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RESEARCH ON PRODUCTS AND DEVICES

Off to the park: a geospatial investigation of adapted ride-on car usage

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ABSTRACT

Purpose: Adapted ride-on cars (ROC) are an affordable, power mobility training tool for young children with disabilities. Previous qualitative research has identified environmental factors, such as weather and adequate drive space, as barriers to families' adoption of their ROC. However, we do not currently know the relationship between the built environment and ROC usage.
Materials and Methods: In our current study, we quantified the driving patterns of 14 children (2.5 ± 1.45 years old, 8 male: 6 female) using ROCs outside and inside of their homes over the course of a year using a custom datalogger and geospatial data. To measure environmental accessibility, we used the *AccessScore* from Project Sidewalk, an open-source accessibility mapping initiative, and the Walk Score, a measure of neighborhood pedestrian-friendliness.
Results: The number of play sessions with the ROC ranged from 1 to 76; 4 participants used it less than 10 times and 4 participants used it more than 50 times. Our findings indicate that more play sessions took place indoors, within the participants' homes. However, when the ROC was used outside the home, children engaged in longer play sessions, actively drove for a larger portion of the session, and covered greater distances. Most children tended to drive their ROCs in close proximity to their homes, with an average maximum distance from home of 181 meters. Most notably, we found that children drove more in pedestrian-friendly neighborhoods and when in proximity to accessible paths.
Conclusions: The accessibility of the built environment is paramount when providing any form of mobility device to a child. Providing an accessible place for a child to move, play, and explore is critical in helping a child and family adopt the mobility device into their daily life.

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➤ IMPLICATIONS FOR REHABILITATION: GPS OF ROC USAGE

1. Ride-on cars provided a novel means for young children with disabilities to explore their home and community environments.
2. Children drove their adapted ride-on cars for longer periods of time outside than inside, and in close proximity to their homes.
3. The identification of an accessible route increased driving frequency and drive session duration. Recommending accessible routes and play locations where families can use their adapted ride-on car may be an important aspect of increasing mobility technology use.
4. Because there were a higher number of play sessions inside, it is important to consider indoor accessibility when designing and implementing mobility technology for young children.

Introduction

A child engages with their surroundings by looking, touching, and exploring. The toddler years are typically known as a time of exploration, curiosity, and even troublemaking, as children learn about themselves and their environments. Mobility is not only a key attribute of this exploration, but also a fundamental aspect of identity development and a human right [1]. As such, On-Time mobility should be encouraged for every child in the manner that supports their exploration [1–3]. Powered mobility is a valuable option for children with disabilities, as it allows them to determine their own path, unlike a stroller or being carried by caregivers, which are typical forms of mobility for nonambulatory children. Research has shown that early power mobility device usage does not interfere with developmental skill acquisition and may actually benefit skill acquisition [1, 4, 5]. Adapted ride-on cars (ROCs) are a popular power mobility device for children with disabilities, as they are affordable, aesthetically appealing, easy to transport, and can be modified for each child's needs [6,7] (Figure 1).

The International Classification of Functioning, Disability, and Health (ICF) provides a useful framework to understand how children and families use powered mobility [8]. The ICF is comprised of five components: Body Functions and Structures, Activity, Participation, Environmental Factors, and Personal Factors. Previous research has focused on ROC usage within the Activity & Participation (e.g., stopping at a target) or Personal Factors domains (e.g., facial expressions and vocalizations). Few studies have examined Environmental Factors, such as the physical, social,

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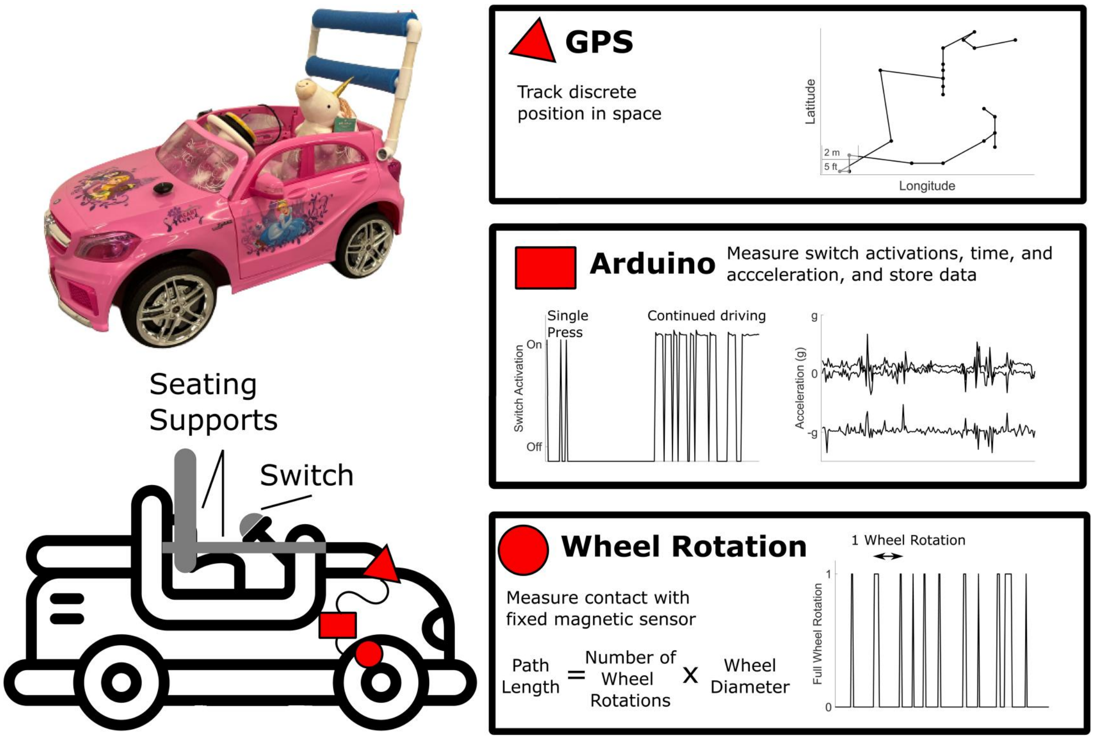

