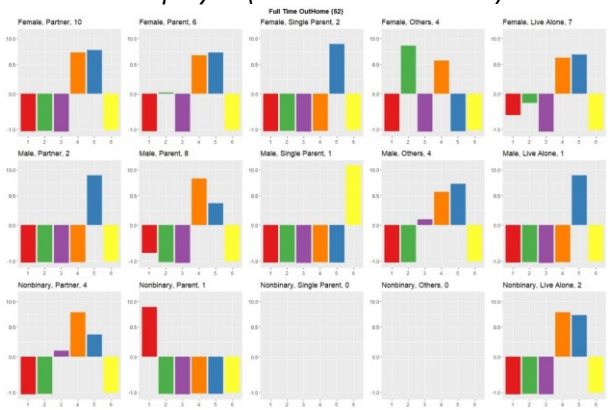
- 1 - Mostly At Home (Household Supporting)
- 2 - Mostly At Home (Household and Non-Household Supporting)
- 3 - Mostly At Home (Non-Household Supporting)
- 4 - Regular Working (Household Supporting at Home)
- 5 - Regular Working (Non-Household Supporting at Home)
- 6 - Mostly OutHome

(b) Propositions for 6 patterns and 75 intersectionality groups (Daynamica, Wednesday)

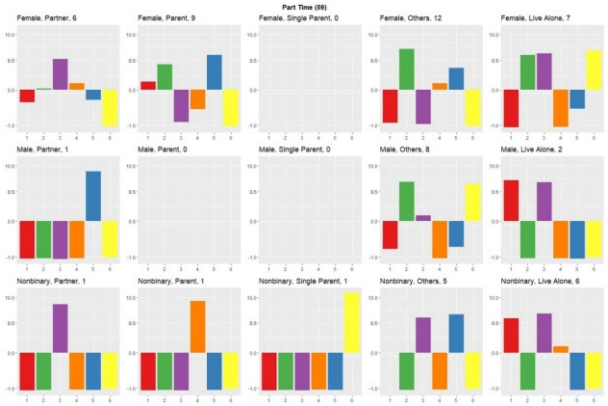
Full-time Employee (Work from Home)



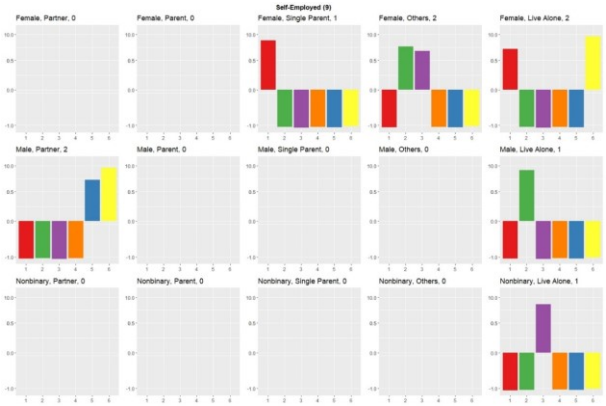
Full-time Employee (Work Outside Home)



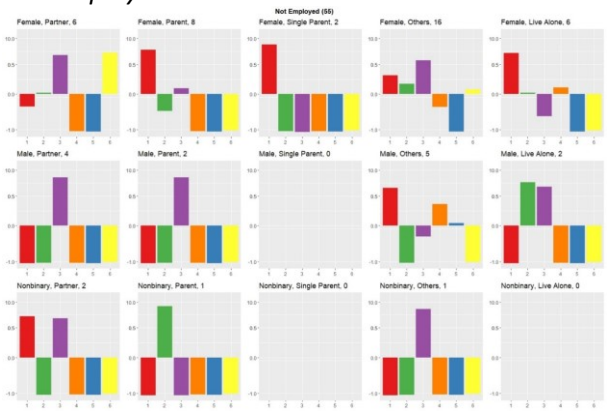
Part-time Employee



Self-Employed



Not Employed

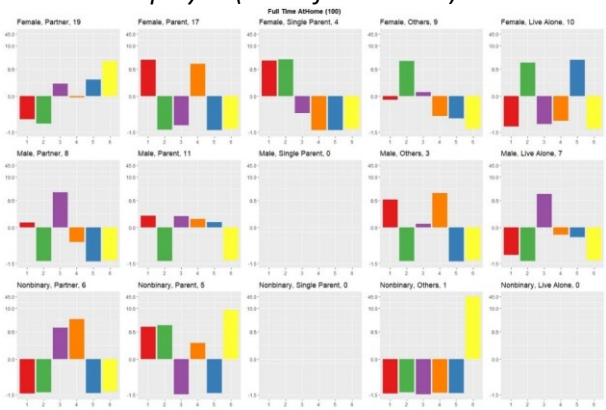


Travel Behavior Patterns

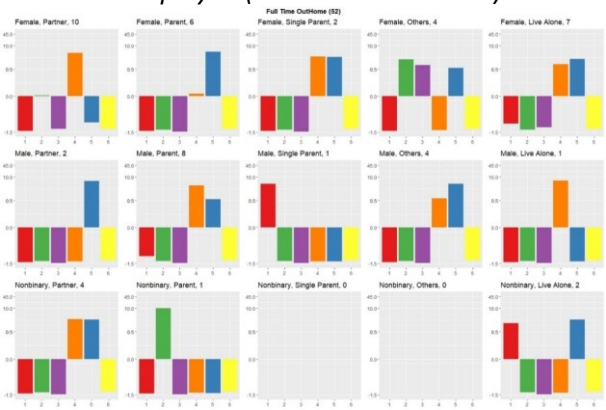
- 1 - Mostly At Home (Household Supporting)
- 2 - Mostly At Home (Household and Non-Household Supporting)
- 3 - Mostly At Home (Non-Household Supporting)
- 4 - Regular Working (Household Supporting at Home)
- 5 - Regular Working (Non-Household Supporting at Home)
- 6 - Mostly OutHome

(c) Propositions for 6 patterns and 75 intersectionality groups (Daynamica, Thursday)

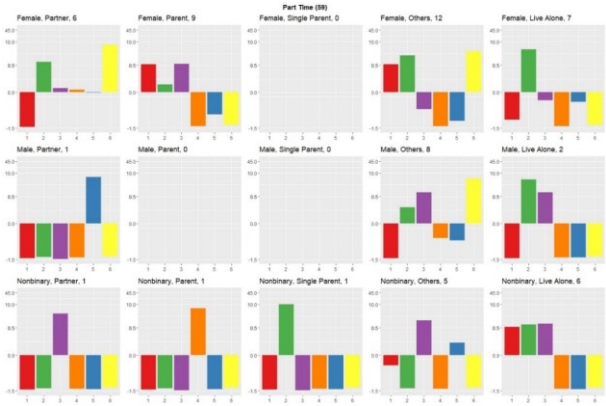
Full-time Employee (Work from Home)



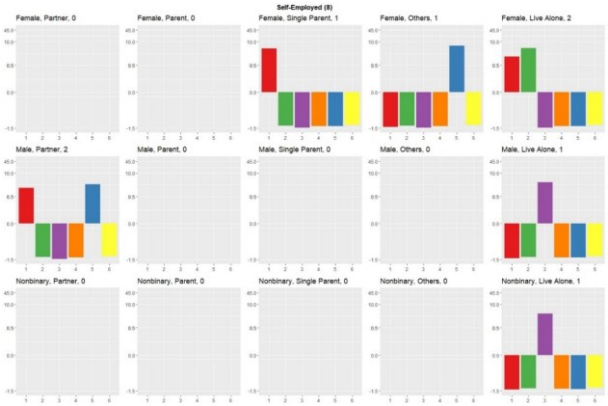
Full-time Employee (Work Outside Home)



