Mind the Gap: How Good Are We at Keeping Our Distance?

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During the Covid-19 pandemic, many countries instigated regulations to encourage us all to physically keep 2 meters apart when we encountered people outside our households or support bubbles, a practice commonly referred to as social distancing by (inter)governmental organizations such as the WHO, the NHS, and the CDC. Anecdotally, however, this distancing appears to have been hard to put into practice: Maybe you've experienced someone reach over you to get a box of pasta from a supermarket shelf (or even done it yourself). Or perhaps—if you have to go into work—you have had a colleague approach you in the corridor or at your desk at what feels like a shorter distance than the recommended 2 meters. Hence, though most of us have tried to keep our distance from others, it is easy to slip up. This is because we are goal-directed beings (e.g., getting pasta is our main goal), resulting in our overlooking secondary goals, like social distancing. Many have become weary of trying to keep their distance. Or maybe we are simply bad at judging 2 meters when we are in a social space. If so, can we design technology to inform us when we have gotten too close to another person?

It seems likely that despite the widespread vaccination program underway, social distancing will remain necessary for some time. Have we internalized the distancing rule, given that more than a year has passed since it was introduced? Or will we need to be constantly reminded, like the "mind the gap" message that is played on parts of the London Underground every time the train doors open? To this end, we have identified the problems of social distancing and a potential solution. We report here on three studies: (i) an exploratory lab study looking at how well people judge 2 meters, (ii) a survey investigating people's attitudes and beliefs about social distancing, and (iii) an in-the-wild study of the efficacy of Bump, a smart wearable device designed to remind, deter, and help office workers keep a safe distance from one another.

Distancing in an Ideal World?

Most research on human perception of physical distance has involved relatively short lengths, for example, between 20 and 120 cm [1]. It says little about how we estimate longer distances. We wanted to conduct a quick study to see how well people can measure 2 meters after a year of being made aware through signs posted in public spaces. Bearing in mind Covid-19-related restrictions, we were only able to ask those people who had come into our university for their work. We ran a lab study, positioning two mannequins apart from each other (see Figure 1). We then asked 19 people (3 women, 16 men) in our building to walk at a normal pace toward one mannequin, stop when they felt they were 2 meters

from it, and then place a piece of sticky tape on the floor to mark the point where they stopped. They repeated this task for the second mannequin. We then measured the distance between the mannequins and the marks the participants made on the floor.

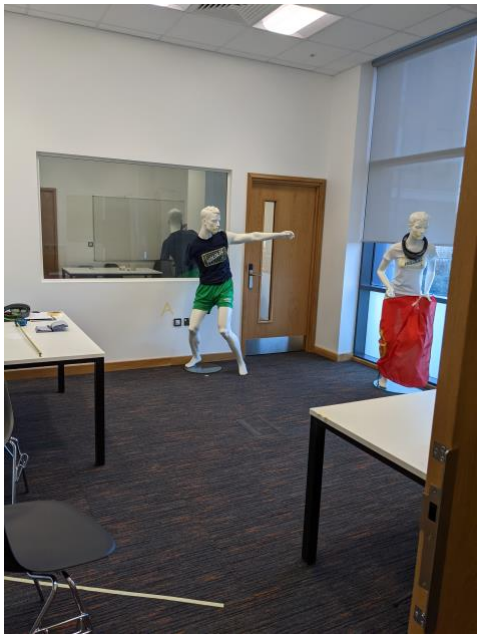

Figure 1. The two mannequins that participants were asked to stop 2 meters from.

Many participants underestimated the distance. On average, participants stopped 35 cm to close to the mannequins, with 68 percent of attempts being between 133 and 196 cm. Two people stopped very close to 2 meters (199 cm and 198 cm); one was far off the mark, at 89 cm (see Table 1). These findings suggest that people find it difficult to estimate the distances commonly required by social-distancing regulations. This is likely to be exacerbated in the real world, especially when people are not actively thinking about the 2-meter rule, and where there are numerous distractions. Such individual variability is a cause for concern. It is similar to how there are both good and bad drivers—however good you may be at keeping your distance, others might not be so careful.

