Measuring Social Communication in the Community: Novel Tools for Advancing Family Participation

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Natural contexts and family involvement are key features of effective intervention approaches. However, the measurement of community participation and parent engagement with children remains complex. Therefore, we examined the feasibility of combining use of the Language ENvironment Analysis (LENA[®]) system and a global positioning system (GPS; i.e., Qstarz[®] BT-Q1000XT). The LENA is a small speech recognition device that captures and quantifies full-day recordings of the natural language environment. The Qstarz BT-Q1000XT is a wearable GPS data logger that allows identification of the locations a person visits. The marrying of these measures allows for an accurate representation of community settings that afford children greater social communication opportunities. Our results show that the combination of measures provides meaningful social communication location data. Also, the participating caregiver reported that the collection of measures was feasible across community settings.

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Learning opportunities for young children occur in the family's natural contexts and encompass myriad routines, locations, contextual features, and occupations. When children engage in community activities, they have the opportunity to practice skills that have cascading effects on development (Dunst et al., 2001), ultimately contributing to positive child outcomes over time (Law, 2002; Segal, 1999). Research has suggested that interventions are most effective when they are embedded in a family's natural environment and routines (Bernheimer & Weisner, 2007). Although the importance of participation in natural contexts and child communication opportunities has been well documented (Anaby et al., 2013; Piškur et al., 2012), little empirical evidence exists on how these opportunities may differ across families' complex daily routines and occupations. Therefore, the purpose of this study was to examine the use of a novel combination of objective instruments to measure child-parent social communication (using Language ENvironment Analysis [LENA[®]]; LENA, Boulder, CO) and locations a family visits (using the Qstarz[®] BT-Q1000XT; Qstarz, Taipei, Taiwan) to inform future intervention efforts.

Community activities in which children with and without disabilities participate can be categorized as instrumental (e.g., going to the grocery store), unstructured (e.g., going to the park), or structured (e.g., attending Boy or Girl Scouts; Little et al., 2014). Within these activities, the language adults direct at young children likely enhances the benefits of the children's participation in the community context. For example, increased adult words at the park (e.g., "Time to go down the slide") may help to enrich the child's experience of the community. In the community context, similar to other contexts such as the home (e.g., Hart & Risley, 1992) and school (e.g., Girolametto et al., 2000), adult talk during routines is arguably a primary mechanism linked to developmental

outcomes. As such, researchers have reported that adult language influences not only social communication (Warren & Yoder, 2004) but also other essential outcomes for children, such as social competence (Phillips et al., 1987), language ability (Girolametto et al., 2000), and cognition (Hart & Risley, 1992). In addition, it appears that many studies have examined adult and child language in home (e.g., Greenwood et al., 2011; Hart & Risley, 1995) and school (e.g., Dykstra et al., 2013; Irvin et al., 2013) contexts, but studies examining adult and child talk in community settings among children with and without disabilities are limited.

The LENA is a wearable sensor worn by the child that captures child and parent language, or speech–talk, in the natural environment. It can be particularly useful for researchers aiming to measure talk in community settings. The tool has allowed researchers to better understand the language environments that children with disabilities experience in the home and school (e.g., Irvin et al., 2013; Thiemann-Bourque et al., 2014; Warren et al., 2010), and it is beginning to be used in the community.

The results of one available study in the community using the LENA indicated that adult and child vocalizations vary by context (e.g., more words from children during public outings, such as to the supermarket, than during travel time; see Soderstrom & Wittebolle, 2013). Although the Soderstrom and Wittebolle (2013) study is informative, it is limited in that it relied on coders to listen to and infer context and specific community settings. Moreover, because this approach both is time consuming and requires reliable coders, it is unlikely to benefit occupational therapy practitioners working directly with families. Thus, the language environments children experience in different community settings remain largely unknown.

