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All Situational Impairments are not Created Equal: A Classification System for Situational Impairment Events and the Unique Nature of Severely Constraining Situational Impairments

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Abstract
This study explores *situationally induced impairments and disabilities* (SIIDs) from a unique perspective. A two-week diary study of mobile technology users was conducted to create a corpus of *situational impairment events* (SIEs) that mobile device users may experience in the wild. As a result, themes and classifications describing the type of SIEs that were encountered (such as ambient environmental and social/cultural issues) were identified. In addition, within the created classification system, the authors identified the presence of a subset of SIEs that where severely constraining in the sense that a workaround is not available or easily obtained, or where a technological solution was found that only led to the introduction of a new SIE. The use of the classification of SIEs as well as the identification of the unique nature of those that are severely constraining can help influence the future design of mobile technologies.
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1 Introduction

Lightweight and highly portable devices (i.e. smartphones) are now the primary means of accessing information while on-the-go (Laudon & Traver, 2015). This *mobile* aspect of mobile technology, however, often places users in contexts where environment, connectivity, and other factors are unpredictable (Barnard, Yi, Jacko, & Sears, 2007) which can lead to situationally induced impairments and disabilities (SIIDs) (Sears, Young, & Feng, 2008).

While prior to the onset of mobile technology use, many user models were still based upon the unimpaired desktop (Wobbrock, 2006), recent research has addressed issues inherent in this new mobile interaction paradigm. Some have focused on identifying cognitive and human factors unique to a mobile consumption environment, while others examined the design of technological solutions to overcome the contextual factors intrinsic in SIIDs.

But perhaps all SIIDs are not alike. Some may be caused due to difficulties accessing one channel, whereas others may be caused by cognitive load or even out of a desire to be respectful to others in a shared space. Little research to date has attempted to examine SIIDs as phenomenological events and/or categorize the similarities and/or differences that users of mobile technology might encounter. The creation of a situational impairment event corpus could assist in the formulation of comprehensive guidelines to influence design.

Also, while there are some SIIDs that can be addressed through alternative modalities or user-developed workarounds, some SIID events cannot be dealt with simply. Consider an individual who is driving and seeks an update on the arrival time at a location. A four-digit PIN is required before the information can be accessed. Inputting the request by the normal primary modality (typing) is not available. Speaking the PIN via speech recognition is an alternative modality that might be used to overcome this SIID. But, what if this individual is currently listening to their favorite song or it is very hot and they have their car window rolled down resulting in too much ambient noise to promote accurate speech recognition? Temporary workarounds could include foregoing listening to music and lowering the volume, or temporarily rolling up the window and briefly bearing the additional heat long enough to complete the I/O transaction. But what if another person was in the car and the driver did not wish to reveal the PIN by speaking it out loud?

Interaction with a device may be difficult in the presence of an SIID, but may be impossible when all of the available interface modalities are unattainable or if the alternative solution creates an additional problem. In these cases, the user is experiencing what we term a *severely constraining situational impairment* (SCSI) which can be defined as: *An occurrence of a situational impairment and disability*

where a workaround is not available or easily obtained, or where a technological solution was found that only led to the introduction of a new situational impairment and disability.

This study is an examination of SIIDs from the two perspectives described above. A qualitative diary study was conducted, where for two weeks, participants recorded every occurrence of a *situational impairment event* (SIE) from which a small SIE corpus was created. A phenomenological analysis of the SIE corpus was then conducted to reveal SIE themes and answer two research questions:

1. What are the challenges faced by individuals experiencing SIIDs, and are there common themes that can describe them?
2. Do individuals experience SCSIs and are they thematically different from SIIDs?

The findings of this study could serve to influence future design of mobile technology to better account for all types of SIIDs, which would benefit both situationally impaired users as well as users with more permanent or omnipresent impairments.

2 Related Work

Central to the discussion of mobile device usage is the concept of *context*, or information that can be used to characterize the situation of entities considered relevant to the interaction between user and application (Dey, Abowd, & Salber, 2001). Context can be categorized further as consisting of (1) the user, their activities, and the social environment, (2) the environment or location, physical conditions and infrastructure, and (3) the available applications and I/O channels (Sears, Lin, Jacko, & Xiao, 2003). This study seeks not only to understand the inter-relationship of user, appliance, and environment, but also the nature of the artifacts that are created as the result of this mobile induced inter-relationship.

