Handheld Computers for Direct Observation of the Social and Physical Environment

CLARENCE C. GRAVLEE
University of Florida
SHANNON N. ZENK
University of Illinois at Chicago
SACHIKO WOODS
University of Michigan
ZACHARY ROWE
Friends of Parkside
AMY J. SCHULZ
University of Michigan

This article evaluates the use of handheld computers for systematic observation of the social and physical environments. Handheld computers, also known as personal digital assistants (PDAs), make the advantages of computer-assisted data collection (CADC) more accessible to field-based researchers. In particular, CADC with handheld computers may improve data quality, reduce turnaround time, and enhance research capacity for community-academic partnerships. Here, we describe our experiences using handheld computers for the Healthy Environments Partnership's Neighborhood Observational Checklist, an instrument for systematic observation of the social and physical environments. We discuss hardware and software considerations, observer training and implementation strategies, and observer attitudes toward using handhelds in the field. We conclude that handheld computers are a feasible alternative to pen-and-paper forms, and we identify ways that future researchers can maximize the advantages of CADC with handheld computers to advance our understanding of how neighborhood context relates to individual-level outcomes.

Keywords: *social environment; observation; data collection; handheld computers*

A growing body of evidence implicates neighborhood context in the social distribution of many phenomena including violence, depression, high-risk behavior, and physical health. However, the causal pathways that link neighborhood context to individual-level outcomes are poorly understood

Field Methods, Vol. 18, No. 4, November 2006 382–397
DOI: 10.1177/1525822X06293067
© 2006 Sage Publications

(Robert 1999; Ellen, Mijanovich, and Dillman 2001; Sampson, Morenoff, and Gannon-Rowley 2002; Diez Roux 2003; Kawachi and Berkman 2003). One key problem is that methods for measuring relevant features of neighborhood environments are underdeveloped (Macintyre, Ellaway, and Cummins 2002; Cummins et al. 2005). Many studies rely on census and administrative data sources or on interview data about residents' perceptions of neighborhood conditions. These data are important but incomplete; comprehensive assessment of neighborhood conditions also requires direct observational measures (Sampson and Raudenbush 1999; Caughy, O'Campo, and Patterson 2001).

Methods of neighborhood observation have improved significantly in recent years, but one unresolved issue is the preferred mode of data collection. For example, the Project for Human Development in Chicago Neighborhoods observed eighty neighborhoods from a slow-moving vehicle. Inside the vehicle, two video recorders taped both sides of the street, and two trained coders recorded observations in a log (Raudenbush and Sampson 1999; Sampson and Raudenbush 1999). Caughy, O'Campo, and Patterson (2001) argue that making observations from a moving vehicle raises significant ethical and methodological problems (e.g., it is intrusive and disrespectful, the technology is cost prohibitive). To address these problems, they trained pairs of observers to walk through Baltimore neighborhoods and record observations on paper forms. Many other researchers have collected similar types of data on paper forms (e.g., McGuire 1997; Farquhar 2000; Weich et al. 2001; Craig et al. 2002; Pikora et al. 2002; Emery, Crump, and Bors 2003; Cunningham et al. 2005).

This article contributes to the development of neighborhood observational methods by evaluating the use of handheld computers to collect neighborhood observational data. Handheld computers, also known as personal digital assistants (PDAs), make the benefits of computer-assisted data collection (CADC) more accessible to field-based researchers. Here, we describe our experiences using handheld computers for the Healthy Environments Partnership's Neighborhood Observational Checklist (NOC), an instrument

---

The Healthy Environments Partnership (HEP; www.hepdetroit.org) is a project of the Detroit Community–Academic Urban Research Center (www.sph.umich.edu/urc). We thank the members of the HEP Steering Committee for their contributions to the work presented here, including representatives from Brightmoor Community Center, Detroit Department of Health and Wellness Promotion, Detroit Hispanic Development Corporation, Friends of Parkside, Henry Ford Health System, Southwest Detroit Environmental Vision, Southwest Solutions, University of Detroit Mercy, and the University of Michigan Schools of Public Health, Nursing and Social Work and Survey Research Center. HEP is funded by the National Institute of Environmental Health Studies, #RO1 ES10936-0. *Address correspondence to Clarence C. Gravlee, University of Florida, Gainesville, FL 32611-7305; cgravlee@ufl.edu.*

for systematic observation of the social and physical environments. We evaluate potential advantages and disadvantages of using handhelds, discuss important technical decisions, and show that observers generally responded favorably to using handhelds in the field.