Measurement of family participation in the community is also limited. Parent report measures remain the popular approach to assessing children’s engagement within community settings (e.g., Young Children’s Participation and Environment Measure [YC–PEM]; Khetani et al., 2013). This approach, however, is limited in that it does not fully capture parent–child talk and the exchanges (i.e., conversational turns) that are the foundation of family routines. Similarly, researchers have relied on parent time diaries to identify the locations that families visit (Kuo et al., 2013; Mazurek & Wenstrup, 2013; Orsmond & Kuo, 2011). However, research has suggested that this method has a number of limitations, such as participant burden and respondent error (Anderson et al., 1985; Chen et al., 2015). For example, one study found that parent time diaries misclassified location in 48% of time–location responses versus a

global positioning system (GPS) worn by typically developing children ages 3–5 yr (Elgethun et al., 2007). Combining LENA and GPS could address the known limitations of parent report and advance the measurement of adult and child language in community settings. If occupational therapy practitioners are able to understand the places where adult–child language is limited, interventions can better address such gaps. For example, if a parent is not talking with his or her child at the grocery store, an occupational therapist may emphasize the language opportunities at that community location.

If occupational therapy practitioners better understand the language environments across differing community contexts and activities for typically developing children, they can better develop and refine contextually relevant family-centered interventions that meaningfully support the participation of children with disabilities. This pilot investigation used a case-study design to examine the language environments in community settings experienced by one child during the family’s naturally occurring routines using precise, objective measures: the LENA system and Qstarz BT-Q1000XT (a GPS logger). This study addressed the following research questions:

1. What is the feasibility of combining the LENA and the Qstarz logger to measure adult–child social communication in community settings?
2. How does adult and child talk differ by community setting?

Method

Procedure

We collected language and location data on 1 typically developing boy (age 5 yr, 2 mo) over an approximately 5-hr period (10:00 a.m.–3:15 p.m.) using LENA and the Qstarz GPS logger (Figure 1). The primary caregiver (a White man whose highest level of education was a high school diploma) was instructed in how to turn the devices on and off as well as where to place them on the child’s clothing. The LENA was placed in a specially designed t-shirt sold by the LENA Foundation, and the Qstarz logger was attached to a belt loop on the child’s right side. Using MATLAB (MathWorks, Natick, MA), a program was developed to place the LENA speech estimates (i.e., adult words, child vocalizations, and adult–child turns) processed via the tool’s Advanced Data Extractor at a rate of 1 s. The 5-s GPS estimates from the Qstarz logger were also transformed to 1 s and, in turn, tied to actual locations (e.g., park, grocery store) via Quantum Geographic Information System (QGIS; <https://www.qgis.org/en/site/>),

Figure 1. (A) LENA digital language processor and (B) Qstarz GPS data logger.

Note. GPS = global positioning system; LENA = Language ENvironment Analysis.

a free, open-source desktop geographic information software (GIS). With the speech and location estimates on the same metric, we were able merge the two types of data. The caregiver was asked to keep a parent diary of time spent in individual locations to verify the QGIS analysis.

Measures

LENA System. LENA consists of a digital language processor and speech recognition software. The device records up to 16 hr of a natural audio environment. The accompanying software then processes the recording to provide adult word counts, child vocalizations (e.g., words, babbles, and prespeech communication), and adult–child turns (i.e., back-and-forth exchanges between the child wearing the LENA and adults; see Gilkerson & Richards, 2008, for additional information on LENA metrics). The system differentiates between meaningful and distant speech and silence; noise (e.g., overlapping speech, crying) and other environmental sounds (e.g., television) are categorized as nonmeaningful speech (Yoshinaga-Itano & Gilkerson, 2010). Considerable testing has been conducted to determine LENA’s reliability (see Warren et al., 2010; Xu et al., 2009). A recent synthesis showed that more than 50 studies from 2009 to 2017 relied on the LENA to capture child talk, adult talk, or both; the device has been used extensively with children at risk for and with disabilities, and its use in contexts outside the home (e.g., school and community) has expanded since the tool’s initial development (Greenwood et al., 2018).