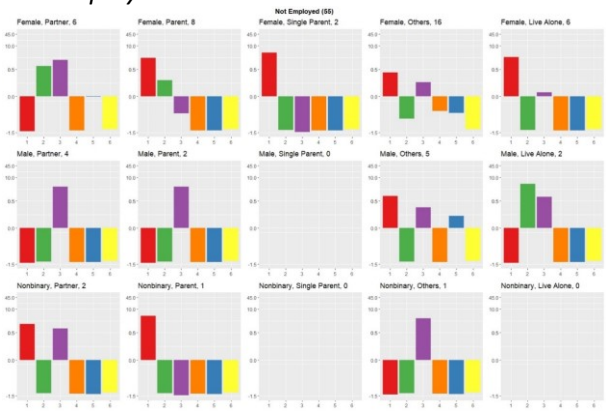
Part-time Employee



Self-Employed



Not Employed

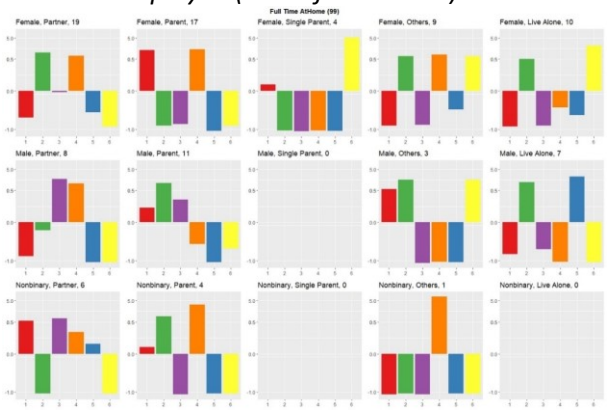


Travel Behavior Patterns

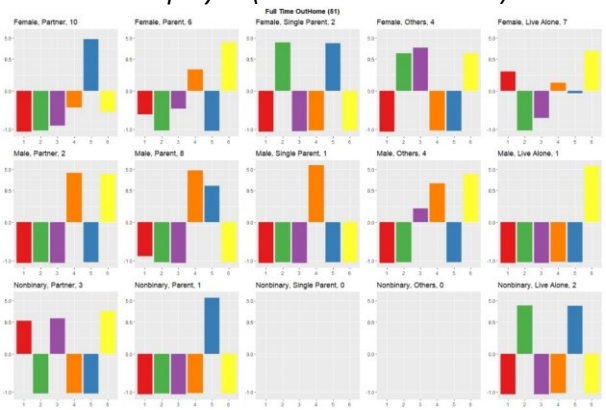
- 1 - Mostly At Home (Household Supporting)
- 2 - Mostly At Home (Household and Non-Household Supporting)
- 3 - Mostly At Home (Non-Household Supporting)
- 4 - Regular Working (Household Supporting at Home)
- 5 - Regular Working (Non-Household Supporting at Home)
- 6 - Mostly OutHome

(d) Propositions for 6 patterns and 75 intersectionality groups (Daynamica, Friday)

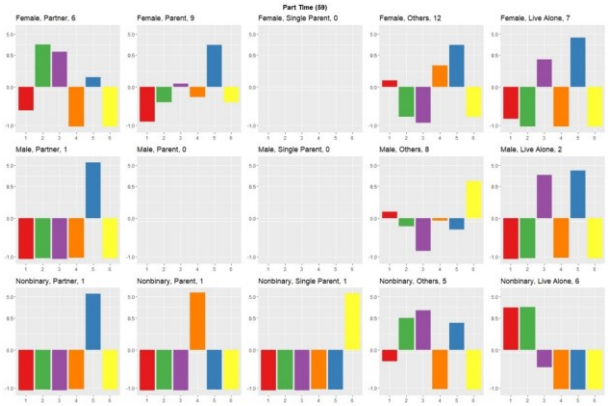
Full-time Employee (Work from Home)



Full-time Employee (Work Outside Home)



Part-time Employee



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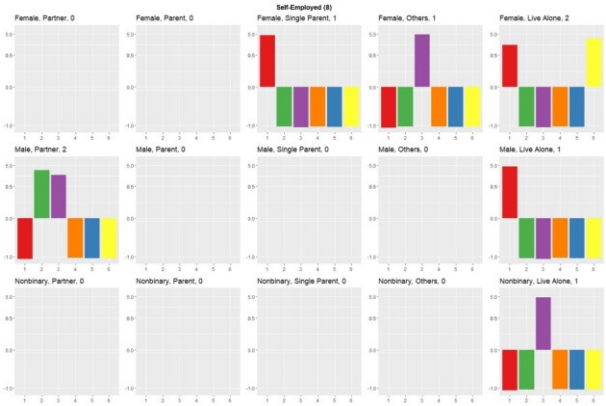

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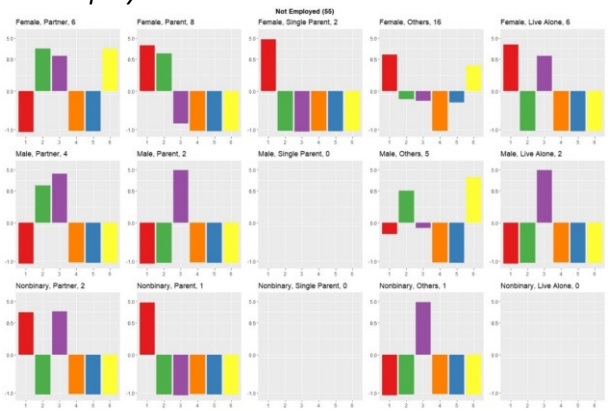
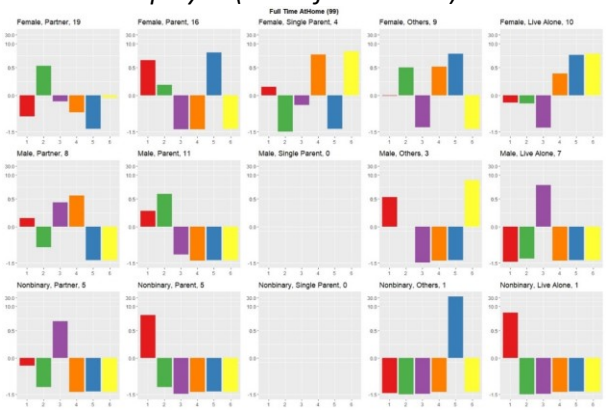


Travel Behavior Patterns

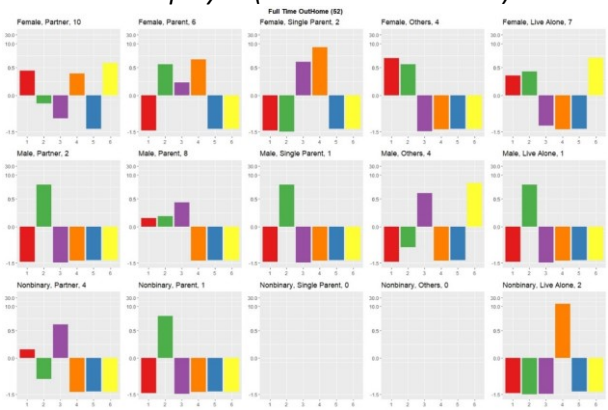
- 1 - Mostly At Home (Household Supporting)
- 2 - Mostly At Home (Household and Non-Household Supporting)
- 3 - Mostly At Home (Non-Household Supporting)
- 4 - Regular Working (Household Supporting at Home)
- 5 - Regular Working (Non-Household Supporting at Home)
- 6 - Mostly OutHome

(e) Propositions for 6 patterns and 75 intersectionality groups (Daynamica, Saturday)

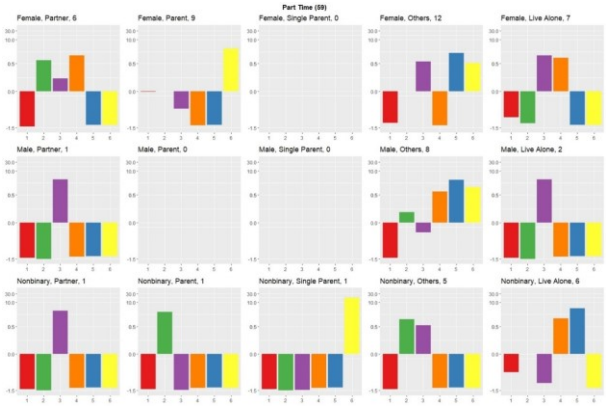
Full-time Employee (Work from Home)



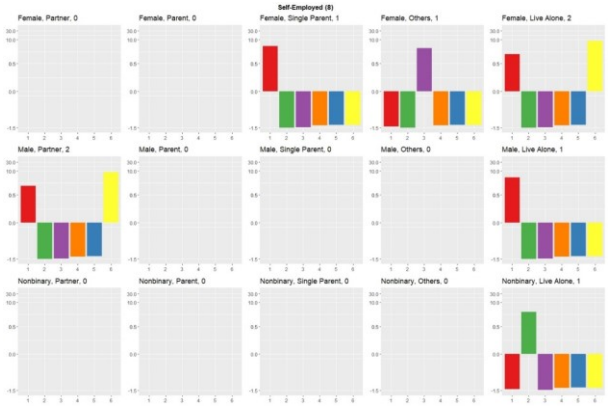
Full-time Employee (Work Outside Home)