COMPUTER-ASSISTED DATA COLLECTION: HANDHELD COMPUTERS

As compared to pen-and-paper methods, CADC offers five key advantages (de Leeuw and Nicholls 1996; Couper and Nicholls 1998). First, a well-designed CADC system reduces missing data by ensuring that responses are given for all appropriate items and that skip patterns are implemented properly. Second, CADC software can impose range or consistency checks during data collection to help observers recognize and correct input errors in the field. Third, CADC eliminates the costly and error-prone step of data entry and reduces the need for postcollection editing and coding. Fourth, CADC permits more complex instrument designs than are feasible with pen-and-paper methods, including randomization and complicated skip patterns. Fifth, CADC provides information about the data-collection process, including how observers proceed through the instrument and the time and duration of each observation. This information can reveal problems in the instrument and may deter unwanted observer behavior, such as data falsification (Couper, Hansen, and Sadosky 1997; Couper 2000).

Handheld computers make CADC more accessible for direct neighborhood observation because they reduce the costs and mobility constraints of standard CADC. The cost efficiency of CADC depends on the balance between front-end investments in technology and training versus back-end savings from reduced postcollection processing (e.g., no separate data entry, less data editing and coding; Tourangeau 2004). Handhelds improve this trade-off by reducing the front-end investment in technology. Entry-level handhelds with the Palm operating system are currently available for as little as $100, and full-featured models top out at around $500. Moreover, handheld computers provide the mobility required for direct neighborhood observation. Most models weigh less than six ounces, and some devices have enough battery life to last for days of full-time data collection.

These qualities make handhelds attractive to researchers in many fields. They have been used for data collection in social and demographic surveys (de Heer 1991; Forster and Snow 1995; de Leeuw, Hox, and Kef 2003; Hewett, Erulkar, and Mensch 2004), evaluation research (Fletcher et al. 2003), nursing (Weber and Roberts 2000; Bobula et al. 2004), psychology

(Kahng and Iwata 1998; Barrett and Barrett 2001; Dixon 2003; Bassett and Dabbs 2005),[1] horticulture (Villordon, Franklin, and LaBonte 2004), clinical trials (Koop and Mosges 2002), school-based research (Parr, Jones, and Songer 2004; Trapl et al. 2005), public health and epidemiology (Johannes, Crawford, et al. 2000; Johannes, Woods, et al. 2000; Bernhardt et al. 2001; Bernhardt, Usdan, and Burnett 2005; van Griensven et al. 2006), observational studies (Ice 2004), and ethnographic research (Greene 2001; Gravlee 2002). However, the potential for using handheld computers in neighborhood observation has yet to be fulfilled.

The Neighborhood Observational Checklist

The NOC was developed as part of the Healthy Environments Partnership (HEP). HEP is a community-based participatory research project affiliated with the Detroit Community–Academic Urban Research Center. It was formed in October 2000 as part of the National Institute of Environmental Health Science's Health Disparities Initiative. HEP examines aspects of the social and physical environment that contribute to racial and socioeconomic inequalities in the risk of cardiovascular disease in Detroit. The project draws on multiple data sources to evaluate the social and physical environments, including a face-to-face survey, monitoring of airborne particulate matter, and direct neighborhood observation with the NOC (Schulz et al. 2005).

The NOC is based primarily on the Chicago Community Adult Health Study's Systematic Social Observation tool. It was adapted for use in Detroit through a community-based participatory process described elsewhere (Zenk et al. 2005). The final instrument measures up to 140 items at three spatial scales—block face, street, and block. It covers a broad range of topics including land use; physical conditions of residential and nonresidential buildings and grounds, sidewalks, and streets; recreational resources; types of businesses; advertisements; activities of observed adults and teenagers; and symbols of ethnic identification. NOC observers collected data in the summer and early fall of 2003.

Like its predecessors, the NOC was conceived as a pen-and-paper instrument. However, one of us had previous experience using handheld computers for data collection (Gravlee 2002) and suggested that implementing the NOC with handheld computers may improve data quality, reduce turnaround time, and enhance research capacity for the partnership and for HEP-NOC observers. The final decision to use handhelds was based on a pilot test using both handheld computers and pen-and-paper forms for the NOC. Pilot-test participants reported that handhelds facilitated data collection, and community partners were enthusiastic about using this new technology.

Hardware and Software Considerations

The range of hardware and software options for mobile data collection has expanded dramatically in the past few years. The choice of appropriate hardware and software depends on budgetary constraints and on the type of data required for a project. For example, researchers who want to integrate photographs or global positioning system (GPS) data into direct neighborhood observation may need to invest in high-end handhelds that support cameras or GPS devices (Schlossberg n.d.). In contrast, researchers who want to implement text-based instruments such as the NOC will find that the simplest and least expensive handhelds are often the most useful. Our hardware selection was based on five criteria:

- Cost. We required a relatively inexpensive device (~$100 each).
- Battery type. We preferred standard AAA batteries so that observers could replace batteries in the field and would not need to recharge the device.
- Screen type. We preferred a monochrome rather than color screen for longer battery life.
- Operating system. We preferred Palm-powered computers rather than Windows Pocket PC devices because they are generally less expensive yet support the necessary software.
- Expansion card. We required a device with an expansion slot for backing up data in the field to minimize the risk of losing data before the handhelds were synchronized with the central desktop computer.