Some research and literature on addressing situational impairments focuses on understanding how SIID phenomena affects the user from a cognitive and/or human factors perspective. Lin, et al., showed that, while attempting data input onto a PDA with a stylus and walking through an obstacle course, participants reduced their walking speed by 36% and increased their error rate compared to walking on a treadmill (Lin, Goldman, Price, Sears, & Jacko, 2007). Barnard, et al. attempted to address the apparent disconnect between environmental mobile device use and evaluation by varying contextual conditions and recording changes in behavior (Barnard, Yi, Jacko, & Sears, 2007). The research measured task performance of mobile device users while varying three contextual factors: task type, motion, and lighting level. The results of their study revealed that varying the lighting condition and whether or not the participant was in motion had an impact on the performance. Ali, et al. examined the SIIDs impacting individuals with visual impairments to better understand the ways in which technologies could be developed to support mobile interactions when the visual channel is unavailable. Their data gathering study highlighted the challenges faced with one handed mobile device operation while navigating and the impacts of inhospitable environments when performing mobile tasks. Findings have aimed to guide the design of future mobile interfaces to better meet the needs of users whose needs are often excluded from the design process (Ali, Kuber & Hurst, 2016).

Other research focuses on designing technology that can overcome SIIDs and improve performance. Goel, et al, presented a system called *WalkType* which used the built-in accelerometer of touch screen devices to create an adaptive text entry technique that increased typing speeds and accuracy compared to a control while the user is walking (Goel, Findlater, & Wobbrock, 2012).

Also, there is the consideration of the use of wearable technology and mobile devices that are context-aware. In examining the use of persuasive technology to promote more active life-styles in people, Harrison, el al, discuss taking advantage of smaller and more computationally sophisticated mobile device and wearable technologies that sense user behavior (Harrison, Consolvo, & Choudhury, 2010).

The focus of these studies has been on explaining the phenomenon of SIIDs and/or designing technology to attempt to overcome SIIDs. The authors of this study, however, have found no research that has attempted to catalogue and/or develop a corpus of SIIDs. The ability to classify and identify generalized types of SIIDs might make it simpler to create and utilize more specific principles, guidelines, and heuristics that can more effectively steer the design of mobile technology towards overcoming SIIDs. This study is an attempt to begin the creation of that classification system.

In addition, the understanding of different modalities and their potential incorporation for input and output tasks is useful in the addressing of SIIDs. It is, after all, the very nature of a situational impairment that results in the prevention or the encumbrance of an interface modality. Research, however, has not focused on SIIDs where not only the primary input modality might be impaired, but also the secondary and perhaps tertiary modality is limited or unavailable. In some cases, the situation may not just be impairing the completion of an I/O transaction, but is severely constraining the I/O transaction to the point

of multiple modality impairment (i.e. auditory and tactile) or total failure. Or in some scenarios the technological solution to one type of situational impairment, creates a different situational impairment. In these situations, the user has not developed a workaround and may, after several attempts, simply give up. These cases, may represent a major challenge for mobile technology design.

This study attempted to address this gap by identifying categories and themes for SIIDs. In addition, this study searched for the existence of *severely constraining situational impairments* (SCSIs), their relative place within the SIID problem space, and whether SCSIs suggest different implications for mobile technology design.

3 Study Design and Methodology

3.1 Diary Study

A solicited diary study (Koopman-Boyden & Richardson, 2013) was undertaken, in order to better understand SIIDs from a phenomenological perspective. SIIDs are often misunderstood or at least under-understood phenomena (Bolger, Davis, & Rafaeli, 2003). Diaries provide a personal perspective versus the interpretation of a researcher (Symon, 2004), enabling the capture of rich descriptions. Specifically, the study was fashioned in the spirit of a reconstruction diary, where descriptions of daily activities are entered into predefined time slots (Kahneman, Krueger, Schkade, Schwarz, & Stone, 2004). This method was used recently in a study where participants described how they used their smartphones during specific daily event intervals (Oulasvirta, Rattenbury, Ma, & Raita, 2012), and in a study that compared the use of smartphones and tablets for everyday activities (Müller, Gove, Webb, & Cheang, 2015).

For the present study, we specifically sought to identify SIEs which were ad hoc occurrences. Therefore, no specific time interval was required other than the requirement of a minimum of one report per day (see description in the next subsection).

3.2 Methodology and Procedure

Smartphone users (15 total, six female) with an age range of 20 to 64 years (mean 34.7, standard deviation 14.4) participated in a two-week diary study preceded by a 30-minute introductory session. Participants were provided with informed consent forms and told that each would receive $20 compensation upon completion. The two-week time period appears to be a common time frame for shorter and non-longitudinal research such as the present study, and is similar to the length of time spent evaluating smartphone usage (i.e. Oulasvirta, Rattenbury, Ma, & Raita, 2012; Müller, Gove, Webb, & Cheang, 2015).