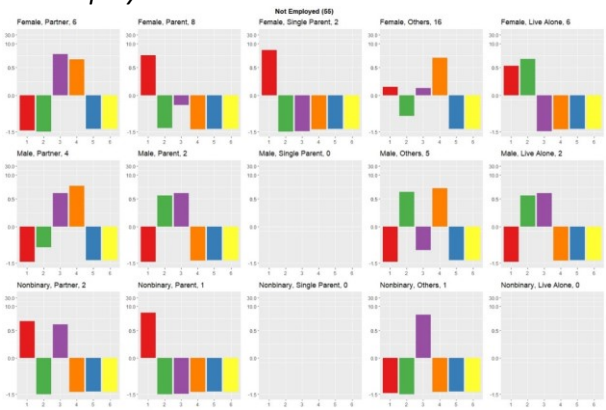
Part-time Employee



Self-Employed



Not Employed

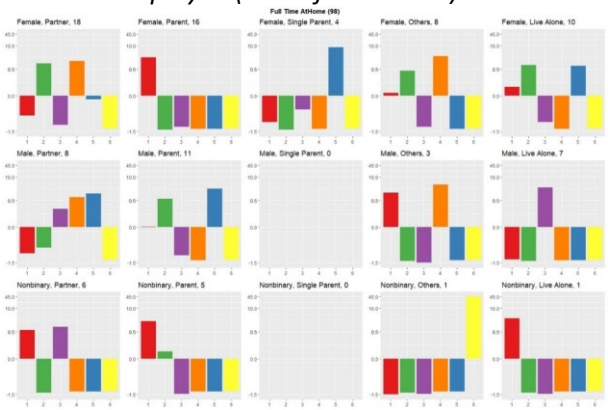


Travel Behavior Patterns

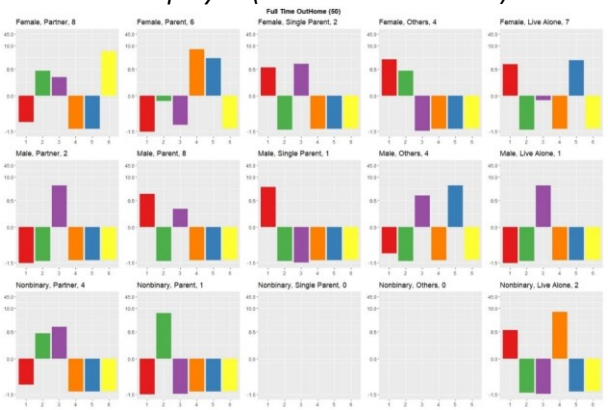
- 1 - Mostly At Home (Household Supporting)
- 2 - Mostly At Home (Household and Non-Household Supporting)
- 3 - Mostly At Home (Non-Household Supporting)
- 4 - Regular Working (Household Supporting at Home)
- 5 - Regular Working (Non-Household Supporting at Home)
- 6 - Mostly OutHome

(f) Propositions for 6 patterns and 75 intersectionality groups (Daynamica, Sunday)

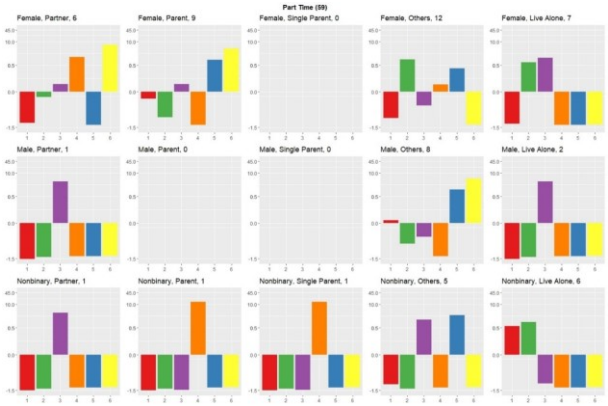
Full-time Employee (Work from Home)



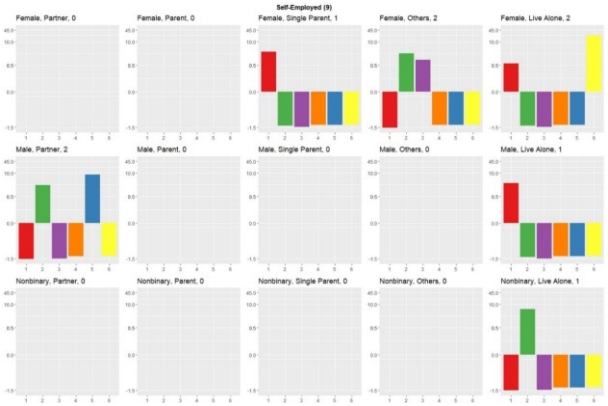
Full-time Employee (Work Outside Home)