Because many consumers prefer color screens and rechargeable batteries, relatively few recent models satisfied our criteria. We considered older models from several manufacturers and purchased sixteen Palm m125 computers for our team of observers. The main advantage of the Palm computer over other devices was that its expansion slot supports a generic expansion card that is widely available rather than a proprietary format. Unfortunately, we experienced technical problems with the touch-screen sensitivity on four handhelds. Given the low cost of handheld computers, researchers may want to purchase extra devices in case of similar technical problems.

Our software selection was shaped by a positive experience with Entryware Pro software (Techneos Systems, Vancouver, BC, Canada) in a previous project (Gravlee 2002). Although this software was designed for survey research, it met our criteria for the NOC:

- Ease of use. No programming skills are required to design and deploy the instrument for handheld computers.
- Multiple users. It supports an unlimited number of handhelds for data collection and merges data into a single database.

- Complex designs. It permits skip patterns and can be customized to support variable block sizes (i.e., the software cycles through block-face and street-level items based on the number of streets in each block).
- Question and response types. It supports multiple choice, yes/no, open-ended numeric, and open-ended text responses.
- Data quality. It supports range and consistency checks during data collection and helps prevent changes to the instrument that could harm data integrity.
- Data export. It exports data as plain text or as a formatted and labeled SPSS® file, which integrates with data management and analysis software.

Figure 1 illustrates how selected items from the NOC appeared on handheld computers using version 4.2 of Entryware software.[2]

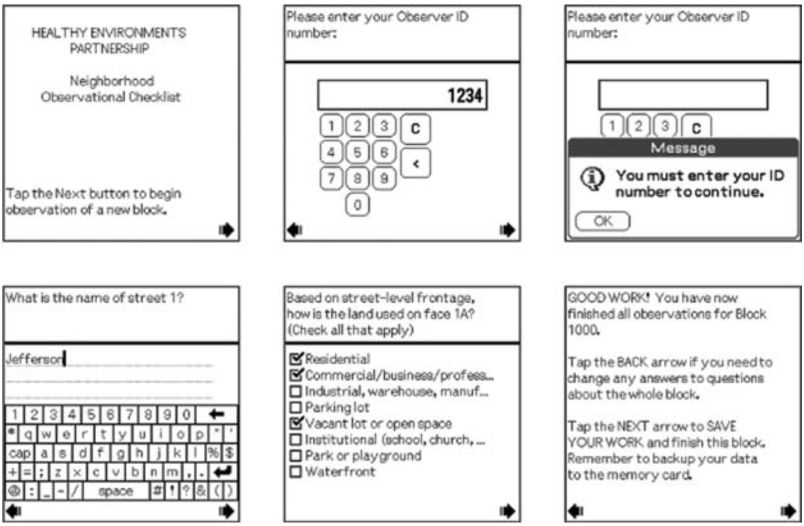
One challenge in using Entryware software for the NOC was finding the right balance between structure and flexibility. Because Entryware software was designed for survey research, the version we used assumed that users advance through the instrument one question at a time. The advantage is that skip patterns are implemented correctly and users are forced to answer all questions in a specified order, which minimizes missing data and interobserver error. The disadvantage is that users may not be able to record observations as they make them. For example, rather than coding the presence of an alcohol advertisement when they first notice it, observers must wait until they reach the appropriate point in the instrument.

On balance, we decided that the potential gains in data quality from imposing structure outweighed potential losses from restricting flexibility. Our compromise, in response to requests from field staff during training, was to equip each handheld case with a small pencil and notepad so that observers could make notes when necessary to facilitate recall.[3] Other software options (e.g., Pendragon Forms, PocketSurvey) allow users to choose between viewing a single question or the entire form at once, and version 5.0 of Entryware software, released in fall 2005, supports instruments that allow users to jump to specific questions.

Training and Implementation

Using handheld computers presented both challenges and opportunities for observer training. The main challenge was to teach observers not only about the NOC but also how to implement it using handhelds. Most NOC observers had worked previously as survey interviewers for HEP or other projects. This experience facilitated training in basic standards of data collection. However, CADC in general and handheld computers in particular were new to most observers. Only one of the eleven observers reported owning a handheld computer, and none had used handhelds for data collection.

FIGURE 1
Screen Shots from the Neighborhood Observational Checklist on Techneos Entryware Software for the Palm OS



Our training program, therefore, assumed that observers had no knowledge of handheld computers (Zenk et al. n.d.). We prepared a thirteen-page user guide (available on request) with step-by-step instructions on using the handheld for the NOC. In addition, using Entryware software, we designed an interactive tutorial and installed it on the handhelds. The tutorial showed observers how to navigate through different types of questions used in the NOC.

Using handheld computers also provided unanticipated benefits for observer training and for refining the NOC, because we were able to monitor the reliability of items and observers during the training process (Zenk et al. n.d.). Observers completed approximately 35 hours of training, including fieldwork in practice blocks. The use of handheld computers meant that practice data were available for analysis as soon as observers returned the handheld for synchronization with the central database.