ID	Age/Sex	Education
Cohort 1 (mean age = 21, standard deviation 1)		
RD1P1	22/F	Current Undergrad Student
RD1P2	20/M	Current Undergrad Student
RD1P3	22/M	Current Undergrad Student
RD1P4	20/F	Current Undergrad Student
RD1P5	21/M	Some Undergrad
Cohort 2 (mean age = 32, standard deviation 7.9)		
RD2P1	29/M	Current Grad Student
RD2P2	27/M	Undergrad Degree
RD2P3	46/F	PhD (or terminal degree)
RD2P4	28/M	Undergrad Degree
RD2P5	30/F	Graduate Degree
Cohort 3 (mean age = 51, standard deviation 9.4)		
RD3P1	48/M	Graduate Degree
RD3P2	39/F	Graduate Degree
RD3P3	64/M	Graduate Degree
RD3P4	48/F	Graduate Degree
RD3P5	56/M	Graduate Degree

Table 1. Participant Demographics (by Cohort)

The study was divided into three separate cohort groups of five participants each. The demographics breakdown of each cohort appears in Table 1 above. The first group ranged 20 to 22 years. The second group ranged 27 to 46 years. Through these two cohorts (one younger, mostly

university students and the other older, employed full-time), the study sought both a cross section of ages and experience as well as the opportunity to observe separate age stratifications in isolation. After these two cohorts had completed their diary studies, the data from both were analyzed and codes were created. The codes were then confirmed by running and subsequently coding a third cohort with a slightly higher age stratification range (39 to 64 years).

Participants were informed that they would be cataloging any occurrence of a *situational impairment event* (SIE) when using their smartphone. An SIE was defined as what occurs any time they wish to interact with their smartphone (either by inputting information or receiving output) and some aspect of the current situation impacts/prevents them from completing the process to their satisfaction. Each participant was then given a document with six SIE scenarios to give them a better idea of the level of descriptiveness they would need to provide. Participants were encouraged to *over report* and that no event should be considered too trivial. Finally, they were informed that even if no SIE occurred, they were to report at least once per day and, should they miss a day, would receive a gentle reminder email.

SIE occurrence reports were to be delivered by email after the event occurred and each participant agreed to only report during safe and appropriate conditions. Electronic recording of diary data was used as this modality lessens transcription errors and reduces the human labor cost for both participants and researchers (Green, Rafaeli, Bolger, Shrout, & Reis, 2006). Email was chosen over SMS or a dedicated diary app. SMS's per message character limitation (Rönkä, Malinen, Kinnunen, Tolvanen, & Lämsä, 2010) made it inappropriate for this study. A dedicated diary app was eliminated from consideration as the result of a set of pilot studies that were run, where participants spent too much time focusing on interacting with the app, thereby detracting from their focus on the SIEs.

4 Results

4.1 SIE Categories

Analysis was conducted using a Grounded Theory style-approach to discover common themes in the SIEs that were experienced as opposed to the confirmation of an a priori theory (Glaser & Strauss, 1967). The authors discussed and reviewed the diary excerpts from Cohort 1 which produced some initial raw ideas as to what the possible SIE themes might be. Discussion and analysis of data from Cohort 2 refined these raw themes as well as added some new ones. As the result of this coding analysis, five main SIE categories, each with sub-categories, were identified that represent challenges faced by individuals experiencing SIIDs. Each are defined and described briefly in Table 2 below and will be discussed in the next section.

Category	Description	Sub Categories
Technical Issues	A technical fault, glitch, or other non-user or environmental issue that prevents effective completion of a transaction.	**Connection**: Something technical prevents connecting to an information source (i.e. bad cell phone reception or no Wi-Fi). **Power**: There is no, or insufficient, electrical power (i.e. low battery) to effectively complete the transaction. **Other Technical**: A technical issue other than connection or power that prevents effective transaction.
Ambient Environmental Issues	Anything about the environmental context of the transaction space that is hindering or preventing effective transaction completion.	**Meteorological Conditions**: Some aspect of the weather (i.e. sun, rain, heat, or cold) that is hindering or preventing effective transaction. **Ambient "Noise" Conditions**: Some non-meteorological ambient condition is creating "noise" in the communication channel hindering or preventing effective transaction. The "noise" can be any non-meteorological input that is negatively affecting the signal-to-noise ratio of the transaction signal (not necessarily just audible noise) including another human.
Workspace/Location Issues	Issues that hinder or prevent the ability to effectively complete a	**Inaccessible Location**: The information appliance is within reach but in a space that

