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COMMENT

Passive sensing of mobile media use in children and families: a brief commentary on the promises and pitfalls

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In my work with families, screen use and the management of screen use are frequent concerns I hear from parents and families. Additionally, I have strived to help parents realize that their focus should not only be on their children's screen use but also on how their own use while around their children impacts their parenting and their children (e.g., refs. [1–3]). Many parents and families feel as if they are drowning in a flood of media use and devices while others are unaware of the impact of their use. Anecdotally, many parents tell me they feel they use their phone too much. Furthermore, in my research, I often utilize self-reports, which for years I have suspected might result in the underreporting of use and technology distractions. In fact, much of the research on media use relies on self-reports. Thus, there has been a need for something better, something closer to the reality of individuals' and families' media use, and passive sensing of device and media use—like was done by Yuan et al.[4]—is a promising direction.

In line with my above intuition, Yuan et al.[4] found that most parents are not accurate reporters of their phone use. Not only could this prove to be a problem for research but also for prevention and interventions. For instance, it could mean that many of the findings that rely on self-reports of media use could be suspect, with effects being stronger (or weaker) than they currently appear in the published research. Additionally, if individuals are asked to report on their phone or other media use in therapy, medical, or other clinical settings, their answers may unintentionally misrepresent what is occurring in their life, potentially leading to interventions that are not well-fit to the individual's or family's actual media use. Yet, although passive sensing could give us more accurate information on individuals' actual use, only research can tell us which type of data will be most useful for predicting outcomes. It would be important for researchers to determine whether actual use or self-reports (individuals' perceptions) best predict outcomes over time for individuals, children, and families.

Below I outline a few exciting directions as well as limitations/struggles in regard to passive sensing of media use. Please note this is not meant to be an exhaustive list.

EXCITING FUTURE DIRECTIONS AND USES FOR PASSIVE SENSING

The potential of passive sensing is exciting for examining individuals' and families' lived experiences. We are often interested in understanding how children develop, family members interact, positive and negative outcomes develop, and much more. However, "ideal longitudinal research is characterized by the seamless integration of a well-articulated theoretical model of change, an appropriate temporal design, and a statistical model that is an operationalization of the theoretical model" (see ref. [5], p. 507). In other words, our research designs and data collection efforts must match our theories of family and developmental processes, and then the statistics we use to analyze our data should also match our theories. Depending on the spacing of assessments, we gain a very different view of the processes involved and may even miss the processes entirely—if the spacing is too large between assessments.[5] Passive sensing allows us to view media use on a moment-to-moment basis across a day, getting us closer to real life. This is important because we often make assertions about causation or theory but utilize data that is not the best suited to answer our research questions. Let me present an example. It is likely that daily technology interruptions in face-to-face interactions between parents and children may cause children to act out. However, in our recent work, we utilized parent self-reports at a single point-in-time or across months to examine this conceptualized causal process.[2,3] Yet, passive sensing of media use linked with ecological momentary assessment data (such as multiple, random self-reports across a day of child behavior, emotional states, stress, relationship feelings, and so forth) would allow for an examination of the actual within-person, moment-to-moment question at hand, getting us closer to understanding the causal process involved—instead of inferring what is happening about causation from between-person, point-in-time surveys or observations.

Another exciting avenue for passive sensing would be for use in interventions or clinical settings. Researchers and intervention scientists have already begun working in this domain. For example, Heron and Smyth[6] wrote a review article in 2010 on ecological momentary interventions, and their review concluded that interventions in individuals' lives designed around mobile technology can be effective. According to Google Scholar, their article has been cited 904 times, and a search for "ecological momentary intervention" limited to 2018 and after brings up 212 results (as of 31 May 2019), suggesting that this line of research on ecological momentary interventions has continued to expand.

Some potentially promising uses for passive sensing interventions could include nudges or notifications centered around screen limits and other recommendations given by the American Academy of Pediatrics.[7,8] This could be done in a variety of ways, but as one example imagine working with a parent, and they inform you that they typically are with their children from 5:30 p.m. until 9 p.m. They have also decided to follow the AAP's recommendations that you taught them and implement this as a

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screen free time. Passive sensing apps could be designed to monitor phone use and if the phone is used during this predetermined time the phone could give a gentle nudge or reminder to be fully present with their family. (Note that some phone tracking apps already on the market—such as QualityTime—allow individuals to set phone use limits, such as locking the device during a certain time period.) There are also many more advanced ways to do this and more, where one could design apps or devices that interact with one another such that if a device is used in the presence of a family member the device would recognize this and would therefore nudge them to be present with their family. One could also use location data such that the device recognizes when the individual is at home, school, or some other predetermined location and could give nudges when the phone is used in that specific location. The possibilities are exciting and endless for interventions.