Between training sessions, we analyzed practice data to identify items with high and low agreement among observers. We also used time stamps generated automatically by the software to identify observations that took longer than expected. In some cases, this information led to revised item wording, response categories, or operational definitions. In subsequent training sessions, we provided feedback to observers and solicited their ideas about why some items had low interobserver agreement. We used interrater reliability statistics from the final practice block to evaluate observers' performance and to certify them for fieldwork. Eleven of fifteen people who completed training met the certification requirement of overall kappa $\geq .75$ for the final practice block (for details on interrater reliability, see Zenk et al. n.d.).

If we had implemented the NOC with pen and paper, it would not have been feasible to assess interrater reliability during training without substantial delays. We have no way formally to test the impact on data quality. At a minimum, however, the ability to monitor interobserver agreement made the training process more efficient by focusing attention on items and observers with low reliability.

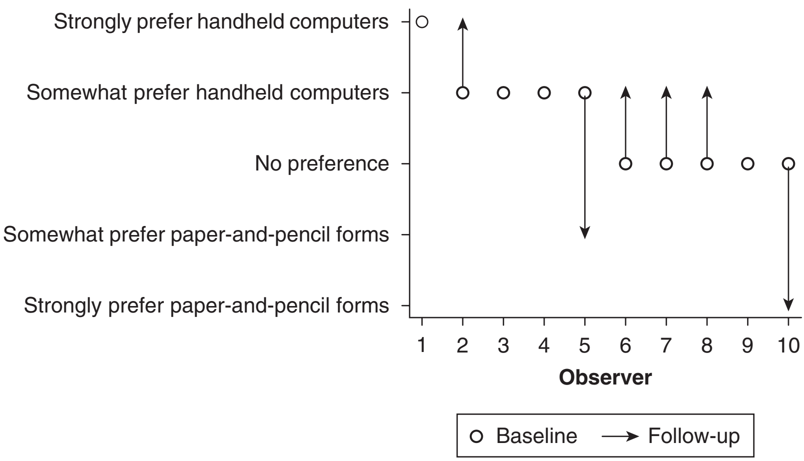
User Perceptions

The potential advantages of CADC depend on users' comfort and satisfaction with the technology. To assess NOC observers' attitudes toward handheld computers, we administered a brief questionnaire before training and after data collection was complete. Ten of the eleven observers who were certified for data collection completed the questionnaire at baseline and follow-up. Nine were women; all had at least some college education; and their mean age was 41.1 years ($SD = 7.3$). There is no evidence that observers who completed training but were not certified differed from the others in terms of their perceptions of handheld computers.

Figure 2 displays observers' overall preference for handhelds versus paper-and-pencil forms at baseline and at follow-up. Before training, five observers expressed no preference for either handhelds or paper-and-pencil forms. The remaining five somewhat or strongly preferred using handheld computers for the NOC. Thus, although NOC observers did not have previous experience with handheld computers, they were receptive to the technology. After data collection was complete, four observers reported a stronger preference for handheld computers than they had at baseline, such that seven of ten observers preferred handhelds over paper-and-pencil forms. Two other raters, including one who preferred handhelds at the outset, more strongly preferred using paper-and-pencil forms at follow-up.

Table 1 provides some insight into factors that may affect observers' overall preference. Three questions assessed observers' attitudes about ease of use. Nine of ten NOC observers agreed that handhelds were easy to use (Q1) and that handhelds made it easier to do their job (Q9). All ten rejected the suggestion that it was difficult to learn to use the handheld (Q3).

FIGURE 2
User Preferences for Handheld Computers
versus Paper-and-Pencil Forms before Training and after Data Collection



We also tried to gauge observers' opinions about the size of handhelds, because size is both a unique benefit and potential weakness of handheld computers. Nine observers liked the size of the handheld in general (Q2). Seven of ten reported it was not difficult to read words on the screen (Q4). These results allay concern that small screen size is a major barrier to using handhelds for CADC. Still, instruments must be designed with screen size in mind. Researchers also should weigh the importance of screen size in choosing a handheld computer, since newer models offer larger resolutions than do models from a few years ago. For example, the Palm T|X device has a resolution of 320 × 480 pixels, and the Alphasmart Dana unit has a widescreen 560 × 160 display, whereas the Palm m125 has a resolution of only 160 × 160 pixels.

We speculated that using handheld computers might enhance the research capacity or professionalism of NOC observers. Table 1 suggests that observers did not see such a benefit for themselves (Q5, Q7). Table 1 also indicates that four observers worried about the safety of using handheld computers in the neighborhoods where they collected data (Q6). The observer who strongly preferred paper forms at follow-up noted, "I think that using the PDA is not very safe in some areas because you are to concentrate on putting information in the PDA, and someone can attack you."