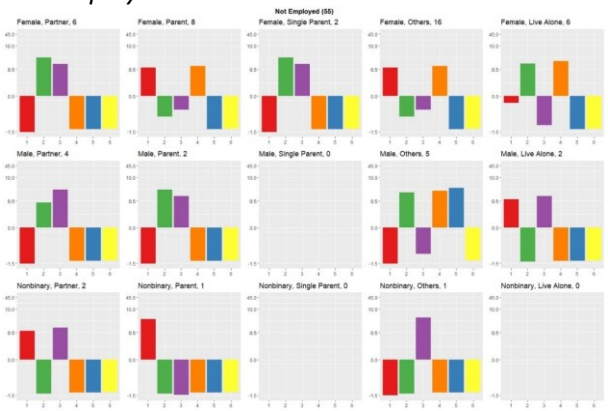
Part-time Employee



Self-Employed



Not Employed

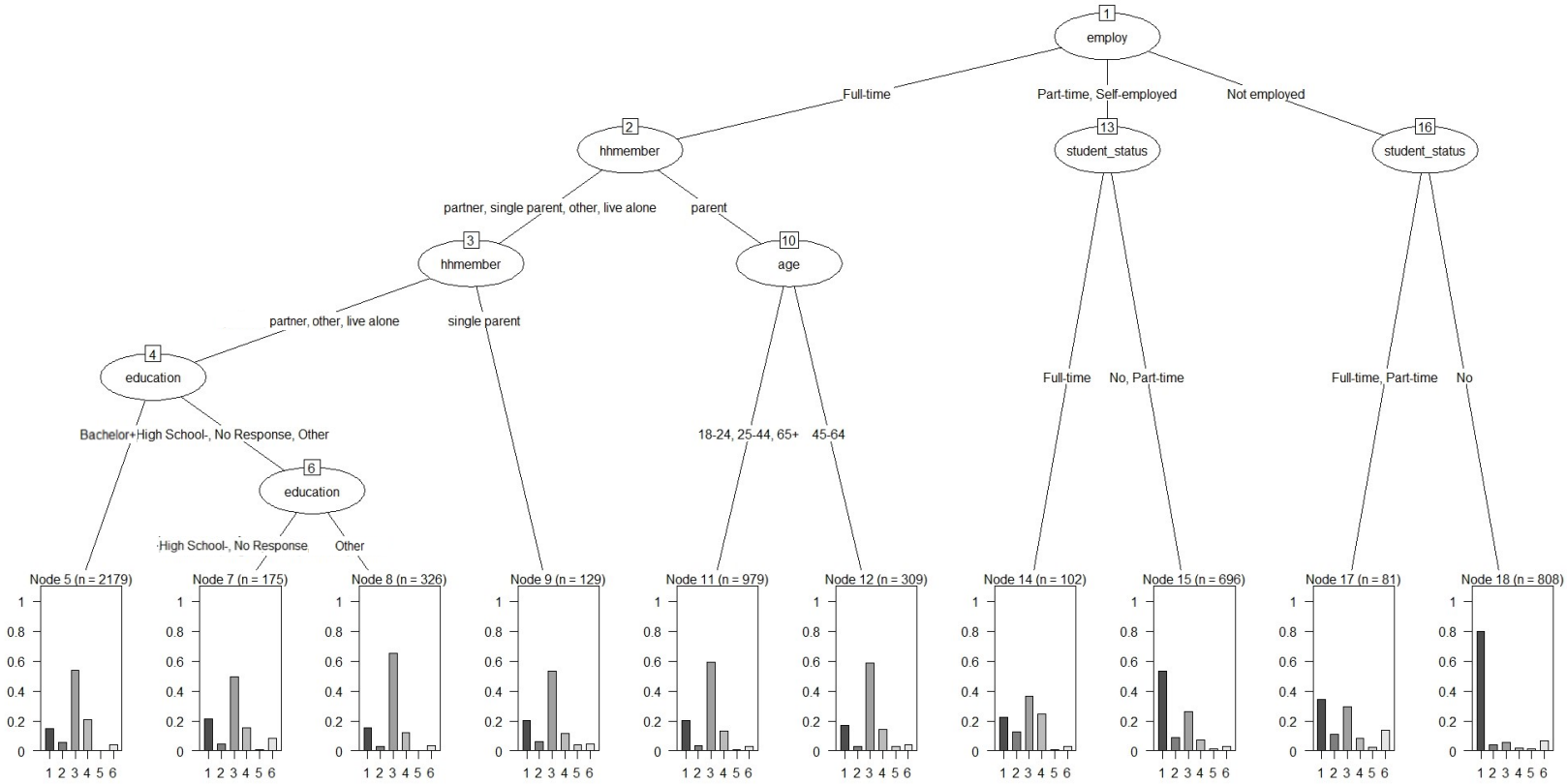


Travel Behavior Patterns

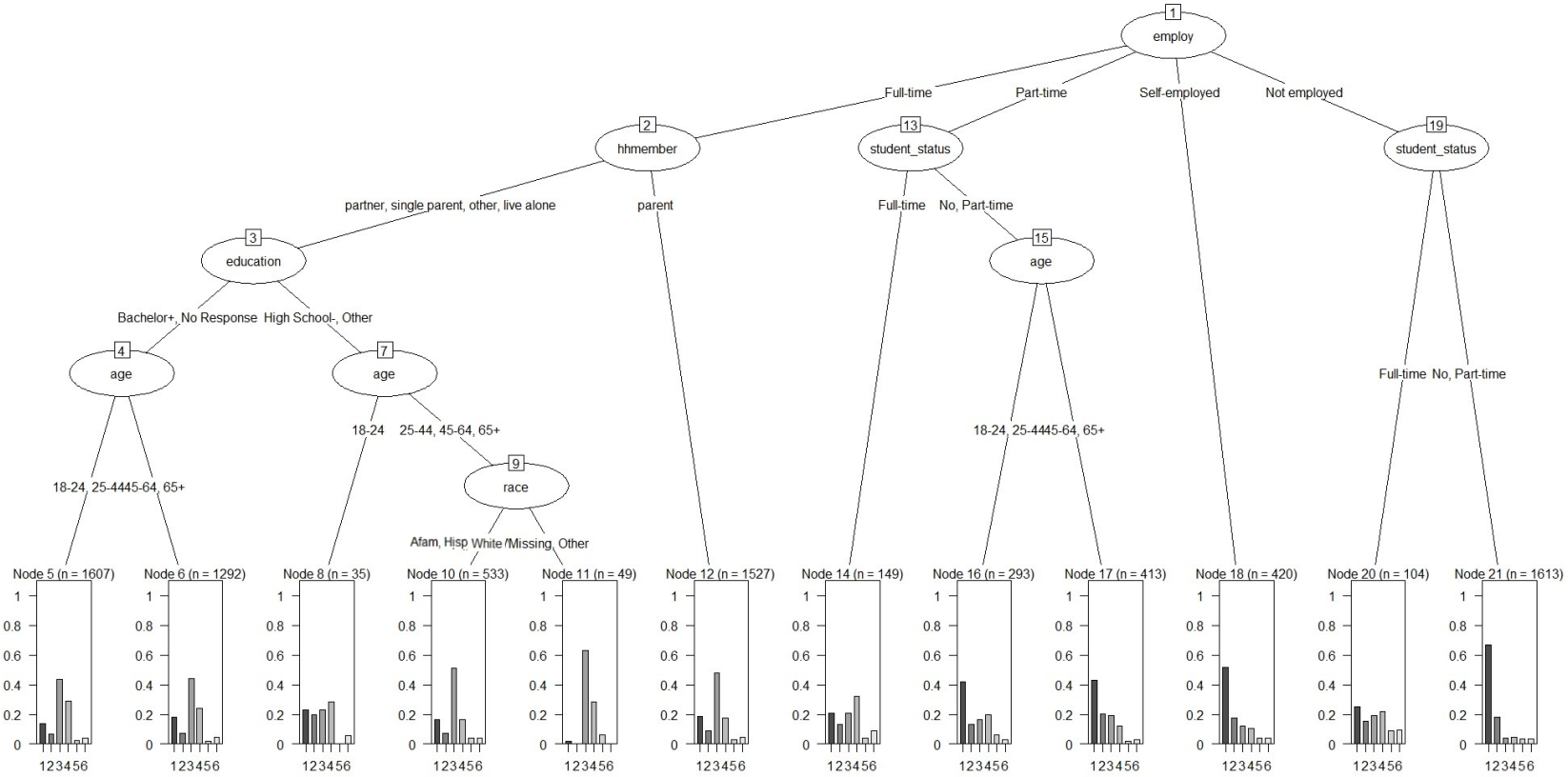
- 1 - Mostly At Home (Household Supporting)
- 2 - Mostly At Home (Household and Non-Household Supporting)
- 3 - Mostly At Home (Non-Household Supporting)
- 4 - Regular Working (Household Supporting at Home)
- 5 - Regular Working (Non-Household Supporting at Home)
- 6 - Mostly OutHome

APPENDIX I
CHI-SQUARE AUTOMATIC INTERACTION DETECTION (CHAID) DETECTION OF INTERSECTIONALITY GROUPS - TBI DATA

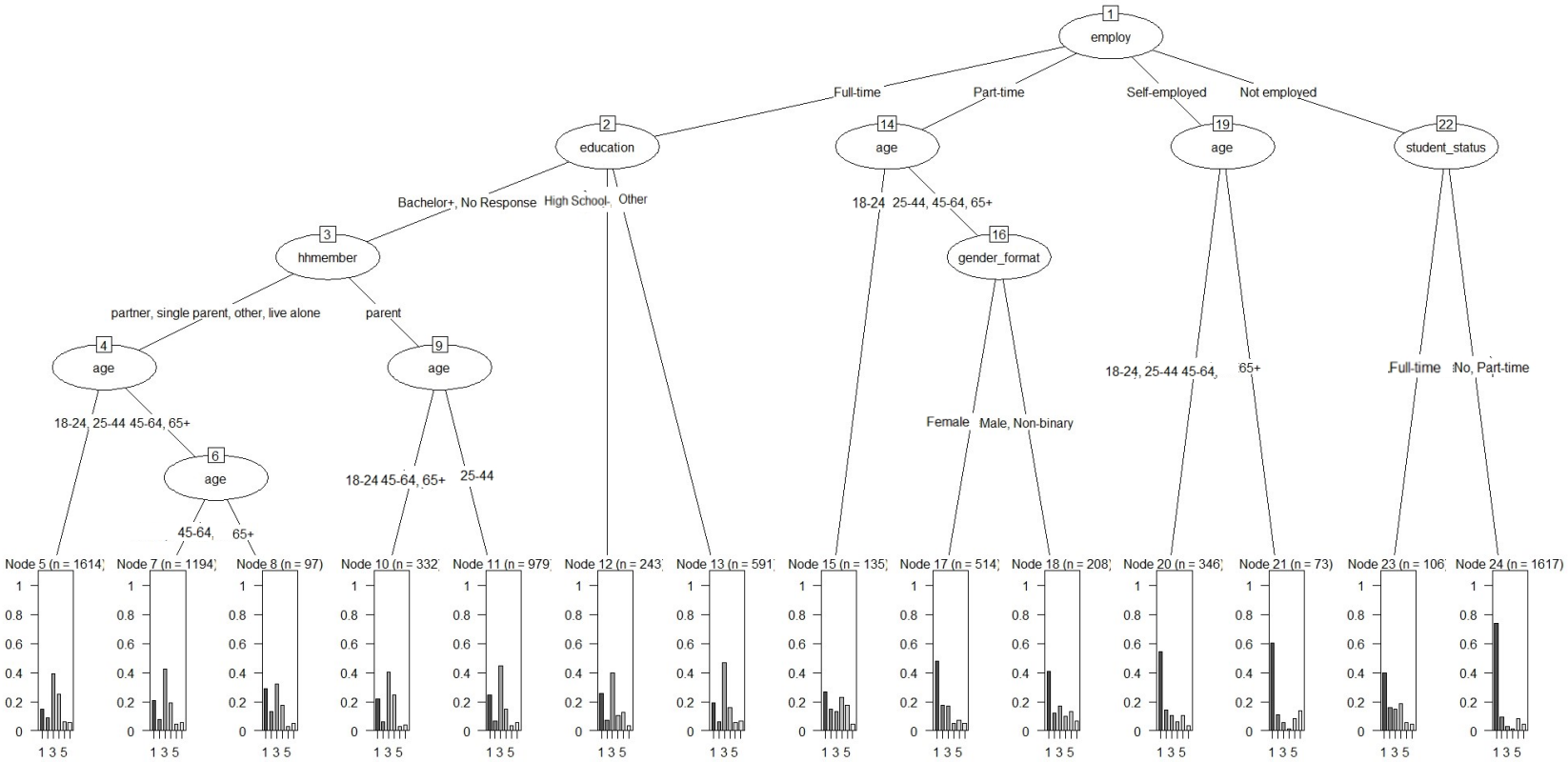
(a) Intersectional groups generated by CHAID (TBI Monday)