Figure 1. An adapted ride-on car (ROC) with the three datalogger components. The GPS mouse is located on the hood, the main body of the datalogger is located behind the front wheel, and the magnetic contact sensor to measure wheel rotations is located on the right front wheel.

and attitudinal environments in which the child lives and plays [9, 10].

A prior review of eleven ROC studies noted that the two largest barriers to device usage were limitations of the device (e.g., noisy and large size) and environmental barriers, such as the weather and inadequate drive space [9]. Qualitative studies have shown that families primarily use adapted ROCs outdoors in their local neighborhood [11, 12]. Current ROC models have a large turn-radius, which can make driving in confined spaces difficult. As such, having access to a large space where the child can safely play and learn to use the device is paramount [9, 11, 13–15]. Assessing the space where a child uses powered mobility is part of device provision, and can be a reason why a child may not receive a device [16, 17]. Quantifying how the environment interacts with, affords, and/or hinders ROC usage is critical to support future use and deployment. To date there has been no study that has examined how early powered mobility usage is impacted by the built environment [17]. Studies in adults using powered and manual wheelchairs have shown that community mobility is significantly impacted by access to transit, climate, and the physical environment [18–20].

The objective of this study was to quantify the driving patterns of children using ROCs in the community environment using geospatial data. The first aim of our research was to quantify how driving habits differed when the child was driving outside versus inside of their home. Similar to prior research, we hypothesized that there would be more ROC usage outside of the home than inside. Our second aim was to evaluate where families used the ROC and investigate environmental factors that may affect usage. We hypothesized that families would use the ROC more if they lived in an area where there were places that they could drive to, such as a park. Understanding the relationship between the built environment and ROC usage is critical to guide families as they start their power mobility journey.

Materials and methods

Participants

We recruited participants who met the following inclusion criteria: 1) were between 12 and 48 months old at study onset; 2) had a diagnosis of developmental delay or cerebral palsy with any level (I-V) of associated motor ability according to the Gross Motor Function Classification System (GMFCS) or communication ability according to the Communication Function Classification System (CFCS); and 3) lived in a household where English was spoken proficiently. To use a ROC safely, the child had to be able to maintain and tolerate a seated position with or without support while moving through space for 30 min.

Study design

This study is a quantitative analysis that is part of a larger prospective, observational study. All families were given ROCs outfitted with custom dataloggers to use as they saw fit for a one-year period (Table 1). This time period was selected to document the natural evolution of ROC use over time, and to our knowledge, is the longest deployment of ROCs in the field to date with consistent data tracking. Families were instructed on safe use of the ROC and encouraged to use them in both indoor and outdoor environments; however, specific dosage recommendations were not provided to observe family-selected ROC use patterns. All study procedures were approved by the Institutional Review Board at the University of Washington, and written informed consent obtained from the child's legal guardian.

Ride-on car specifications

The ROCs used in this research were modified by trained members of the research team using established protocols for ROC

Table 1. Terms and metrics used to describe ROC usage.

Term	Definition
Play session	A period where there was at least one switch activation and at least one hour had passed since the prior switch activation.
Switch activation	The voltage input from the switch was above a set high voltage threshold.
Indoor play session	The presence of no GPS data for a play session or no more than 20% of geospatial data for a play session being within the boundaries of the participant's residence.
Outdoor play session	80% or more of geospatial data being outside of the boundaries of the participant's residence during a play session.
Active drive time	The time in minutes that a child was activating the switch during a play session.
Duration of play session	The total time from the first switch activation to the end of the last switch activation for a singular play session.
Geospatial path length	The distance a child travelled in a play session as measured by the summed Euclidean distance between adjacent GPS points [22].
Path length	The distance a child travelled in a play session as measured by the number of wheel rotations multiplied by the circumference of the wheel.
Drive radius	The maximum Euclidean distance from the participant's residence to the furthest geospatial coordinate during a singular play session.
AccessScore	A measure of the accessibility of the sidewalks on a singular street determined from Project Sidewalk accessibility data.
Walk Score	A measure of how pedestrian-friendly an area is determined by the availability of community amenities within walking or rolling distance.

modification [6, 7]. The ROCs were rewired to be activated by a large, easy-to-push switch that is mounted on the steering wheel, and an emergency on/off switch on the rear of the vehicle. Similar to prior research, custom seating supports (armrests and backrest) were added using materials such as PVC pipe (household water pipe), pool noodles, and kickboards (Figure 1). For additional safety and support, a seatbelt or 5-point harness were added, as necessary.