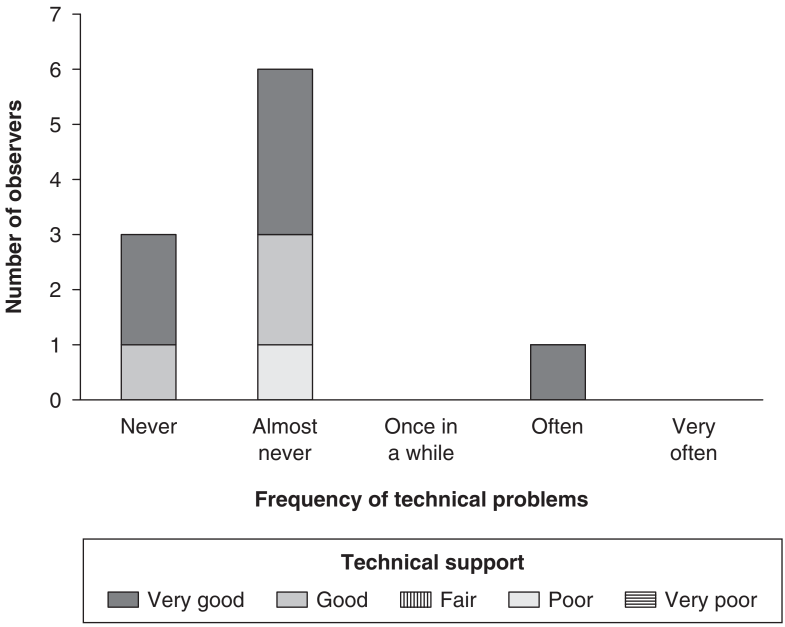
TABLE 1
Frequency Distribution and Summary of User Attitudes toward Handheld Computers after Data Collection (N = 10)

	Strongly Agree	*Agree*	*Undecided*	*Disagree*	*Strongly Disagree*	*Mean (SD)*[a]
The handheld computer is easy to use.	6	3	1	0	0	1.5 (0.71)
I like the size of the handheld computer.	2	7	1	0	0	1.9 (0.57)
It was difficult to learn to use the handheld.	0	0	0	5	5	1.5 (0.53)
It is difficult to read the words on the handheld screen.	0	2	1	5	2	2.3 (1.06)
I feel more professional using the handheld than I would with a paper-and-pencil form.	3	3	1	1	2	2.6 (1.58)
I worry about someone trying to steal the handheld in the field.	1	3	0	5	1	2.8 (1.32)
Using handheld computers helps my career development.	1	0	7	2	0	3.0 (0.82)
Using handheld computers made me more interested in the project.	2	5	2	1	0	2.2 (0.92)
Handheld computers made it easier to do this job.	4	5	0	1	0	1.8 (0.92)
In future research projects, I would prefer to use paper forms instead of a handheld computer.	1	0	0	5	4	1.9 (1.20)

a. For calculation of means and SD, items 3, 4, 6, and 10 are reverse coded. Means closer to 1.0 indicate more favorable ratings.

Given that 40% of NOC observers expressed similar concerns, it would be advisable to address this issue during training in future projects (e.g., be alert to context; be willing to leave the field, if necessary; work in pairs).

FIGURE 3
Observers' Ratings of Technical Support, by Frequency of Technical Problems Encountered



User feedback highlighted one software-related issue that would improve satisfaction with handheld computers. Several observers stressed the importance of being able to return to completed sections of the instrument to correct mistakes. The version of Entryware software we used required observers to save data at the end of each street. They were then unable to view or edit data from previous streets. Consequently, if observers later recognized a mistake, they had to alert project staff to edit the master database. Version 5.0 of Entryware software eliminates this restriction. During the design phase, researchers may now specify whether users can skip to specific questions or sections of the instrument and whether users can edit data saved on the handheld from previous observations.

Last, user feedback indicates that NOC observers encountered few technical problems in the field. Figure 3 shows that nine of ten observers reported never or almost never having problems with the hardware's or software's working properly. When problems did occur, observers were generally satisfied with the technical support they received; nine of ten rated it as *good* or *very good*. Future researchers should expect relatively trouble-free operation of handhelds in the field but should develop sufficient expertise in their CADC system to provide support when problems arise.

CONCLUSIONS

Handheld computers make the advantages of CADC increasingly accessible to field-based researchers, including those who use direct neighborhood observation. The HEP-NOC benefited from the mobility of handheld computers and from reduced costs in data entry and postcollection processing. Although CADC may have advantages for data quality, our resources and research design did not allow us formally to test whether the use of handheld computers for data collection significantly improved data quality as compared to pen-and-paper methods. Future research should address this limitation; studies designed explicitly to compare data quality and costs across data-collection modes would be valuable.

Our experience highlights several factors that improve the likelihood of success with handheld computers for direct observational studies. First, it is important to tailor the choice of hardware and software to the specific needs of a project. Entryware software for Palm-powered computers worked well for the NOC, and improvements in the current version make it an even more attractive option. But it is not the only option, and alternative products may better meet the needs of other projects.