Qstarz BT-Q100XT. The Qstarz BT-Q100XT is a GPS data logger that uses mapping technologies to provide real-time location estimates every 5 s (updates to the device now allow for location estimates to be captured on a 1-s interval). The tool has ample evidence of concurrent validity in use with young children in community settings (i.e., parent reports of locations visited showed 91.9%–99.9% agreement with κ statistics, ranging from 0.49 to 0.99; O’Connor et al., 2013).

Parent Reports (Demographic Form and Time Diary).

Parent reports were completed by the primary caregiver. The demographic form was completed at the onset of participation and included questions related to family and child demographic variables such as gender, family income, race/ethnicity, and child diagnostic and medical status. The parent time diary was a two-column document on which the parent indicated entry and exit times and the locations visited.

Data Analysis

The Qstarz GPS logger generated a new data point with associated latitude, longitude, speed, time, and date every 5 s. For this study, data generated from the Qstarz were downloaded from the device into Qstarz software to produce a comma separated values (CSV) file. The Qstarz CSV file was brought into QGIS. Each data point was then plotted using the latitude and longitude coordinates and validated in QGIS by comparing plotted data points with county GIS zoning data and satellite imagery. Data points in roadways were assigned to a travel group and further verified by confirming speed of travel of those data points. Using a QGIS vector analysis tool (i.e., Points in Polygon), we then associated the 6,102 location data points with the adult and child talk estimates that were processed via our MATLAB program. We relied on descriptive statistics to determine the amount of parent and child language as well as adult–child turns by location. The time diaries were used to help us ensure that there were no unforeseen issues with the child wearing the Qstarz logger (i.e., locations listed in the parent diary that did not emerge in the QGIS program).

Results

Research Question 1

Results for the child wearing the LENA and GPS showed four clusters of community activity and language: the

family’s home, a fast-food restaurant, a big-box store, and a gas station. Data were also calculated for travel between locations. The 5-hr and 15-min speech–location recordings indicated that the three settings visited outside of the home resulted in 2,052 vocalizations from the child (mean [*M*] = 25 per minute), 2,684 words from the adult (*M* = 38 per minute), and 665 conversational turns (*M* = 10 per minute). The average adult word, child vocalization, and adult–child turn rate was calculated by dividing the total number of these speech counts by the time spent in specific locations; see Table 1 and Figure 2 for complete results. The caregiver reported no challenges in using the devices during data collection, and the locations in the time diaries aligned with those from the QGIS program.

Research Question 2

Our results indicated that the child and parent vocalized most in the home, and this was also where the highest number of adult–child turns took place. The gas station was the location with the least amount of adult and child speech. The restaurant and big-box store were settings in which the rate of child speech was higher than adult words per minute. The rate of adult–child turns per minute at the gas station resembled that at the big-box store, even though time spent at the gas station was brief. Although a larger amount of time was spent in the home relative to the big-box store, the rates of child vocalizations were similar. The rate of adult–child turns were high during travel and were only exceeded by that in the home.

Discussion

The findings of this study showed that researchers can feasibly capture adult–child language across community settings by integrating two tools (LENA and Qstarz logger). Best practice aimed at increasing participation among children with disabilities necessitates the use of natural environments. To design targeted intervention approaches aimed at increasing children’s social

communication opportunities across settings, knowledge is needed about the extent to which community settings facilitate language exchanges.

Specifically, our findings suggest that adult words and child vocalizations per minute as well as adult–child turns per minute were highest at the family’s residence. However, the child’s words per minute were also high at the big-box store, followed by the fast-food restaurant. These results suggest that instrumental activities of daily living may be stimulating for children, as evidenced by their talk. These environments may be rich with visual and auditory input that children find novel and that they are then motivated to engage with caregivers. Although it was not a specific community location, an interesting finding was that the second largest amount of adult–child turns took place during travel time.