Datalogger

ROCs were equipped with a custom datalogger behind the right front wheel [21]. The datalogger consisted of a voltage interrupt detector to record voltage changes from switch activation, a real-time clock to record date and time, a triaxial accelerometer, a magnetic contact (Hall effect) sensor to track wheel rotations, and a GPS mouse to track geospatial position (Figure 1). The horizontal positioning accuracy of the GPS mouse was 2.5 m. An Arduino Pro-Mini microcontroller board was used to collect, sync, and save data to a secure digital (SD) card for the research team to access at mid-study and study completion. The data was collected at 0.2 Hz, increasing to 5 Hz when the switch or wheel rotation sensor was activated. Families were able to keep the ROC after study completion, if they so chose, and all data collection equipment was removed from the ROC.

Data analysis

The goal of this research was to evaluate ROC usage in the home and community environments, which relied on the data collected from the GPS, switch activation, and wheel rotation sensors from each ROC. We created custom MATLAB scripts for data analysis (MathWorks, Natick, Massachusetts). Play sessions were defined by a switch activation that occurred at least an hour after a previous switch activation (Table 1). To account for instances where the switch may have been jammed, we filtered the data to exclude any play sessions that were longer than an hour and the switch had been pressed for less than 10% or more than 90% of the play session duration.

GPS data

GPS data were used to determine whether each play session was inside or outside of the child's home. GPS sensors can be impacted by the number of visible satellites and the presence of obstructions, such as buildings or trees [23, 24]. As such, the GPS data were filtered to reduce outliers and improve data reliability. We removed erroneous points that were outside of two standard deviations (2 standard deviations = 95% confidence interval) of the mean geospatial location for each play session or had a difference of 0.001 degrees (∼100 m) between consecutive datapoints as ROCs are unable to travel this distance in less than 5 s. We also filtered out geospatial coordinates that were infeasible, such as a latitude greater than 90 degrees or latitude or longitude equal to zero. At the sampling rate utilized by the datalogger, the child would be unable to move more than a few meters between samples. We defined play sessions inside the home as the presence of no GPS data or more than 20% of the data points for a drive session were within the manually defined boundaries of the participant's home.

Descriptive data

To describe a child's usage of their ROC, we calculated the number of play sessions, play session duration, active drive time, and path length from the wheel rotation and GPS position for outdoor play sessions (Table 1).

Environmental factors

To evaluate the effect of environmental factors on ROC usage, we combined ROC sensor data with sidewalk accessibility scores from Project Sidewalk and the proximity of community locations to their home. Project Sidewalk is an open-source crowdsourcing platform that uses Google Street View to identify sidewalk accessibility issues, such as surface problems or missing curb ramps. We used the *AccessScore* from Project Sidewalk's API [25] which gives a score from 0 = inaccessible to 1 = accessible depending on the number of environmental barriers to mobility (e.g., lack of curb cuts, poles in the way) [26]. This data was only available for three participants (P5, P10, P17) who lived in Seattle-proper, as the accessibility data is manually gathered by volunteers through Project Sidewalk's platform [25]. We also evaluated how pedestrian-friendly the environment near each participant's home would be for ROC usage with the Walk Score (walkscore.com) [20, 27]. The Walk Score is scaled from 0 to 100 with 100 being the most walkable; scores less than 50 indicates that most or all errands require a car. For example, a score of 91 means that an individual can walk in their neighborhood to accomplish all daily errands, such as grocery shopping, picking up dry cleaning, or stopping at the local bakery; and is representative of living in a downtown area or main street. We selected this as a metric because it helps to indicate the quantity of amenities nearby that the family could walk or wheel to. Finally, we looked at the proximity of family-friendly third spaces—tertiary locations that an individual could frequently visit that is not home or work. We identified parks and elementary schools as family-friendly third spaces as both locations may have an area for a family with young children to play and socialize, and as such may increase the frequency at which a child would use a ROC. Logan et al. 2014 indicated that driving around the neighborhood led to more socialization both for the child and the caregivers, as their child was able to engage with children in the neighborhood [12]. We manually looked up the nearest park and elementary school to each participant's home using Google Maps. Using the geospatial location of the third spaces, we observed participant's drive maps to see if they visited these spaces.

Statistics

We used Wilcoxon rank sum tests with an alpha of 0.05 to compare differences in the number of sessions, session duration, active driving time, and distance traveled between the indoor and outdoor play sessions. This test was selected because our data did not follow a normal distribution, and we were conducting a comparison between two independent groups. We also calculated pooled mean and pooled standard deviation for a weighted picture of the entire group based on the number of play sessions for each participant. We conducted a linear regression between path length and Walk Score to quantify the relationship between community amentities and distance travelled.