But how generalizable are the behaviors recorded in our U.K.-based lab to global contexts (only three of our participants were from India and China)? Findings from another survey about cultural differences in how comfortable people feel in proximity to one another revealed Argentines were happy to get as close as 77 cm to one another; Hungarians stopped at 131 cm [2]. No one, regardless of culture, indicated a preference for being more than 140 cm from another person. Taken together, these findings suggest that there are both individual and cultural differences in “natural” and “enforced” social distancing.

Distance from Mannequin A (in cm)	Distance from Mannequin T (in cm)	Participant M/F
115	136	M

180	154	M
186	178	F
199	197.5	M
110	89	M
195	198	M
177	157	F
178	209	M
114	132	M
183	175	M
130	140	M
176	162	M
176	178	M
179	179	M
176	186	M
128	141	M
174	174	F
159	170	M
Mean 163	Mean 164	
Std Dev 29	Std Dev 29	

Table 1. How far each participant stopped in front of each mannequin.

Distancing Out and About

In our second study, we wanted to explore people's concerns and beliefs about social distancing. A total of 118 people age 18 and older (41 percent female, 54 percent male) recruited through mailing lists, social networks, and ads on Twitter and Facebook participated in an online survey. Our recruitment was focused on the U.K. The incentive was a raffle of five £25 Amazon vouchers. Most participants were either employed full time (65 percent) or were full-time students (25 percent); 78 percent of participants indicated that they were currently working or studying from home.

Previous research has focused on people's perceptions of personal and social spaces more generally [3], rather than specifically during a pandemic. We asked a number of questions, including how difficult or easy it would be to maintain 2 meters of distance in different social situations. Our findings showed that it would be most difficult when someone enters a lift you are already in or when a coworker holds a door open for you. The easiest was when standing in a queue (see Figure 2).

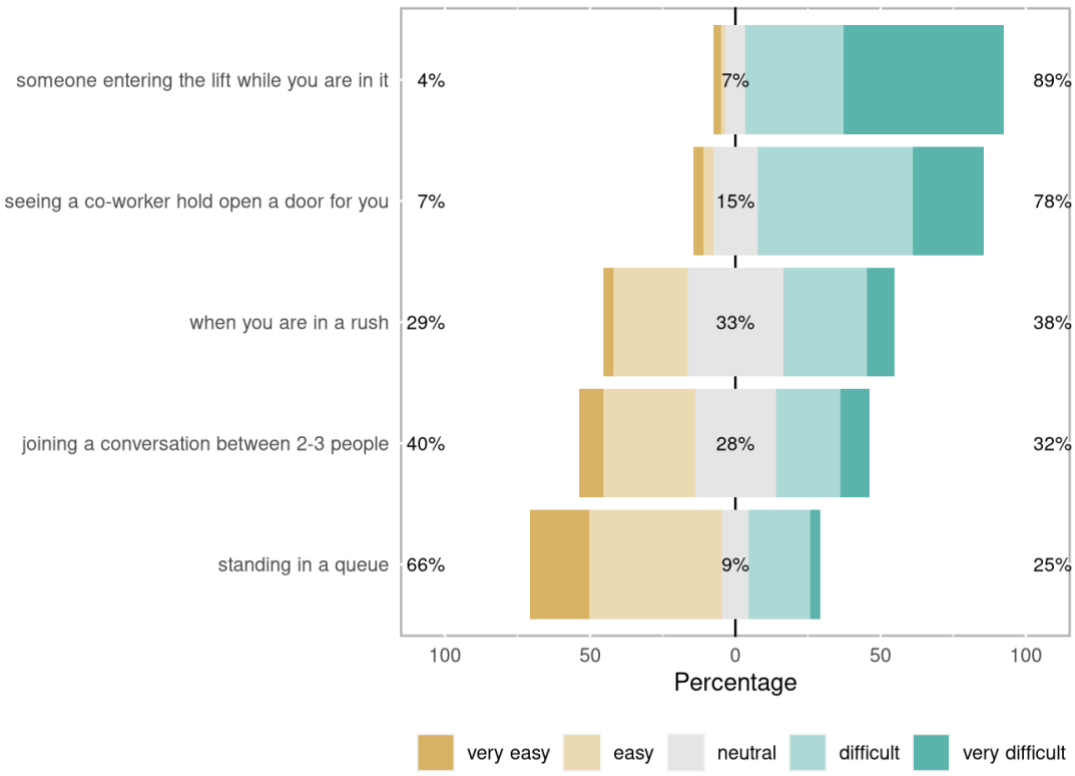

Figure 2. How difficult or easy would maintaining 2 meters of distance be in the following situations? Results of an online survey with 118 returns.