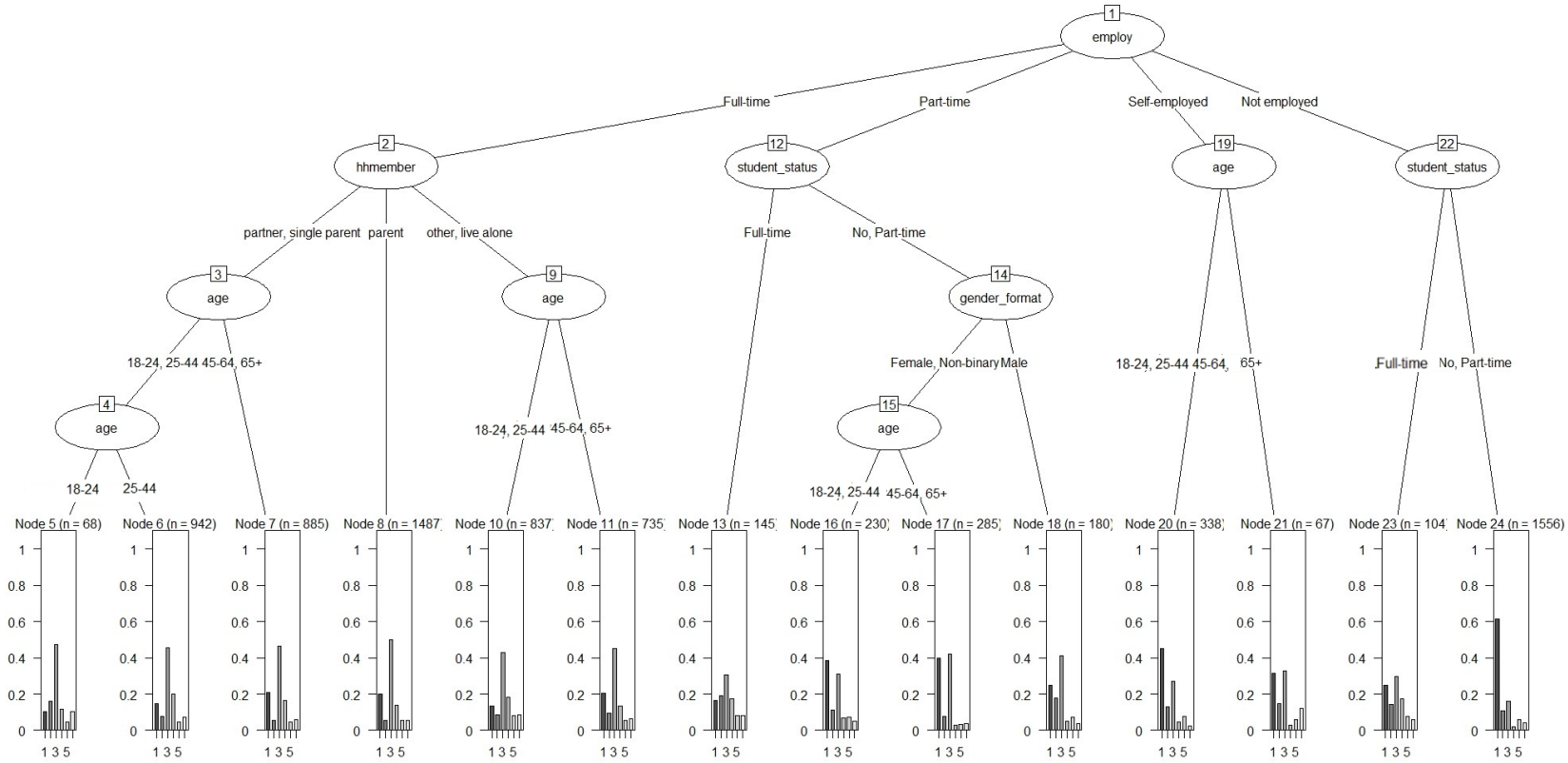
(b) Intersectional groups generated by CHAID (TBI, Wednesday)



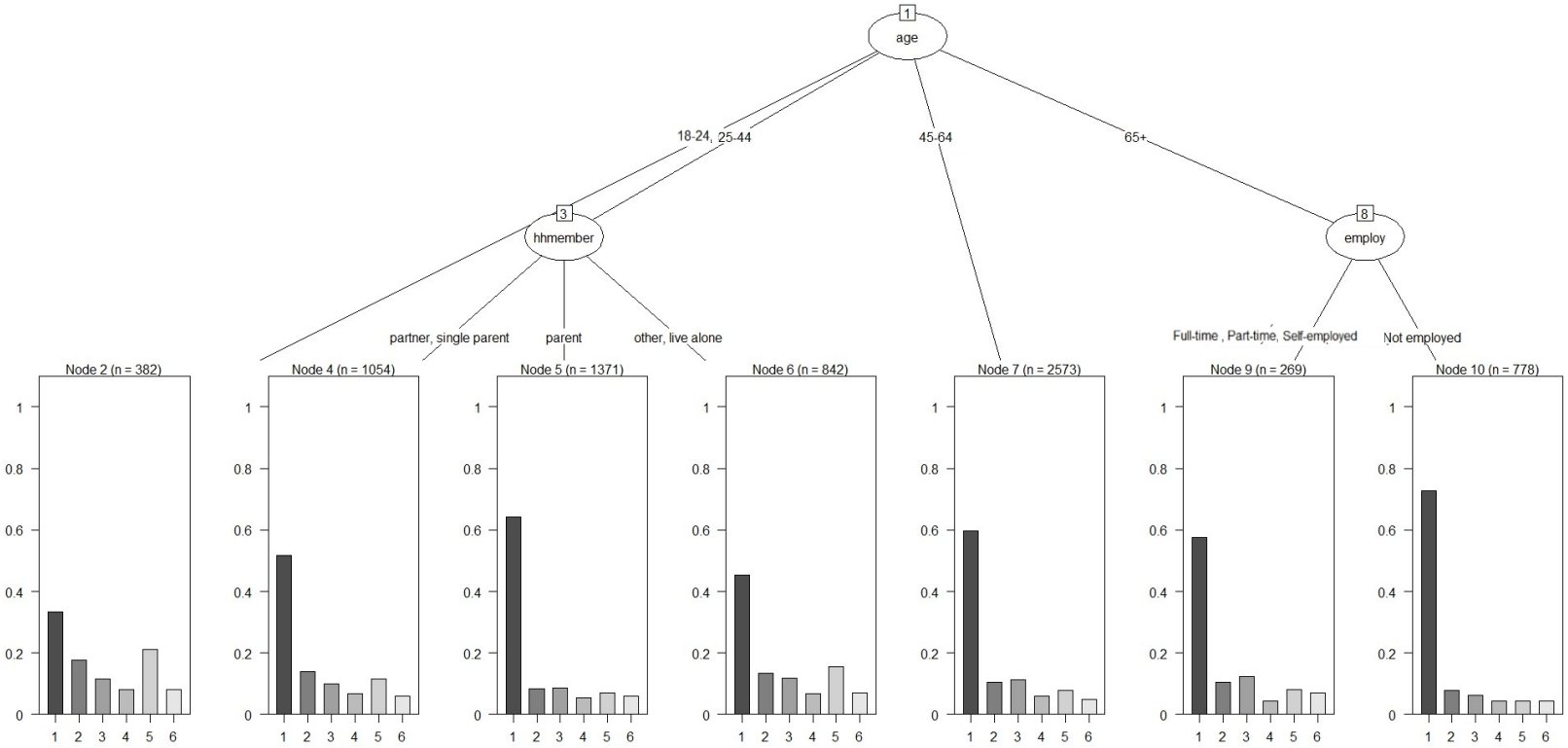
(c) Intersectional groups generated by CHAID (TBI, Thursday)