Second, our project benefited from having personnel with previous experience using handheld computers for CADC. One virtue of Palm-powered hardware and software is their relative simplicity. Researchers with no programming skills can design and deploy data-collection instruments for handheld computers. Yet, it is important for project personnel to become proficient in the chosen CADC system to deal with potential problems and to maximize the benefits of the technology.

Third, although the use of handhelds reduced postcollection processing and improved turnaround time after data collection, it also required additional time to select a CADC system, to develop and test the instrument on handheld computers, and to train observers in the technology. Researchers should plan on this trade-off between front-end and back-end costs.

NOTES

1. Barrett and Barrett (2001) developed the free, open-source Experience Sampling Program (ESP) software for running surveys or experiments on the Palm platform (http://www.experience-sampling.org/).

2. For details about Entryware software, see the review by Gravlee (2002) and visit http://www.techneos.com/.

3. It is possible to make notes using the handheld itself. One could toggle between Entryware software and other programs such as the Palm OS's Memo application. However, this would require observers to be extremely proficient in entering text on a Palm device. Because our instrument required text entry in only one place (street name), we opted not to train observers in Palm's Grafitti writing software.

REFERENCES

Barrett, L. F., and D. J. Barrett. 2001. An introduction to computerized experience sampling in psychology. *Social Science Computer Review* 19 (2): 175–85.

Bassett, J. F., and J. M. Dabbs. 2005. A portable version of the go/no-go association task (GNAT). *Behavior Research Methods* 37 (3): 506–12.

Bernhardt, J. M., V. J. Strecher, K. Bishop, P. Potts, E. M. Madison, and J. Thorp. 2001. Handheld computer-assisted self-interviews: User comfort level and preferences. *American Journal of Health Behavior* 25 (6): 557–63.

Bernhardt, J. M., S. Usdan, and A. Burnett. 2005. Using handheld computers for daily alcohol assessment: Results from a pilot study. *Journal of Substance Use* 10 (6): 347–53.

Bobula, J. A., L. S. Anderson, S. K. Riesch, J. Canty-Mitchell, A. Duncan, H. A. Kaiser-Krueger, R. L. Brown, and N. Angresano. 2004. Enhancing survey data collection among youth and adults: Use of handheld and laptop computers. *Computers, Informatics, Nursing* 22 (5): 255–65.

Caughy, M. O., P. J. O'Campo, and J. Patterson. 2001. A brief observational measure for urban neighborhoods. *Health & Place* 7 (3): 225–36.

Couper, M. P. 2000. Usability evaluation of computer-assisted survey instruments. *Social Science Computer Review* 18 (4): 384–96.

Couper, M. P., S. E. Hansen, and S. A. Sadosky. 1997. Evaluating interviewer performance in a CAPI survey. In *Survey measurement and process quality*, edited by L. Lyberg, P. Biemer, M. Collins, E. de Leeuw, C. Dippo, N. Schwarz, and D. Trewin, 267–85. New York: John Wiley.

Couper, M. P., and W. L. Nicholls II. 1998. The history and development of computer assisted survey information collection methods. In *Computer assisted survey information collection*, edited by M. P. Couper, R. P. Baker, J. Bethlehem, C. Z. F. Clark, J. Martin, W. L. Nicholls II, and J. M. O'Reilly, 1–17. New York: John Wiley.

Craig, C. L., R. C. Brownson, S. E. Cragg, and A. L. Dunn. 2002. Exploring the effect of the environment on physical activity: A study examining walking to work. *American Journal of Preventive Medicine* 23 (2, suppl. 1): 36–43.

Cummins, S., S. Macintyre, S. Davidson, and A. Ellaway. 2005. Measuring neighbourhood social and material context: Generation and interpretation of ecological data from routine and non-routine sources. *Health & Place* 11 (3): 249–60.

Cunningham, G. O., Y. L. Michael, S. A. Farquhar, and J. Lapidus. 2005. Developing a reliable senior walking environmental assessment tool. *American Journal of Preventive Medicine* 29 (3): 215–17.

de Heer, W. F. 1991. The use of handheld computers in social surveys of the Netherlands Central Bureau of Statistics. *The Statistician* 40:125–38.

de Leeuw, E., J. Hox, and S. Kef. 2003. Computer-assisted self-interviewing tailored for special populations and topics. *Field Methods* 15 (3): 223–51.

de Leeuw, E., and W. L. Nicholls II. 1996. Technological innovations in data collection: Acceptance, data quality and costs. *Sociological Research Online* 1 (4). Available at http://www.socresonline.org.uk/1/4/leeuw.html.

Diez Roux, A. V. 2003. Residential environments and cardiovascular risk. *Journal of Urban Health* 80 (4): 569–89.

