Wearable Sociometers in Chaotic Simulated Environments[1]

Denny Yu
Health Sciences Research,
Mayo Clinic,
Rochester, MN 55905

Renaldo C. Blocker
Health Sciences Research,
Mayo Clinic,
Rochester, MN 55905

M. Susan Hallbeck
Health Sciences Research,
Mayo Clinic,
Rochester, MN 55905

Ashokakumar Patel
College of Medicine,
Mayo Clinic,
Rochester, MN 55905

Kalyan S. Pasupathy[2]
Health Sciences Research,
Mayo Clinic,
Rochester, MN 55905
e-mail: pasupathyk@mayo.edu

1 Background

Sociometers are wearable devices that record speech patterns, body movements, user proximities, and face-to-face interactions [1], see Fig. 1. They capture and store frequency and duration of such interactions. Such interaction data can be used to gain a macrolevel perspective of interactions, quantify behaviors of participants, gain insights, and identify areas to intervene prospectively. Although the technology was piloted almost a decade ago, its potential in applied research has only been recently recognized to study gender, collaborative spaces, and personality in domains such as office, finance, and healthcare [2–4]. Typically, sociometers have been used in settings to study interactions between two isolated individuals in less chaotic settings such as in dating and interviews.

The potential of these devices has not been tested in unstructured and more complex environments. Research is needed to compare sociometers data against gold standards to understand their limitations and potential. The objective of this paper is to understand the limitations and potential of sociometer devices in a live in situ field disaster preparedness simulation [5]. This paper has two specific aims to compare sociometer data:

(1) with field observation notes to see if sociometers can capture macrolevel interactions; and
(2) to video recorded (ground truth) interactions to test the granularity and accuracy of sociometer data.

These results may facilitate use of sociometers in similar chaotic environments with complexity and uncertainty such as the emergency department.

2 Methods

The study was conducted in a dynamic disaster preparedness simulation environment involving over 150 actors and community participants for a total of 3.4 hr [5]. In this scenario, actors were moulaged and trained to simulate an infectious disease outbreak. Volunteer medical students, faculty, and community participants were tasked to respond to the unfolding emergency by identifying, triaging, and treating the large influx of "zombies." The specific focus of this study was on the aid station participants that were tasked with providing routine care to refugees, making decisions about patient transfers, and treating minor injuries.

Five participants from the aid station and two observers wore sociometers around the neck (Figs. 1 and 2). The aid station participants consisted of four roles: leader, physicians ($n = 2$), physical therapist (PT), and nurse (NS). In addition, three faculty members supervising the entire simulation were also instrumented with sociometers. Abbreviations for participants are as follows: aid station lead (LD); medical physician female (MF); medical physician male (MM); NS; PT; observers (O1 and O2); and simulation supervisors (S1, S2, and S3).

Each sociometer device contained a WT12 Bluetooth module [6]. The Bluetooth transmitter scanned for discoverable signals from other devices at 25 s intervals, and each scan required 10 s. Range for detecting Bluetooth signals in an office environment had been reported to be 1.5–4.5 m [2]. Interaction was defined as the duration that each sociometer device was within the Bluetooth detection range. Data over time were collected from each participant's sociometer [6]. Interactions over time data were downloaded using software provided by the Sociometric Solutions [6].

Comparison of interaction data was conducted using two methods. First, observer-O1 recorded major activities real-time using an electronic tablet application. Second method compared sociometer data with a 15 min video recording of a debrief session where the group primarily remained stationary in a circle with occasionally movement observed for LD, MM, and O1 (Fig. 2). Interaction data from the video were manually annotated using

Fig. 1 Participant wearing white sociometer device

Fig. 2 Debriefing session during the live disaster simulation. Stars represent sociometers on participants. From left to right: MF, MM, PT, LD, and NS.

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[2]Corresponding author.
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Table 1 Total duration of interactions (min) between each pair of participants

	LD	MF	MM	NS	PT	O1	S1	O2	S2	S3
LD	X	54	82	51	82	61	7	13	6	2
MF		X	44	0	40	5	0	7	7	7
MM			X	46	134	3	0	16	2	3
NS				X	51	4	0	13	0	0
PT					X	8	0	4	1	3
O1						X	0	60	0	0
S1							X	28	31	14
O2								X	33	16
S2									X	17
S3										X

video annotation software. Interactions detected by the sociometer devices during the 15 min video interval were compared with the video annotations.