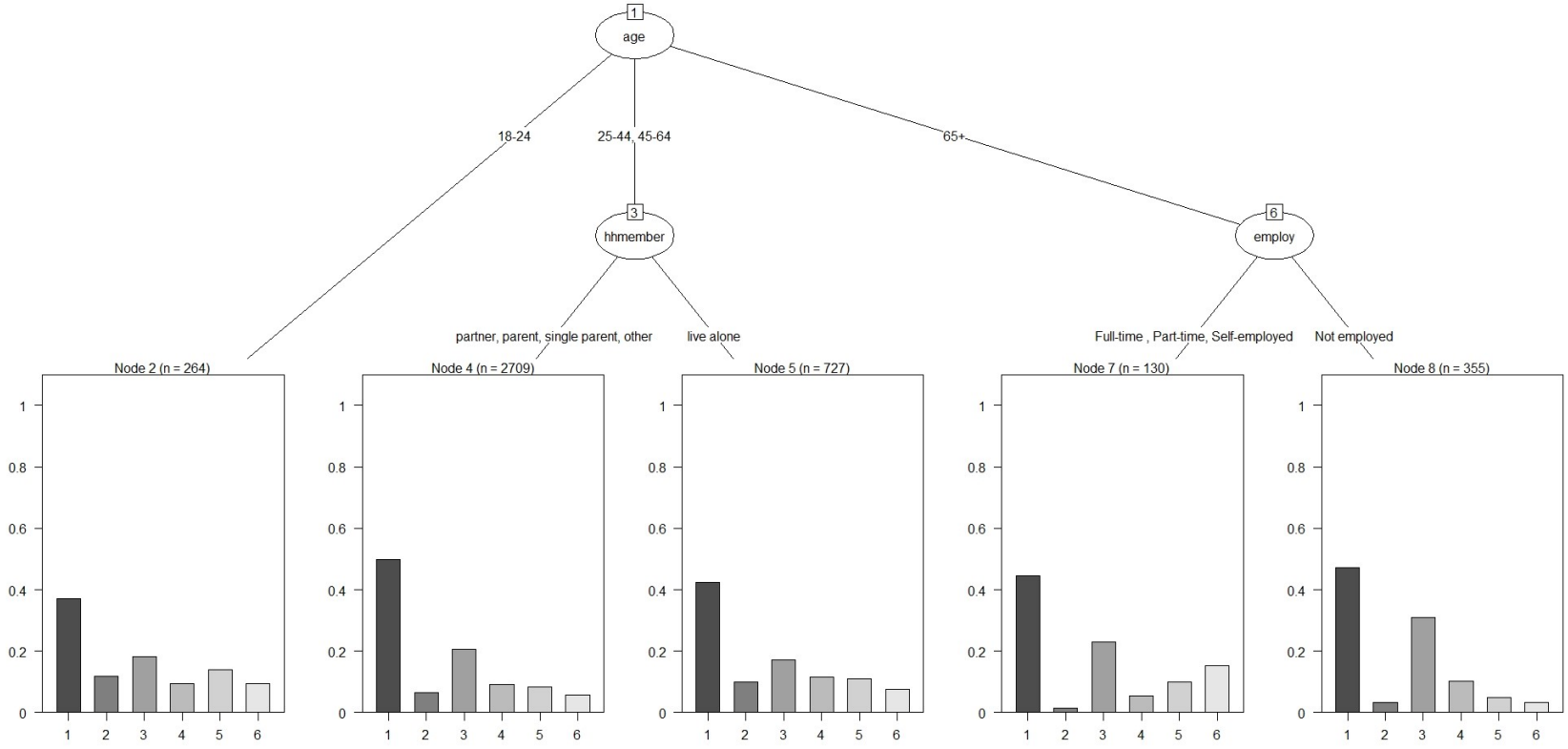
(d) Intersectional groups generated by CHAID (TBI, Friday)



(e) Intersectional groups generated by CHAID (TBI, Saturday)

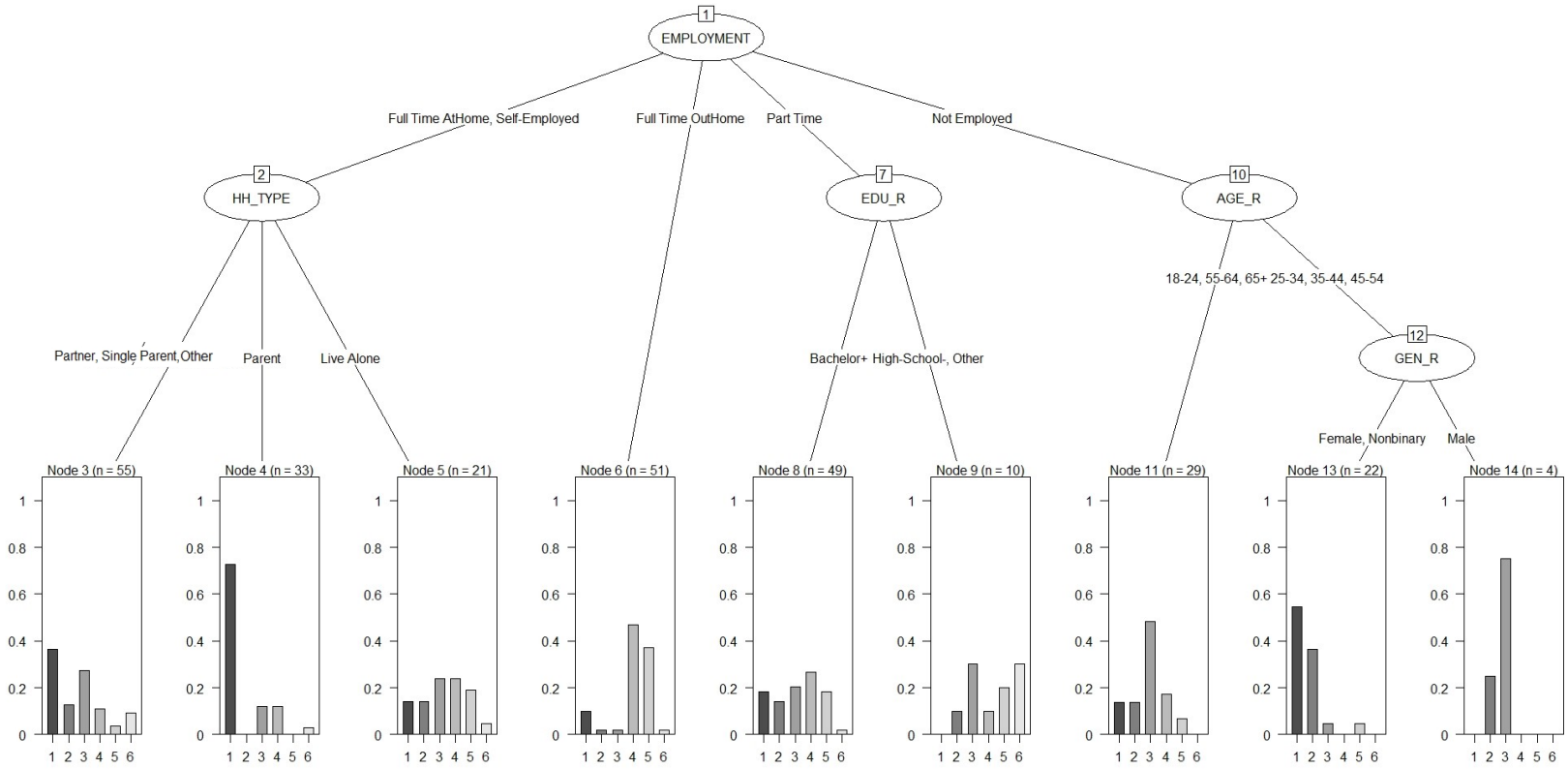


(f) Intersectional groups generated by CHAID (TBI, Sunday)