Table 2. Participant demographics.

Participant	Age (years)	Gender	GMFCS[1]
1	4	M	III
2	2	F	IV
3	3	F	III
5	4	M	III
6	5	M	II
7	3	M	IV
8	3	F	IV
9	4	F	III
10	1	F	III
13	3	F	II
15	1	M	II
17	1	M	II
18	2	M	IV
19	1	M	III
N = 14	2.5 ± 1.45	8 M: 6 F	II: 4 III: 6 IV: 4

[1]GMFCS: Gross Motor Function Classification System Level

Results

Nineteen participants and their families enrolled in the study. Fifteen participants completed all study procedures, with one data logger failure, resulting in fourteen complete data sets (Table 2) and included 8 males and 6 females (aged 2.5 ± 1.45 years [Ave ± SD] at the start of the intervention). From the original 19 participants, two participants withdrew from the study due to moving out of state and intensive therapy schedules, and two were lost to follow-up. Families were located throughout Western Washington, within a 2-h drive radius of Seattle. Three of the participants' primary residence were apartments during the course of the study, and three participants moved between enrollment and study completion. For these participants, we used the geospatial location of the primary residence where they were for the majority of the study for all calculations based on the participants' travel from home.

Inside vs. outside driving

We quantified the driving patterns of families using ROCs in their home and community environments for a year. We found that children drove for a longer period of time and a further distance when the child was driving outside versus inside of their home (Table 3). On average, families used the ROCs for a total of 20 (range: 0-57) play sessions inside and 15 (range: 0-52) outside of the home (Figure 2A) over the course of a year. However, the children played with the ROCs for a longer period of time during outside play sessions, with an average play session duration of 10.4 min (Figure 2B) and active drive time of 6.9 min (Figure 2C) outside, compared to 7.5 min play session duration and 2.9 min of active drive time inside ($p \ll 0.01$). Children also drove a further distance when play sessions were outside (Figure 2D), with an average path length of 214 m, compared to 53 m inside ($p \ll 0.01$).

Looking at the driving patterns of individual children inside versus outside of the home illustrates different usage patterns. For example, P15 had similar driving patterns whether driving inside and outside, while P10 actively drove for more of the play sessions outside than inside (Figure 3). P5 also had similar driving patterns when they were outside and inside, but actively drove

Table 3. Play session number, active drive time, play session duration, and path length for each child.

Car	N	N_o	N_i	t_o	t_i	T_o	T_i	L_o	L_i
1	15	1	14	0.07	3.23	0.10	11.69	0.00	35.56
2	76	19	57	0.95	0.89	3.57	4.14	9.57	9.61
3	70	34	36	3.10	2.32	7.63	8.24	27.75	17.62
5	31	22	9	13.66	9.41	34.96	12.95	269.06	288.26
6	23	4	19	1.18	0.32	1.24	2.61	1.53	3.18
7	7	0	7	–	1.72	–	8.65	–	6.88
8	20	6	14	0.54	0.91	1.47	3.82	8.59	8.09
9	14	6	8	14.30	4.31	18.64	12.21	152.24	94.38
10	65	52	13	15.41	6.47	19.71	13.11	311.05	85.25
13	7	2	5	1.28	2.55	2.08	8.50	1.70	11.67
15	56	15	41	3.76	1.63	4.82	1.90	85.15	31.15
17	5	5	0	19.46	–	22.36	–	1230.92	–
18	1	1	0	5.47	–	7.25	–	293.01	–
19	38	26	12	10.14	1.37	11.16	2.27	393.06	38.38
Ave	31	15	20	6.87	2.93	10.38	7.51	214.12	52.50
SD	–	–	–	6.51	3.56	22.16	8.31	252.14	91.98

N, Total Play Sessions. N_o, Total Play Sessions Outside. N_i, Total Play Sessions Inside. L_o, Average Path Length Outside (m). L_i, Average Path Length Inside (m). t_o, Average Drive Time Outside (min). t_i, Average Drive Time Inside (min). T_o, Average Play Session Duration Outside (min). T_i, Average Play Session Duration Inside (min). Pooled averages (Ave) and Standard Deviations (SD) are shown.