3 Results

A summary of the interactions for all participants during the 3.4 hr simulation is shown in Table 1. When scanning for other Bluetooth devices, sociometer devices do not detect themselves, and thus no values exist for the diagonal. The most prevalent interaction between two individuals was 134 min and occurred between the male physician and the PT. The lead had the most interaction (358 min) and supervisors had the least interactions (62–80 min). Simulation supervisors interacted with aid station participants less than other supervisors and observers.

A 15 min video recording of the aid station debrief session (Fig. 1) was compared with the data collected by the sociometers to understand the application and limitation of the device against a ground truth. Figure 3 plots the interactions collected by the sociometers during the video segment.

4 Interpretation

Sociometer devices captured several unique dynamics that were consistent with observations recorded during the entire disaster preparedness scenario (Table 1 and Specific Aim 1). The sociometer on the lead recorded the most interactions and is consistent with their observed role in ensuring clear communication between participants, supervisors, and observers during the simulation. While the lead had the most interactions, PT and MM had the most interactions (305–306 min) with the other aid station participants (i.e., LD, MF, MM, NS, and PT).

Although summary data in Table 1 of the full simulation are consistent with behaviors noted from recorded observations (Specific Aim 1), comparing sociometer devices with video data revealed several calibration limitations (Fig. 3 and Specific Aim 2). For this paper, comparisons between sociometer and video will focus on O2, who video recorded the debrief session (Fig. 2) during the simulation, and O1, who systematically circled the group. At video time = 0, the sociometer on O2 briefly detected signal from MM who is standing approximately 1.5 m in front (Figs. 2 and 3). As MM turned to face the group, sociometer failed to detect interactions between O2 and MM until MM briefly turned perpendicular toward O2 at $t = 360$ s (Fig. 2). In contrast, no interactions were recorded between O2 and PT who was directly in front of O2 (Fig. 2). These two examples suggest that current calibration settings on sociometer devices have difficulty capturing interactions between devices when bodies obstruct their line-of-sight. Due to the circle formation during the debrief, the sociometer on observer O1 was frequently obstructed from the sociometers of the other participants; however, interactions were detected between LD and O1 when LD exited the circle to debrief with the observers at time = 461 s (Fig. 2), but was 15 s offset

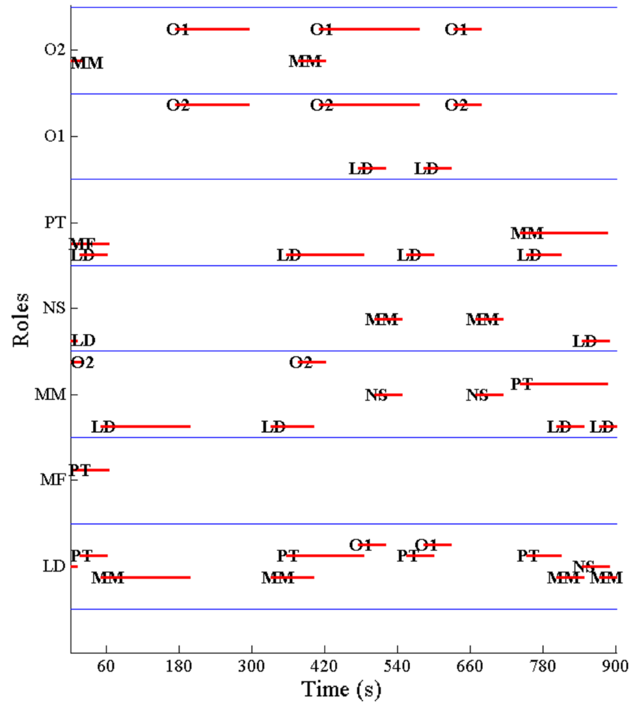

Fig. 3 Interactions (s) recorded by the sociometers during the 15 min video segment. *Y* axis = participants; abbreviations on plot represent interactions with *y*-axis participant; and line = redinteraction duration (s).

from the timestamp observed in the video and can be explained by the Bluetooth scanning interval settings. Although interactions between O1 and O2 was successfully detected when O1 debriefed with O2 at $t = 395$ s, false detection also occurred at time = 159 s when O1 was 12 m away, back turned, and with two aid station participants in between.

This study demonstrated the application of sociometers in a complex, dynamic, and chaotic field-based training environment. Results presented in this study: (1) provide information on interactions among participants during a simulated disaster event and (2) highlight limitations of the sociometer devices in this environment. In conclusion, sociometers can be valuable to the informatics field of study and offer unique information about interactions during a prolonged period of time (Table 1) [1–4]. Our analysis also suggests further refinements are needed for future iterations of this device, including: (1) calibrating Bluetooth detection frequency and detectable durations for short granular studies, (2) reduce false detections, and (3) reduce interference that hinders detecting true interactions.

References

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