Our findings qualify those reported by Soderstrom and Wittebolle (2013) and demonstrate that the amount of child and adult talk in public, outside visits varies and should perhaps be examined separately. Moreover, our results suggest that travel may be an important setting for adult–child exchanges, which was not the case in the Soderstrom and Wittebolle study. This discrepant finding could be related to our use of GPS rather than coders listening to and categorizing community settings on the basis of LENA audio recordings. Another contributing factor could be that Soderstrom and Wittebolle had both a larger sample and more measurement points. Clearly, more research with increased sample sizes is needed to investigate how community location affords social communication opportunities.

For caregivers of children with disabilities, community activity participation can be difficult (Bernheimer & Keogh, 1995; DeGrace, 2004; Gallimore et al., 1999). To ease and promote participation, family-centered intervention approaches for young children with disabilities ideally focus on (1) expertise that is embedded into families’ activities and routines and (2) strategies that support families’ priorities (Boyd et al., 2014). Although empirical research has indicated that these two components have the greatest impact on child and caregiver

Table 1. Adult and Child Talk by Location

Location	No. Adult Words	No. Child Vocalizations	No. Adult–Child Turns	Min in Location	<i>M</i> Adult Words/min	<i>M</i> Child Vocalizations/min	<i>M</i> Turns/min
Residence	2,095	925	455	121	17.31	7.64	3.76
Restaurant	265	750	86	155	1.71	4.84	0.55
Big-box store	229	315	80	43	5.33	7.33	1.86
Gas station	42	6	6	4	10.50	1.50	1.50
Travel	53	56	38	17	3.12	3.29	2.24
Total	2,684	2,052	665	340	37.97	24.60	9.91

Note. *M* = mean.

Figure 2. Parent and child talk and conversational turns per minute in home and community settings.

outcomes, translation to practice is often lacking (Stahmer et al., 2005). Families report that participation in community settings is important to their everyday lives, but until now tools to uncover particular places in which caregivers are providing more or less language to their children have been lacking. With the support of occupational therapy practitioners, parents can begin to improve their children's language environment if they have a better understanding of what is happening across settings. This information may also allow them to make more informed decisions about time spent in specific community activities that may or may not produce a rich language environment for children.

Limitations and Future Research

This study relied on a small sample size to test the feasibility of combining the LENA and Qstarz logger and determine the amounts of adult and child talk by community setting. In addition, the LENA does not at this time yield information on the quality of adult and child talk. That said, previous studies have suggested a positive correlation between the quantity and quality of adult talk (Hart & Risley, 1995; Hoff, 2003; Rowe, 2008). The caregiver and child involved in this study may have been affected by the use of the combined devices; however, they expressed comfort in using the tools. With the combination of these devices in all likelihood having implications for intervention, future studies should test the feasibility and acceptability of use among families of children with developmental disabilities. Last, with larger sample sizes, researchers may be better able to understand how parent factors (e.g., education, stress) and child characteristics (e.g., language ability) affect parent and child talk in community settings.

Implications for Occupational Therapy Practice

- Children have different opportunities to engage in social communication with caregivers in community settings; however, existing methods do not capture real-time social communication and locations linked to community participation.
- The integration of the LENA and Qstarz logger captures which community settings afford social communication opportunities to children.
- These tools could be used to better understand adult-child social communication exchanges in community settings and inform intervention.
- The combination of these tools may allow occupational therapy practitioners to provide feedback to parents of children at risk for or with disabilities so caregivers can promote social communication in specific community settings.

Conclusion

This article describes the feasibility of coupling the LENA and Qstarz GPS logger to measure adult-child social communication in the community. The big-box store and restaurant (instrumental activities) were contexts in which the most child vocalizations per minute occurred. These findings are particularly promising because they offer a new method to measure and provide objective feedback regarding the social communication opportunities between parents and children in the community. When occupational therapy practitioners recognize the community settings that foster parent-child talk, as well as settings in which less talk occurs, they may better devise interventions to enrich children's experiences in the community. ▲

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