Another question asked how helpful or unhelpful the various guides that have been used for maintaining 2 meters of social distance are. The most helpful were floor markings and verbal instructions, while the least helpful were announcements and slogans (e.g., “Keep one cow apart”). This suggests directions and direct feedback are seen as being more effective than other methods (see Figure 3).

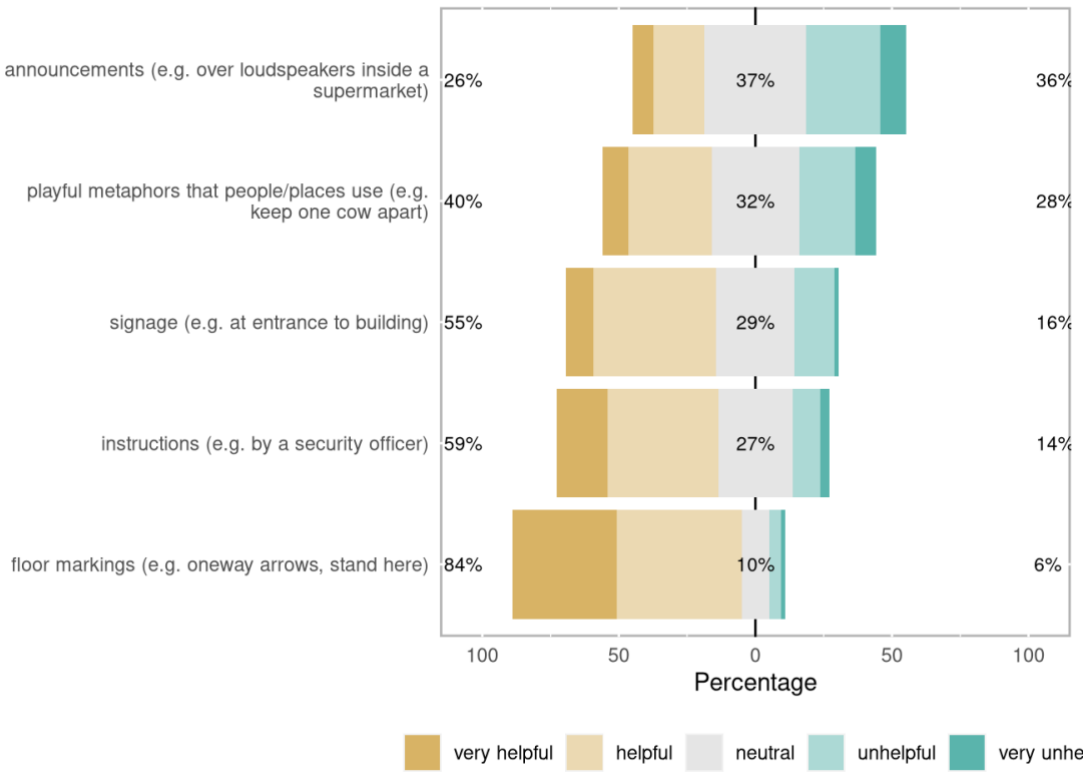

Figure 3. How unhelpful or helpful are the following guides for maintaining 2 meters of social distance?

We then asked participants whether wearing a digital device might help them better distance themselves. Our findings showed that people were favorable toward wearing a device that could help social distancing (see Figure 4). Sixty-two percent of participants indicated they would wear such a device in their place of work or study; 38 percent indicated they would not.