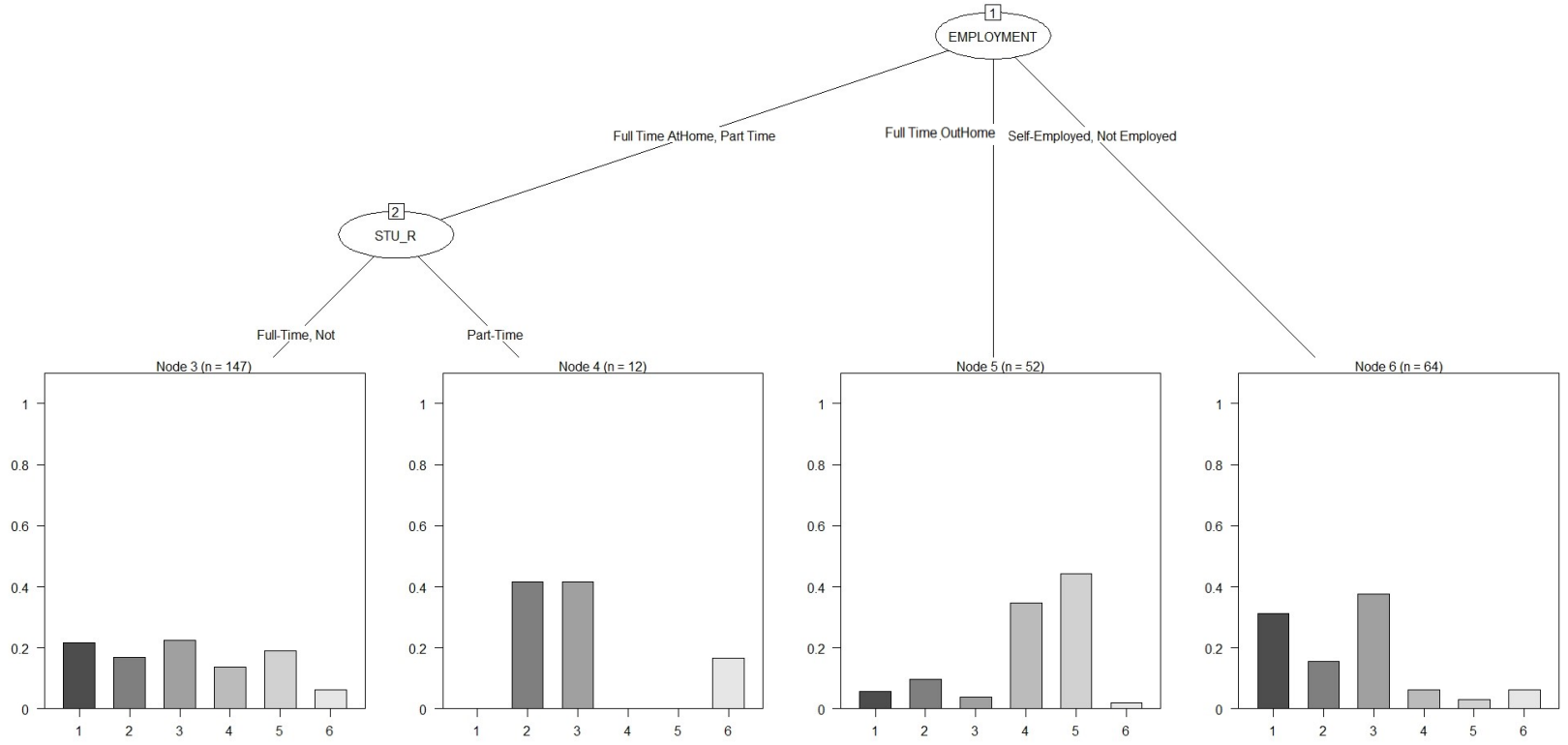
APPENDIX J
CHI-SQUARE AUTOMATIC INTERACTION DETECTION (CHAID) OF INTERSECTIONALITY GROUPS - DAYNAMICA DATA

(a) Intersectional groups generated by CHAID (Daynamica, 2nd Metric, Monday)



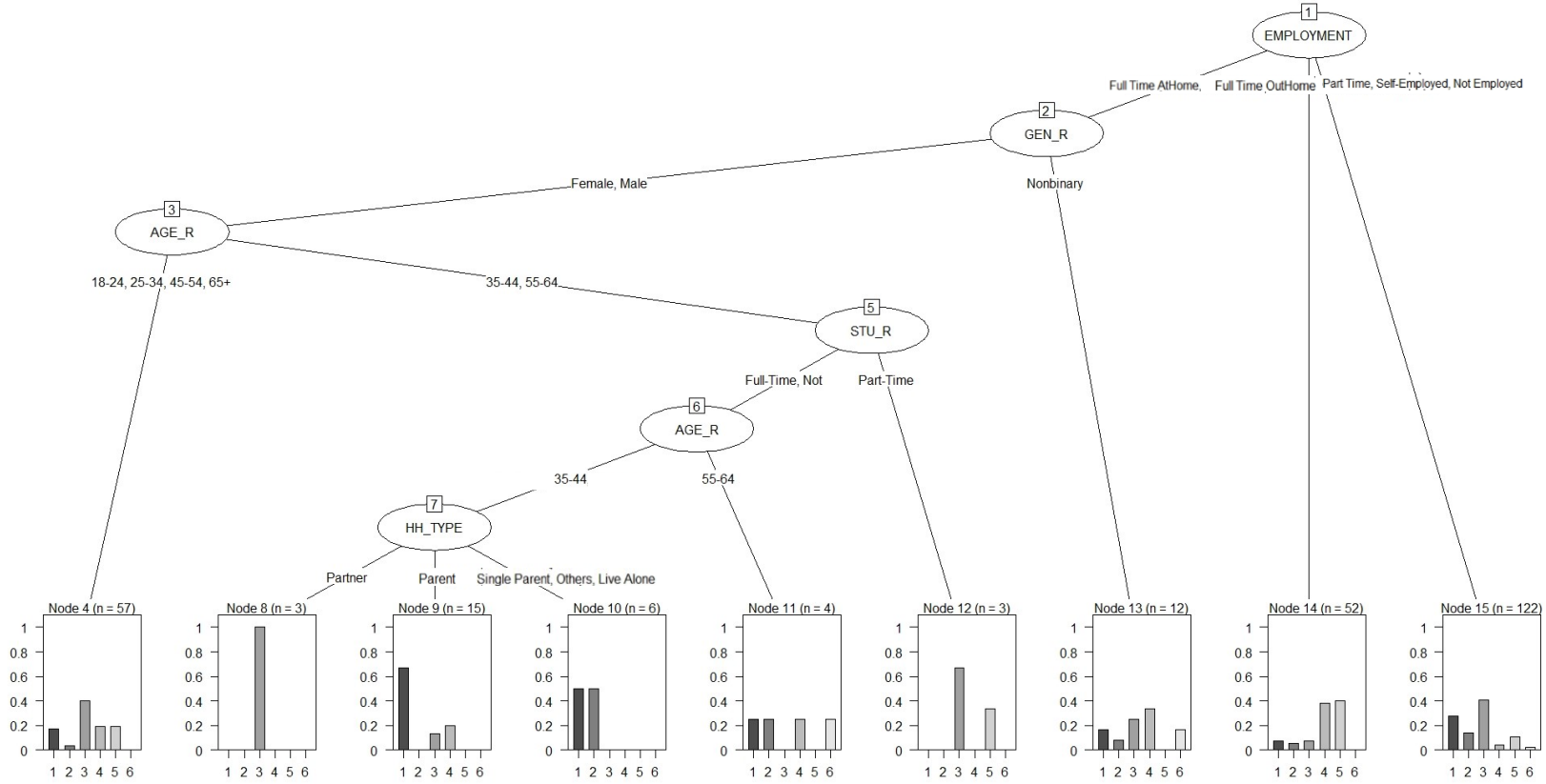
Note: abbreviations of each parameter and it corresponding attribute: (1) EMPLOYMENT: employment status; (2) HH_TYPE: household types; (3) EDU_R: education attainment; (4) GEN_R: self-identified gender.