In terms of therapy/clinical settings, one exciting and incredibly simple way passive sensing apps could be used would be to determine what a patient's media use habits are, times they tend to get on the device most, apps they use the most, and much more. This information could then be used by the clinician to teach the patient about their use and the potential for this use to impact their well-being and family well-being. For example, the clinician and patient may notice together—as they examine the patient's use via the app—that the patient tends to use their phone often from 11 p.m. to 1 a.m. A discussion could then be had about the possible effects of this use on sleep/depression and a plan could be put in place to reduce this use and improve their well-being. Although I do not discuss it here, there are also much more complex ways to utilize passive sensing to track or intervene in patients' lives and improve their well-being (e.g., see ref. [9]; for a review, see ref. [10]).

A FEW LIMITATIONS AND STRUGGLES WITH PASSIVE SENSING

Individuals live media saturated lives where use does not occur only on one device. For instance, one might switch between their phone, computer, tablet, TV, and more across a day (or use multiple devices simultaneously). Passive sensing on smartphones is a good first step, but we need passive sensing data that can integrate media use across devices to truly obtain the best picture of an individual's, child's, or family's media use. As one example, according to self-report surveys, children and teenagers clearly utilize multiple devices per day and also fit into categories of use—some engage in more passive TV viewing, others engage in more mobile gaming, and many more categories.[11] Only having data concerning phone use would miss the complex ways individuals and families engage in media use, and one could mistakenly believe that an individual or child is a light user, when in reality they are a light phone user but engage in much more media use on the TV, tablet, or other devices. Additionally, without data combined across multiple devices, we might successfully help individuals or families to manage phone use, but unbeknownst to us they have simultaneously expanded their TV or tablet use.

Another problem with passive sensing is that researchers do not know *what* participants are doing while on specific apps. For example, an individual could do any variety of things while on social media—e.g., posting photos, expressing love, providing support, engaging in infidelity, criticizing someone's beliefs, comparing oneself to others—all of which could have different effects on well-being. Unfortunately, passive sensing would only tell us that the individual had used social media for a certain amount of minutes/seconds at this specific time in the day.

An additional limitation or difficulty is how best to obtain the passive sensing data in an easy to research format. There are a variety of apps that can easily be downloaded on phones (e.g., Moment, QualityTime). However, these apps often will not allow researchers to access the data, meaning participants will need to export (or screenshot) their use and send these data to researchers. Then researchers may need to do extra steps to prepare the data for storage and analysis. Alternatively, researchers could create their own passive sensing apps or code—like was done by Yuan et al.[4] However, phones and operating systems change frequently, which would likely require updating or creating new apps or code. It is also possible that the passive sensing app does not always continue working in the background on some phones—as was seen by Yuan et al.[4] and has also been reported in user reviews in the app stores for the various phone use tracking apps.

Finally, passive sensing data require a new set of management and analysis tools that many researchers may not currently have mastered. For example, depending on the data that is being collecting there could be privacy, HIPPA, or other concerns, meaning the data must be protected and properly stored. Datasets could also become quite cumbersome with each individual having thousands (or even more) of data points per day (e.g., big data). To utilize passive sensing data to its fullest extent, researchers must also collect and manage other moment-to-moment data streams (e.g., passive sensing of physiology, self-reports of momentary stress or mood) and then link these multiple data streams together. This requires complex data management and also complex statistics that can model the within-person and moment-to-moment processes (e.g., see dynamical systems modeling, data mining, machine learning). Additionally, researchers must not allow themselves to become solely data driven, but must maintain their connections to theory and theory building.

CONCLUSION

Although the tracking or passive sensing of mobile device use is not new, passive sensing applied specifically to parents, children, and families is a frontier not yet fully explored. Passive sensing has the potential to expand our views of individual, child, and family media use and the moment-to-moment processes involved, lending itself useful for finding and better understanding the causal mechanisms and potential links between digital habits and well-being. There are many potential pitfalls and limitations, such as managing apps and multiple phone operating systems, data management, and complex modeling. However, we can and should work together (within and across our various fields) to solve these potential issues and realize the potential of passive sensing for researching and improving the lives of individuals, children, and families.

ADDITIONAL INFORMATION

Competing interests: The authors declare no competing interests.

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