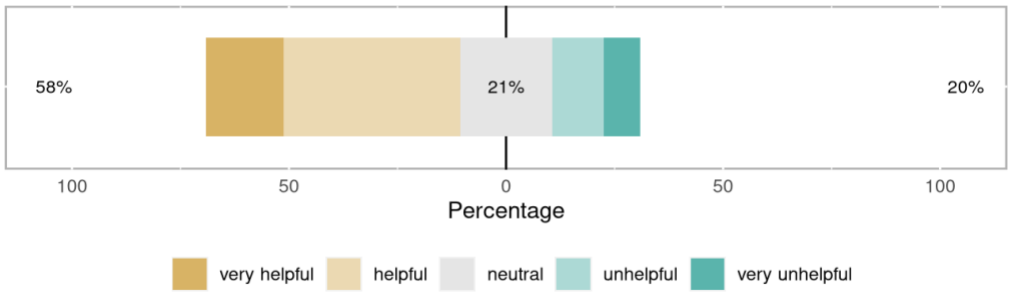

Figure 4. How helpful or unhelpful would you find wearing a device at work or school that could detect and alert you if you are closer than 2 meters to another person?

This response offers support for the benefits of providing such a device in a workplace. Next, we discuss how such a device could influence the social experience of being at work while social distancing regulations are in place.

The Social Experience of 'Minding the Gap'

The pandemic has made us acutely aware of social behaviors that we previously took for granted: shaking hands, waiting in line, opening doors for others, helping people who appear to need help. The more familiar a person is, the stronger the instinct to make contact is. Even after a year of social distancing, the urge to engage in such behaviors persists. A social distancing device can act as a nudge to help wearers stay spatially apart, while also keeping an accurate record of breaches in social distancing. These features can help off-load some of the cognitive demands that social distancing makes of us.

Enforcing social distancing can be awkward and socially sensitive. Moreover, those who are in more risky work (e.g., hospitality staff or nurses) are more vulnerable to getting sick, and may find navigating the workplace during a pandemic particularly taxing and stressful. Alongside the cognitive load of constantly visually estimating 2 meters, the act of asking others to move away can result in difficult conversations. A social distancing device that alerts users to breaches can both allow users to off-load the task of measuring 2 meters and provide an impartial record of breaches. This evidence can empower individuals to ask for change in behavior from others, even those in positions of authority, while reducing any feelings of being unfairly judged or blamed. Conversations change from "Don't get too close to me!" to "Our Bumps are going off; we'd better move back!"

Wearables to the Rescue?

Our third study investigated the lived experience of wearing custom-built social distancing technology. Tharsus, a manufacturing company in the U.K., has developed a wearable device called Bump [4]. The system comprises a network of wearable devices and an online data-management platform (see Figure 5).

Figure 5. Office workers wearing the Bump technology.

Using radio frequency technology, the device detects when the wearer moves within 2 meters of another wearer, and alerts them with a beeping sound and flashing blue LEDs. When either wearer moves within 1.2 meters of the other, the device becomes more "concerned" and emits a constant beeping sound and flashing red lights. All sub-2-meter interactions are recorded and uploaded to an online platform at the end of the day.

To investigate whether these kinds of alerts might improve users' social distancing behavior, we provided one device each for two weeks to 30 employees (28 men, 2 women) at a manufacturing and maintenance service company in North East England. When asked whether they thought the Bump would encourage them and their colleagues to socially distance, 81 percent of the participants said yes. As we were unable to visit the company ourselves, Tharsus provided the study participants with the Bump technology and collected

the interaction data, which we then analyzed. We also remotely interviewed some of the employees about their experiences.

The first week acted as a control; the wearers' devices collected data for their interactions with others, but did not alert them to any breaches in social distancing. In the second week**,** the alert system was set to On by default, but could be turned off if the user wished to.