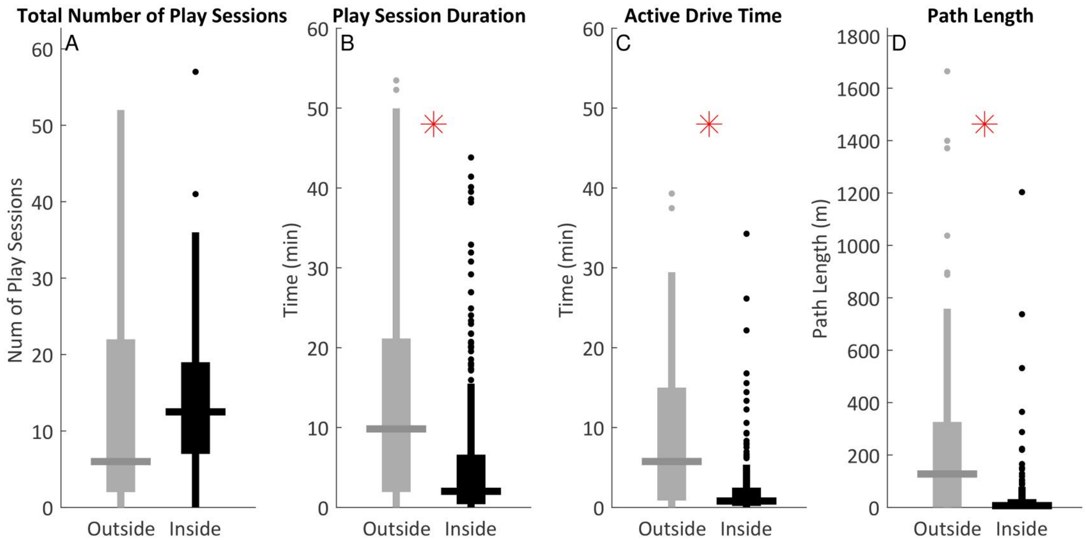

Figure 2. The (a) total number of play sessions, (b) total play session duration, (c) active drive time for each play session, and (d) total length driven for each play session when the participants were driving outside and inside their homes. The children actively drove for a longer time and distance, and the play sessions lasted longer when they occurred outside than inside. However, there were a higher number of play sessions inside than outside. Significance is shown by a red asterisk for play session duration, active drive time, and path length.

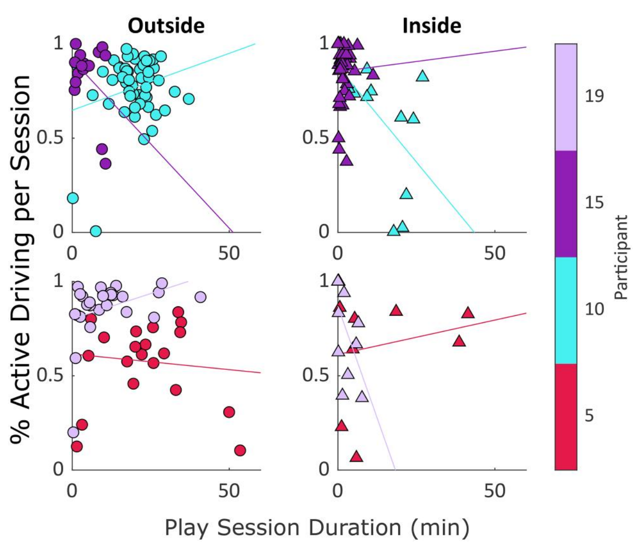

Figure 3. The ratio of active total drive time for each session to play session duration as a function of the total play session duration for four participants (P5, P10, P15, and P19). each participant is represented as a different color. Play sessions outside are demarcated as a circle and inside as a triangle. Each child used their cars for a varied amount of time, with some actively driving during the entire play session and some for only a short time. For plots for additional participants see Supplementary Material.

for a higher percentage of the play session inside. In comparison, P19 actively drove for most of their sessions outside of their home, but actively drove for less of the play sessions inside their home.

Distance from home

The majority of participants drove their cars inside and near their homes (Figure 4). The average maximum distance travelled from home for outside play sessions was 181.4 m (range: 2.38 m – 253.98 km, Figure 4). However, some families took their child's ROC with them while traveling. Most notably, one family took the ROC with them on a ferry and another family took their ROC

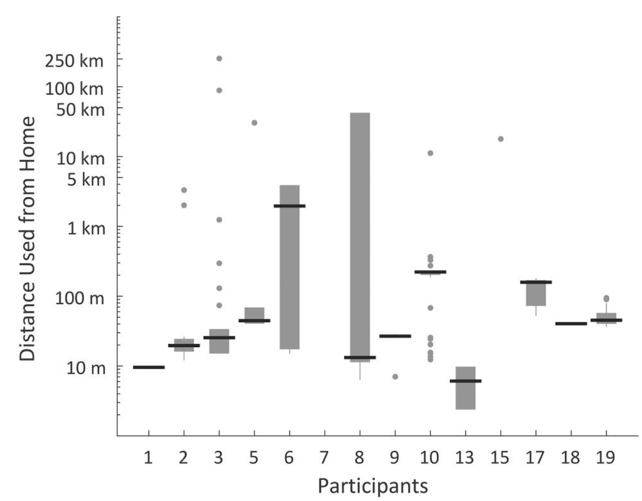

Figure 4. Each boxplot shows the drive radius, or the furthest distance each participant actively drove during a play session from their home. Most of the participants drove in the very near vicinity of their home (within a few hundred meters from home).

camping with them. The furthest distance that one family travelled with their ROC was 253.98 km from their home.