Dixon, M. R. 2003. Creating a portable data-collection system with Microsoft(R) embedded visual tools for the pocket PC. *Journal of Applied Behavior Analysis* 36 (2): 271–84.

Ellen, I. G., T. Mijanovich, and K.-N. Dillman. 2001. Neighborhood effects on health: Exploring the links and assessing the evidence. *Journal of Urban Affairs* 23 (3–4): 391–408.

Emery, J., C. Crump, and P. Bors. 2003. Reliability and validity of two instruments designed to assess the walking and bicycling suitability of sidewalks and roads. *American Journal of Health Promotion* 18 (1): 38–46.

Farquhar, S. A. 2000. Effects of the perceptions and observations of environmental stressors on health and well-being in residents of eastside and southwest Detroit. Doctoral dissertation, Department of Health Behavior and Health Education, University of Michigan, Ann Arbor.

Fletcher, L. A., D. J. Erickson, T. L. Toomey, and A. C. Wagenaar. 2003. Handheld computers: A feasible alternative to paper forms for field data collection. *Evaluation Review* 27 (2): 165–78.

Forster, D., and R. W. Snow. 1995. An assessment of the use of hand-held computers during demographic surveys in developing countries. *Survey Methodology* 21 (20): 179–84.

Gravlee, C. C. 2002. Mobile computer-assisted personal interviewing (MCAPI) with handheld computers: The Entryware System v3.0. *Field Methods* 14 (3): 322–36.

Greene, P. D. 2001. Handheld computers as tools for writing and managing field data. *Field Methods* 13 (2): 181–97.

Hewett, P. C., A. S. Erulkar, and B. S. Mensch. 2004. The feasibility of computer-assisted survey interviewing in Africa: Experience from two rural districts in Kenya. *Social Science Computer Review* 22 (3): 319–34.

Ice, G. H. 2004. Technological advances in observational data collection: The advantages and limitations of computer-assisted data collection. *Field Methods* 16 (3): 352–75.

Johannes, C. B., S. L. Crawford, J. Woods, R. B. Goldstein, D. Tran, S. Mehrotra, K. B. Johnson, and N. Santoro. 2000. An electronic menstrual cycle calendar: Comparison of data quality with a paper version. *Menopause* 7 (3): 200–8.

Johannes, C., J. Woods, S. Crawford, H. Cochran, D. Tran, and B. Schuth. 2000. Electronic versus paper instruments for daily data collection. *Annals of Epidemiology* 10 (7): 457.

Kahng, S., and B. A. Iwata. 1998. Computerized systems for collecting real-time observational data. *Journal of Applied Behavior Analysis* 31 (2): 253–61.

Kawachi, I., and L. F. Berkman. 2003. *Neighborhoods and health*. New York: Oxford University Press.

Koop, A., and R. Mosges. 2002. The use of handheld computers in clinical trials. *Controlled Clinical Trials* 23 (5): 469–80.

Macintyre, S., A. Ellaway, and S. Cummins. 2002. Place effects on health: How can we conceptualise, operationalise and measure them? *Social Science & Medicine* 55 (1): 125–39.

McGuire, J. B. 1997. The reliability and validity of a questionnaire describing neighborhood characteristics relevant to families and young children living in urban areas. *Journal of Community Psychology* 25 (6): 551–66.

Parr, C. S., T. Jones, and N. B. Songer. 2004. Evaluation of a handheld data collection interface for science learning. *Journal of Science Education and Technology* 13 (2): 233–42.

Pikora, T. J., F. C. L. Bull, K. Jamrozik, M. Knuiman, B. Giles-Corti, and R. J. Donovan. 2002. Developing a reliable audit instrument to measure the physical environment for physical activity. *American Journal of Preventive Medicine* 23 (3): 187–94.

Raudenbush, S. W., and R. J. Sampson. 1999. Ecometrics: Toward a science of assessing ecological settings, with application to the systematic social observation of neighborhoods. *Sociological Methodology* 29 (1): 1–41.

Robert, S. A. 1999. Socioeconomic position and health: The independent contribution of community socioeconomic context. *Annual Review of Sociology* 25:489–516.

Sampson, R. J., J. D. Morenoff, and T. Gannon-Rowley. 2002. Assessing "neighborhood effects": Social processes and new directions in research. *Annual Review of Sociology* 28:443–78.

Sampson, R. J., and S. W. Raudenbush. 1999. Systematic social observation of public spaces: A new look at disorder in urban neighborhoods. *American Journal of Sociology* 105 (3): 603–51.

Schlossberg, M. N.d.. From TIGER to audit instruments: Using GIS-based street data to measure neighborhood walkability. *Transportation Research Record*. Under review.

Schulz, A. J., S. Kannan, J. T. Dvonch, B. A. Israel, A. Allen, S. A. James, J. S. House, and J. Lepkowski. 2005. Social and physical environments and disparities in risk for cardiovascular disease: The Healthy Environments Partnership conceptual model. *Environmental Health Perspectives* 113 (12): 1817–25.