Our findings showed that the mean time the wearers spent within 2 meters of another person per day declined by 18 percent in the second week ($t(115) = -2.3662$, p-value = 0.02). An even greater reduction (30 percent) was observed in the time spent within 1.2 meters of another person ($t(115) = -3.9146$, p-value = 0.00015). This suggests the wearable device helped them maintain social distancing more effectively. This behavioral change is likely to have been achieved through several mechanisms. For users who are self-motivated to maintain social distance, the device offers immediate evidence as to when they are in breach of the 2-meter rule, allowing for self-correction. For users who are more skeptical of social distancing, the social consequences of setting off the device's alert system, in public, could be a strong motivating force for avoiding breaches. There is also a potential gamification dynamic, as users can monitor their activity online and work to improve their record. Our study was for two weeks; a longitudinal study might be able to show how wearing the device could improve employees' spatial awareness to the extent that they are able to avoid triggering alerts altogether.

Social and Privacy Concerns

Nowadays many people carry or wear a smart security card when at work. These cards could be adapted or replaced with something like Bump where social distancing is desired. There is the thorny issue, however, that a record of social distancing breaches could be used by management to penalize employees, leading to a loss of agency at work. Such a possibility needs to be discussed within any organization that is considering adopting such technology, as well as whether this kind of management strategy is acceptable and how it will be implemented. Some may see it as yet another form of productivity-monitoring software. There is a difference, though, in what each seeks to achieve. The Bump system in particular isn't designed to increase a behavior like productivity software is (i.e., working faster, completing more tasks in a set time) but rather intended to *decrease* a risky social behavior for the safety of that community. Unlike mobile phones, the devices are not designed not to track users' live location at all times but instead to record only high-risk interactions. Once these differences have been explained, it is a matter of management and employees coming to an agreement as how best to configure and use the system, agreeing on what levels of activity would lead to concern (taking into account false alarms—e.g., interactions where the two people who "bumped" were on opposite sides of a wall), whether to provide incentives and rewards at the end of the workweek, and so on. Furthermore, the supporting platform provides a high level of data transparency for the

users themselves; employees have access to the same evidence as management does. It would depend on the culture of the organization as to how it would share the data collected by such a device—to penalize or to reward, to reveal or to withhold. Clearly, a naming-and-shaming strategy, showing who had racked up the most breaches, would be viewed as offensive by most; but a weekly notification showing which group or team has recorded the least number of breaches that week might be viewed as informative and fun.

Some wearers confirmed that the Bump's beeping and flashing became irritating, which led some to creatively "pervert" the system, such as taking the device off or holding it at arm's length when talking to someone, to prevent the alert from being activated. Similar avoidance behavior has been observed among users of the NHS track-and-trace app, where users have switched their Bluetooth off, deleted the app, or turned their phone off to avoid being "tracked and traced." The Bump differs because it cannot be switched off, and other users can check and police any improper use of the device.

Finally

As we have all experienced, and our three complementary studies suggest, maintaining the 2-meter gold standard is easier said than done; simply put, social distancing is difficult to maintain unaided. While static signs and spray-painted guides can go some way toward reminding people to keep apart, wearable devices, if designed to respect people's privacy, can provide real-time feedback that could lead to effective behavioral change. While our studies have been located primarily in the U.K., the Covid-19 pandemic has highlighted society's shared responsibility and the need for globally coordinated responses, including social distancing restrictions. These restrictions impose a shared but alienating geometric order (keep 2 meters apart!) on an otherwise deeply social and cultural phenomenon of interpersonal distances [5]. We invite the diverse *Interactions* readership to reflect on their experiences and observations of, and impacts on, interactions that have happened because of distancing rules in their contexts. It is a good time for HCI researchers to conduct user studies and experiment with behavioral-change technologies that can help the world prepare for the unlikely and unexpected, joining the ranks of epidemiologists, vaccine makers, and public health policymakers.

Acknowledgments

Thanks to Ellie Jones, Dave Swan, and Paul Featonby at Tharsus for supporting the study of their Bump devices and providing the data for our analysis. The Leverhulme Trust, the Ecological Brain Programme, and the CHERISH Digital Economy Centre supported this work (EPSRC EP/M022722/1).

Endnotes

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Insights

- The different behavioral change strategies that have been deployed to regulate social distancing vary in effectiveness.
- Wearable technology was found to help reduce violations when returning to work, but privacy about the data collected is a concern.
- Now is the time for HCI/UX to conduct timely research into future health emergencies.