As illustrated in Figure 4, some families had a large variation in the distance that they drove each day, while others were fairly consistent in the distance they drove. For example, P9 and P10 tended to drive a similar distance every day (Figure 5), which indicates that they drove a similar path. However, other participants, such as P17 and P19, drove a varied distance, and hence must have altered their drive path between play sessions. Every child and family used the ROC in a different way, and this is reflected in their drive distances. P3 shows us that a child may consistently drive a short distance during each play session, but then go on a few longer adventures to explore their neighborhood.

Measures of neighborhood accessibility

ROC usage was decreased in inaccessible outdoor environments. Participants who lived in areas with higher Walk Scores traveled

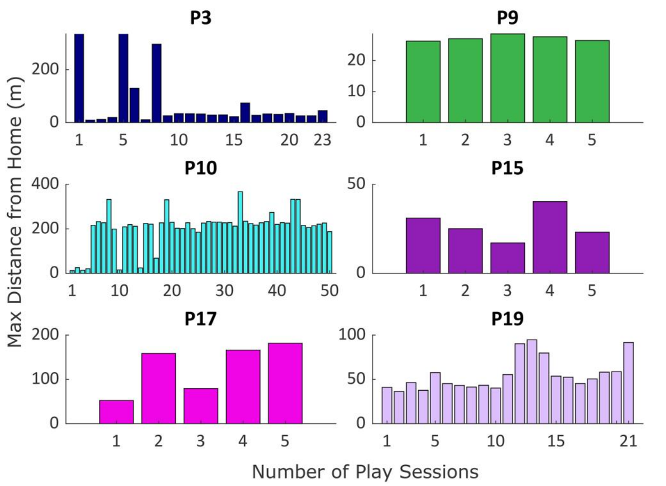

Figure 5. The maximum distance traveled from home for each play session for six participants. Some children consistently drove the same path, while others drove a slightly different path each time. For plots for additional participants see Supplementary Material.

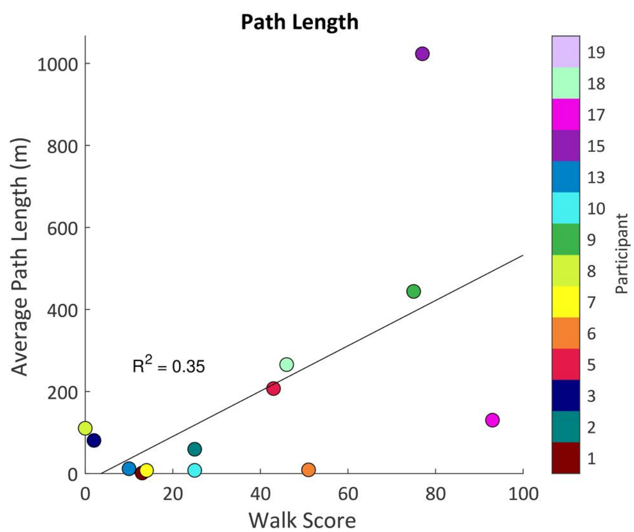

Figure 6. The average path length increased when the children was using their ROC outside of the home as the Walk Score—a measure of pedestrian-friendliness of a neighborhood—increased.

further during outside play sessions ($R^2 = 0.35$, Figure 6). The number of play sessions and the average duration of play sessions increased as Walk Score increased. The average distance traveled outside increased as the Walk Score increased, which may indicate that there were more areas to stroll and roll on the sidewalk. However, all of our families were able to identify a region in which they could use their ROC. The drive paths of four participants who lived in regions with Walk Scores lower than 50 show that each family used their ROC differently (Figure 7). P2 only used their ROC to drive in their driveway and backyard. P9 consistently drove up and down their street and in their driveway. P3 primarily drove just outside of their home, but on a few occasions drove their ROC to a nearby park. P19 varied their drive route each time, driving in the court by their home, and venturing to neighboring streets to explore their neighborhood.

Mapping initiatives, like Project Sidewalk, can provide further insight into environmental barriers and usage patterns [25, 26]. For the three participants (P5, P10, and P17) who lived in regions with sufficient Project Sidewalk accessibility data to calculate AccessScores, we found that participants primarily travelled on accessible paths (Figure 8). The sidewalks bordering P5’s home were rated as highly accessible, however, they primarily drove their ROC in the immediate vicinity of their home. P10 lived close to an elementary school with a playground. They drove on accessible paths to and around the elementary school over 50 times, and only changed their route once to travel on a sidewalk that was less accessible. Three out of four of the streets surrounding P17’s home were classified as inaccessible, and as such, we observed P17 primarily driving in the alley behind their home.

Discussion

In this study, we analyzed ROC usage patterns of 14 children and their families in their homes and local neighborhoods over a year-long deployment. Using a custom datalogger, we quantitatively measured switch activation, device usage duration, geospatial position, wheel rotations, and device acceleration. There was a wide breadth in the frequency to which each family used the device, but most families used the device within a few hundred meters of their home, and we observed that neighborhood features, such as walkability and accessibility of sidewalks, influenced usage and chosen routes.