Tourangeau, R. 2004. Survey research and societal change. *Annual Review of Psychology* 55:775–801.

Trapl, E. S., E. A. Borawski, P. P. Stork, L. D. Lovegreen, N. Colabianchi, M. L. Cole, and J. M. Charvat. 2005. Use of audio-enhanced personal digital assistants for school-based data collection. *Journal of Adolescent Health* 37 (4): 296–305.

van Griensven, F., S. Naorat, P. H. Kilmarx, S. Jeeyapant, C. Manopaiboon, S. Chaikummao, R. A. Jenkins, W. Uthaivoravit, P. Wasinrapee, P. A. Mock, and J. W. Tappero. 2006. Palmtop-assisted self-interviewing for the collection of sensitive behavioral data: Randomized trial with drug use urine testing. *American Journal of Epidemiology* 163 (3): 271–78.

Villordon, A., J. Franklin, and D. LaBonte. 2004. Using personal digital assistants and database forms as tools for field data collection: Practical experiences from research trials. *HortTechnology* 14 (3): 402–5.

Weber, B. A., and B. L. Roberts. 2000. Data collection using handheld computers. *Nursing Research* 49 (3): 173–75.

Weich, S., E. Burton, M. Blanchard, M. Prince, K. Sproston, and B. Erens. 2001. Measuring the built environment: Validity of a site survey instrument for use in urban settings. *Health & Place* 7 (4): 283–92.

Zenk, S. N., A. J. Schulz, J. S. House, A. Benjamin, and S. Kannan. 2005. Application of community-based participatory research in the design of an observational tool: The Neighborhood Observational Checklist. In *Methods in community-based participatory research for health*, edited by B. A. Israel, E. Eng, A. J. Schulz, and E. A. Parker, 167–87. San Francisco: Jossey-Bass.

Zenk, S. N., A. J. Schulz, G. Mentz, J. S. House, C. C. Gravlee, P. Miranda, P. Miller, and S. Kannan. N.d. Inter-rater and test-retest reliability: Methods and results for the neighborhood observational checklist. *Health & Place*: in press.

*CLARENCE C. GRAVLEE is assistant professor of anthropology at the University of Florida, Gainesville. His research examines the contribution of sociocultural factors to racial inequalities in health. Recent publications include "Ethnic Classification in Puerto Rico: The Cultural Model of 'Color'" (*Social Forces*, 2005); "Skin Color, Social Classification, and Blood Pressure in Southeastern Puerto Rico" (*American Journal of Public Health*, 2005, with W. W. Dressler and H. R. Bernard); and "Race and Ethnicity in Public Health Research: Models to Explain Health Disparities" (*Annual Review of Anthropology*, 2005, with W. W. Dressler and K. S. Oths).*

*SHANNON N. ZENK is assistant professor in public health nursing at the University of Illinois at Chicago. Her research focuses on contributions of built and social environments to racial/ethnic and socioeconomic disparities in health. Publications include "Fruit and Vegetable Intake in African Americans: Income and Store Characteristics" (*American Journal of Preventive Medicine*, 2005) and "Neighborhood Racial Composition, Neighborhood Poverty, and the Spatial Accessibility of Supermarkets in Metropolitan Detroit" (*American Journal of Public Health, 2005*).*

SACHIKO WOODS is currently the field coordinator for the Healthy Environments Partnership's Lean and Green in Motown project. She has been working with a community-based participatory research (CBPR) cardiovascular study for the past 3 years facilitating the data collection operations, which include management of blocklisting; in-person, in-depth interviews; focus groups; and direct observation of pedestrian, physical, and social environments using the neighborhood observation checklist and other tools.

*ZACHARY ROWE is program director at Friends of Parkside, a community-based organization in Detroit, Michigan. He is a member of the Healthy Environments Partnership Steering Committee and a partner in the Detroit Community–Academic Urban Research Center. Recent publications include "Discrimination, Symptoms of Depression, and Self-Rated Health among African American Women in Detroit: Results from a Longitudinal Analysis" (*American Journal of Public Health*, 2006, with others) and "Community Action against Asthma: Examining the Partnership Process of a Community-Based Participatory Research Project" (*Journal of General Internal Medicine*, 2006, with others).*

*AMY J. SCHULZ is research associate professor in the School of Public Health and the Institute for Research on Women and Gender at the University of Michigan. She is coeditor (with L. Mullings) of *Gender, Race, Class, and Health: Intersectional Approaches* (Jossey-Bass, 2006). Other recent publications include "Being Part of the World: Detroit Women's Perceptions of Health and the Social Environment" (*Journal of Contemporary Ethnography*, 2004, with L. B. Lempert) and "Psychosocial Stress and Social Support as Mediators of Relationships between Income, Length of Residence and Depressive Symptoms among African American Women on Detroit's Eastside" (*Social Science and Medicine*, 2006, with others).*