(b) Intersectional groups generated by CHAID (Daynamica, 2nd Metric, Wednesday)



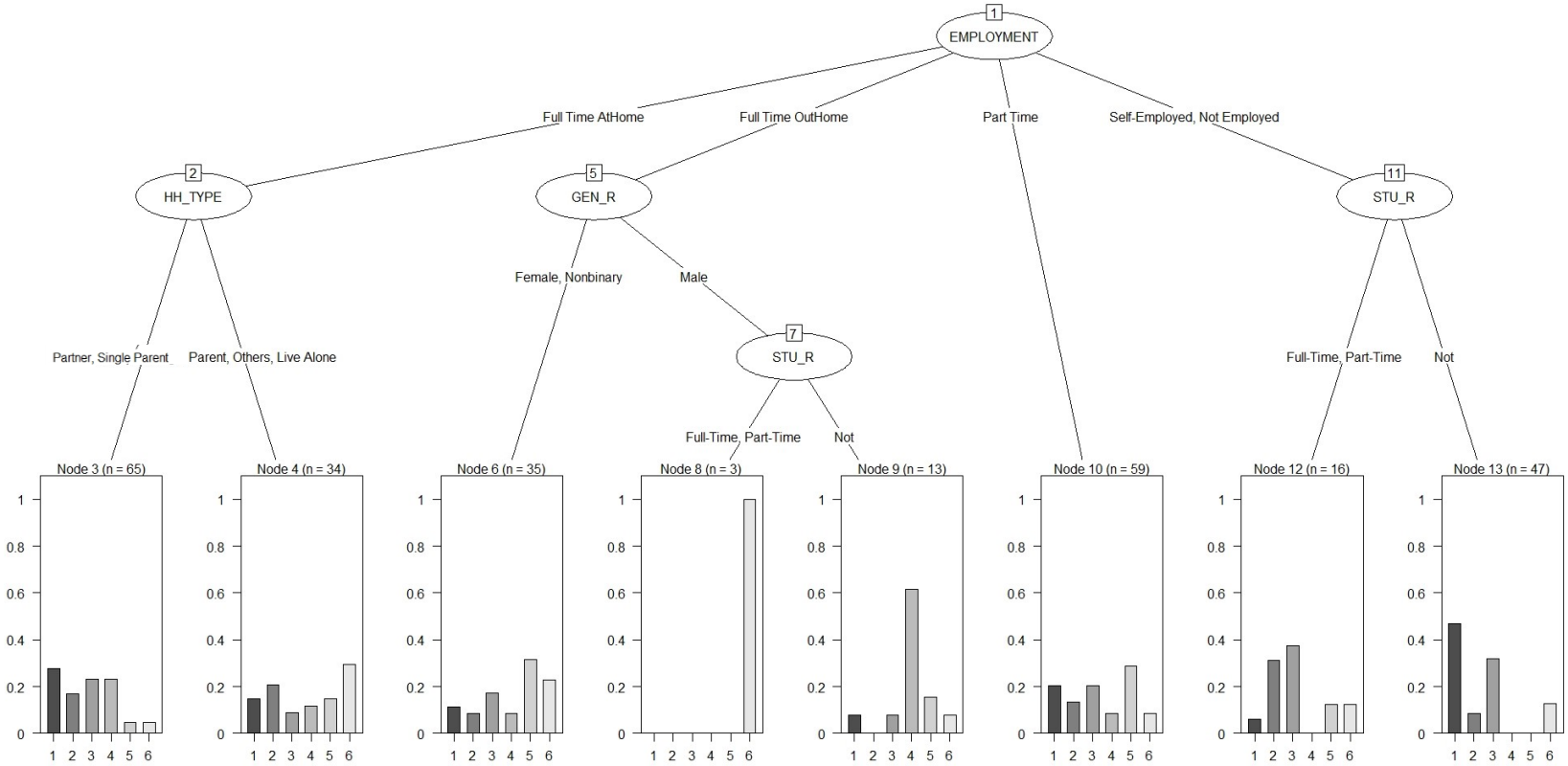
Note: abbreviations of each parameter and it corresponding attribute: (1) EMPLOYMENT: employment status; and (2) STU_R: student status.

(c) Intersectional groups generated by CHAID (Daynamica, 2nd Metric, Thursday)



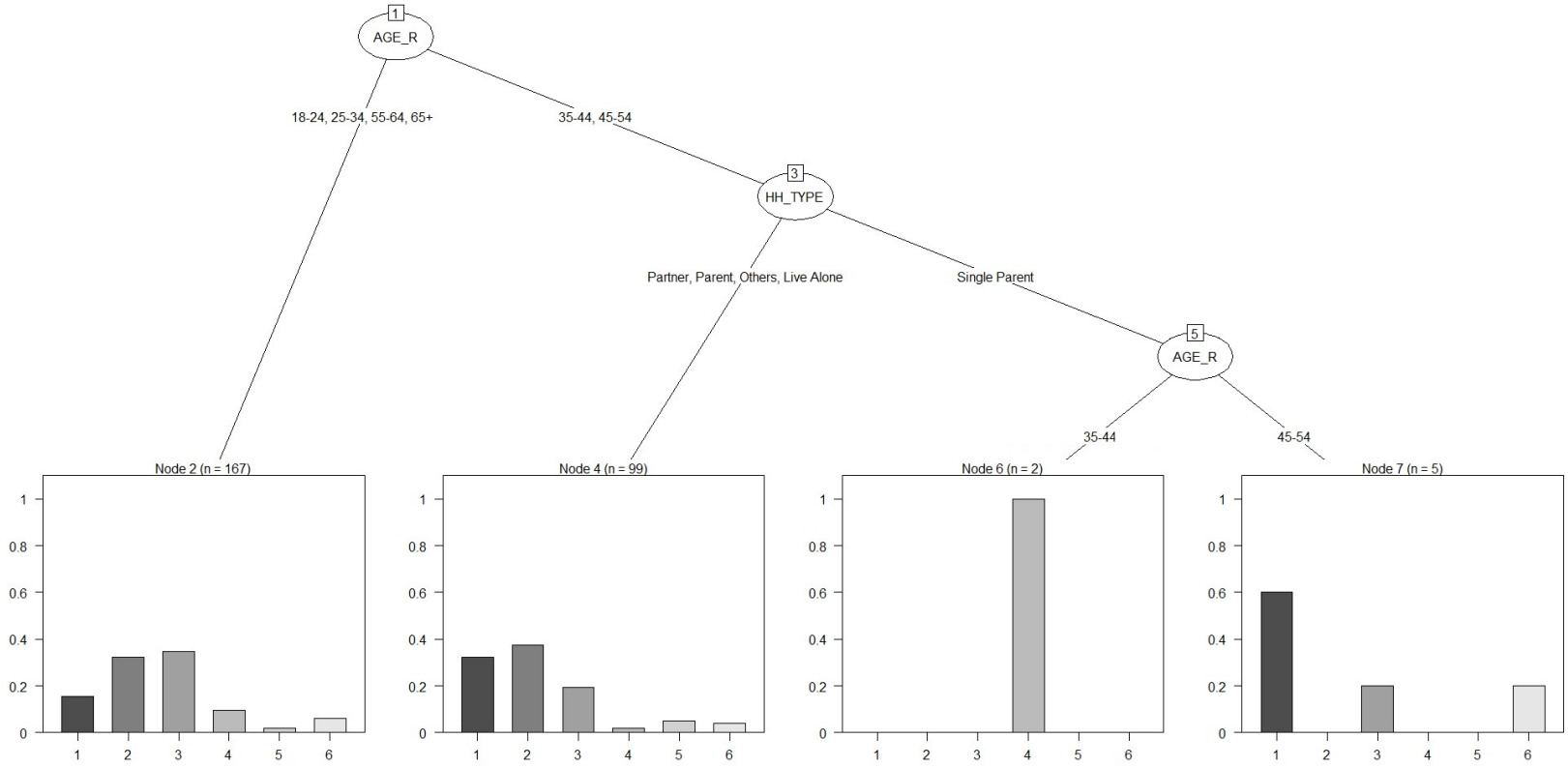
Note: abbreviations of each parameter and it corresponding attribute: (1) EMPLOYMENT: employment status; (2) GEN_R: self-identified gender; (3) AGE_R: age groups; (4) STU_R: student status; (5) AGE_R: age; and (6) HH_TYPE: household types.

(d) Intersectional groups generated by CHAID (Daynamica, 2nd Metric, Friday)



Note: abbreviations of each parameter and it corresponding attribute: (1) EMPLOYMENT: employment status; (2) HH_TYPE: household types; (3) GEN_R: self-identified gender; and (4) STU_R: student status.

(e) Intersectional groups generated by CHAID (Daynamica, 2nd Metric, Saturday)



Note: abbreviations of each parameter and it corresponding attribute: (1) AGE_R: age groups; (2) HH_TYPE: household types; and (3) AGE_R: age groups.