The ROCs were used for longer durations outside the home than inside. Pritchard et al. 2019 showed similar results with 3 out of 4 participants using the ROC outside more than 70% of the time (100%, 92%, 29%, 73%) [11]. However, we observed that our participants had an increased number of sessions inside than in other studies [11, 12]. This could be a result of the families using the device over the course of a year in Western Washington, a region known for higher rainfall [11], or our use of GPS to define indoor driving, which may have over-classified indoor play sessions near the home.

One of the most significant observations from this study was that families that used the ROC the most tended to drive a similar route each play session (P03, P10, P17, P19). Families seemed to identify an accessible area and/or path and stick with it. It should also be noted that the majority of families lived in areas with a lower Walk Score, which means that they would need to drive to accomplish most tasks of daily living (e.g., grocery shopping, doctor’s visits). Hence, families in areas with lower Walk Scores may have had fewer community amenities within walking or rolling distance that they could easily travel to with their ROC, which may have impacted motivation to use the ROC. Future work could examine the impacts on ROC usage when families are provided with custom driving routes or other environmental supports to help families identify and find accessible routes in their neighborhood. These custom driving routes could also include paths to third spaces, such as parks, within walking and rolling distance. Previous studies have also noted the challenge of finding large enough spaces for a child to drive an ROC and have suggested that researchers and clinicians assist in identifying places, such as indoor community play spaces, to increase ROC usage [5, 9, 10, 28].

The accessibility of the physical environment in which the children are living and using their ROC is a major factor in the provision of power mobility devices. If a child does not have a suitable place to maneuver a device, they may not be provided one [13, 16]. Three of the participants in our study lived in apartments, which can have less driving space. If an apartment or home does not have elevators or stairs to get to the sidewalk, these environmental barriers can further hinder outside ROC usage. For three of our participants, we were able to identify the accessibility of the streets in their immediate neighborhood. The resulting drive

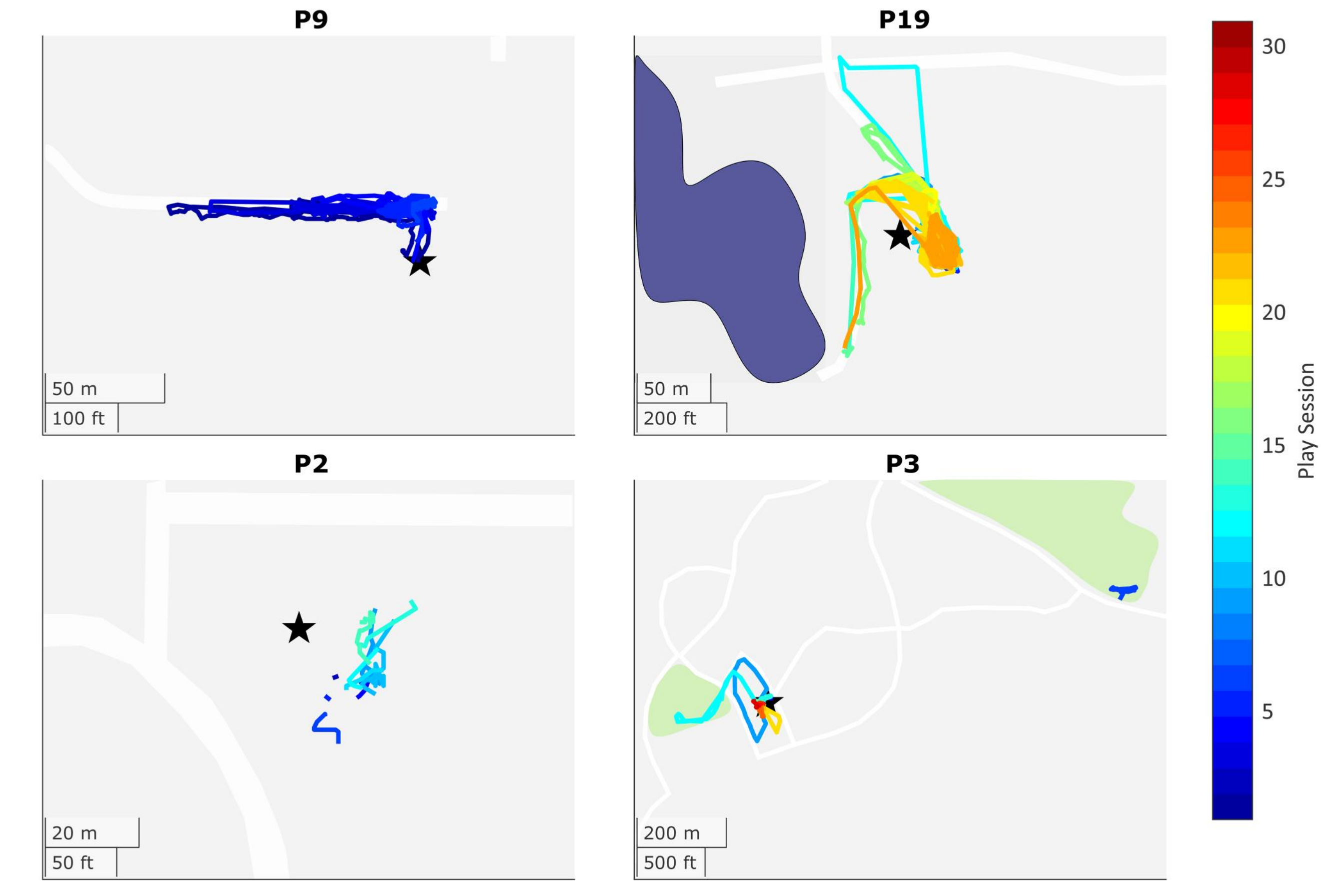

Figure 7. The drive paths for each participant for each play session. The star represents the participant's home. Each child had a unique drive path, with some driving just outside of their homes, while others went up and down the street or around the block.

maps starkly parallel the accessibility of the space, with the participants driving the routes that were most accessible and avoiding inaccessible regions. P10 had more outdoor play sessions than any other child, which may be in part due to the identification of an accessible path in their neighborhood to a third space of interest. However, P10's drive map (Figure 8) indicated they drove on an inaccessible street bordering the elementary school once and then never returned to that path for future sessions, which may be due to difficulties encountered driving the ROC. Similarly, three out of four of the streets surrounding P17's home are classified as inaccessible, and as such, we observed P17 primarily driving in the alley behind their home. P5 also lived near a large park, but we did not observe them venturing there, possibly due to the high grade of the route, which is unnavigable for an ROC [11].

The children in our study mainly used the ROC within the vicinity of their home, with only one family taking it with them when they were traveling. Although ROCs are relatively lightweight for a power mobility device, they are still bulky, heavy, and cumbersome to transfer [9]. There is a low likelihood that families in our study have a wheelchair-accessible van (yet), which could make it easier to transport the ROC [29, 30].

A common limitation in ROC studies is the small sample size, with many of the studies being case studies or case series. This study is one of the largest and longest ROC studies ($N = 14$ over one year); however, the relatively small number of participants means we are unable to generalize or evaluate the impact of specific factors like age, diagnosis, or home environment [17]. Another limitation of this study is that the Walk Score does not include metrics, such as sidewalk quality or dropped curbs, in its calculation, and hence, may not fully show pedestrian accessibility of a neighborhood [31]. We also only had AccessScores for three participants, due to the limited but growing deployment of Project Sidewalk. Project Sidewalk is currently deployed in ten cities, including six in the US, three in Mexico, and one in the Netherlands. Ideally, we would have accessibility information for each participant. To learn more about Project Sidewalk and label obstacles to exploration visit projectsidewalk.org. Future research that uses Project Sidewalk, or other open-source accessible mapping initiatives is important to understand and dismantle environmental barriers that may hinder participation and mobility options. Recently, Project Sidewalk has examined using machine learning to identify environmental barriers from Google Street View, which may make this data more widely available [32, 33]. Future collaboration with the Project Sidewalk team could also help us to get data specifically for the regions where the families in our studies live. Additionally, the *AccessScore* may not be fully representative of the environmental conditions our participants faced as Project Sidewalk data is collected using Google Street View, which is only updated approximately every 18 months. The *AccessScore* also does not account for the grade of a slope, which is a factor that likely impacts a child's ability to drive their ROC. Another limitation of this study is that we cannot verify whether the child was driving or the caregiver was driving (activation and steering) while the child was in the ROC. Previous studies have led us to believe that most likely a child would have activated the switch and held it while their caregivers intervened to steer the ROC. We observed a wide range of usage patterns, with many participants rarely using the car and others with 20+ play sessions (see Supplementary Material for individual data). This may be in part due to us not providing recommendations for

Figure 8. The accessibility scores for the sidewalks near each Participant's (P5, P10, P17) home on the left and the drive path of the participant on the right. Participants generally avoided driving on streets that were not accessible.

frequency and duration of use. However, it does reflect the realities of usage patterns when technology is deployed with families. Future studies may recommend ROC dosage (e.g., 3 times a week for 15 min) or periodic reminders to support the families in fitting technology into their community and lifestyle. This study focused on environmental factors, but there are likely many other factors that contribute to a young child's usage of a powered mobility device. Other factors, such as age, mobility level, family lifestyle, and resources available likely impact frequency of use [9]. Seasonal changes and weather patterns also likely impact a child's outdoor usage of their powered mobility device [9, 18]. These represent important areas for future investigation.

We conducted a year-long geospatial observation study on fourteen families utilizing an adapted ROC. Each family and child utilized their ROC, albeit with varying frequencies and usage patterns. Our findings revealed that the presence of a driving route significantly increased the utilization of ROCs. Therefore, future studies should investigate how the provision of accessible driving routes impacts ROC usage. This research sheds light on the diverse usage of ROCs by families across different environments and over time. We aspire for this work to facilitate policy advancements and advocacy efforts aimed at enhancing accessibility to mobility technologies for children with disabilities during critical developmental stages [3, 17]. The accessibility of the surrounding neighborhood plays a pivotal role in promoting mobility for both children and their families, regardless of the mobility device being utilized. Future research throughout the lifespan should examine both the destinations individuals frequent and those they do not, as this will help identify barriers to freedom in the built environment.

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