	transaction that are geospatial in nature. Either the workspace area is of insufficient size or the resources required are not within sufficient proximity to permit the effective completion of the transaction.	cannot be easily accessed in sufficient time to complete the transaction effectively (i.e. in a jacket/pants pocket or bag). **Workspace Size**: Some aspect of the workspace is affecting movement of resources required in the transaction and therefore hindering or preventing effective transaction (i.e. not big enough to effectively negotiate the input space). **Relative Location**: The relative location of the user and information appliance is such that interaction cannot effectively take place. **Unavailable Resources**: The resources needed to assist in the completion of the interaction are unavailable (i.e. hands full, phone powered off or on silent).
Complexity Issues	Issues that hinder or prevent effective transaction completion resulting from task or ambient complexity.	**Cognitive Load**: The cognitive resources required to effectively complete a transaction are unavailable or not easily accessible to the user as the result of having to hold aspects of the current transaction in working memory or having "other things on their mind" that are not directly related to the current transaction. **Number of Steps**: The number of steps that would be required to complete a transaction are perceived as too numerous or too cumbersome to effectively complete the transaction. **Walking Over Tasks**: The transaction cannot be completed do to another transaction attempting to occupy the active transaction space (i.e. a modal pop-up that appears while attempting to type a text message) or other interruption that may or may not be technology related (i.e. children interrupting an attempt to place a call via Bluetooth). **Gulf of Execution/Evaluation** (Norman, 1988): The user has insufficient knowledge from personal experience or from the current context to either effectively complete a transaction or evaluate whether a transaction has been effectively completed.
Social/Cultural Issues	These issues offer no physical barrier to transaction completion but nevertheless can hinder or prevent effective transaction completion.	**Fear of Reprisal from an Authority**: Completing the transaction may result in a violation of the law or reprimand from a boss, teacher, or other type of authority figure (i.e. texting while driving, in class, or while at work). **Safety**: The completion of a transaction is hindered or prevented due to concern over the potential harm the attempted completion may cause (i.e. getting into an accident while texting and driving or having your device stolen while using it on the street in a "bad neighborhood").

	Socially Acceptable Behavior: The social context is perceived by the user to be inappropriate within the perceived cultural norms or personal moral code for effective completion of the transaction.

Table 2. SIE Categories and Subcategories

A total of 371 SIEs were recorded by the three cohorts. Individual participant totals ranged from as little as seven to as many as 117 (mean 24.7, standard deviation 27.4).

After the first two cohorts were complete, the authors analyzed the data and determined that several themes and sub-themes existed within the data. Based on these themes each author then independently coded each SIE from the first cohort to determine inter-rater reliability. A Cohen's pooled kappa score of 0.78 was calculated. A kappa of 0.75 and above shows excellent agreement between reviewers (Fleiss, 1971).

Table 3 below shows the number of SIEs recorded by category, the % of the total SIEs that number represents, Cohen's kappa value calculated for each category, and a few sample excerpts from each.

Category (Main)	Count (% of total)	Cohen's kappa (κ)	Sample Excerpt
Technical Issues	58 (16.4%)	0.86	*I was attempting to check my e-mail on my phone which was connected to Wi-Fi. Due to a sudden outage in the Wi-Fi, my phone then stopped connecting to the-mail server and told me to check the connection.*
Ambient Environmental Issues:	36 (10.2%)	0.90	*I was outside taking photographs with my phone in the rain. The rain made my phone slightly slippery, which caused me to mess up when making "gestures" a few times.*
Workspace/Location Issues	100 (28.3%)	0.89	*During the ride, I couldn't use the phone comfortably, due to the restricted space with everyone in the car*.
Complexity Issues	110 (31.2%)	0.62	*…I'm at my desk drawing with my sketchbook, have a video up on my laptop, and also wish to text a friend …However, I can't text the friend without 1. Pausing the reference video I'm using on the laptop and 2. Dropping the pencil / picking up the phone.*
Social/Cultural Issues	47 (13.3%)	0.89	*Could feel my phone vibrate multiple times but could not check what or who it was because I was at the movies and it is frowned upon to do so.*

Table 3. SIE and Examples (by Main Category)

4.2 Detection of SCSIs

The authors were also interested in noting any reported SIE that could be categorized as a SCSI or an SIE where (1) choosing an alternative interface modality did not lead to effective I/O completion, (2) there was multiple modality or total failure, or (3) the technological solution to one type of situational impairment created a new situational impairment. Out of the 371 SIEs recorded, the authors were able to identify 61 (16.4%) of the SIEs as potentially qualifying as SCSIs. A detailed discussion with examples appears in the next section.

5 Discussion

5.1 Categories

As the result of coding and analyzing the data, categories were identified that yielded some generalizable findings.

5.1.1 Technical Issues

At first, reports of technical issues were discounted as not being SIIDs. But after further consideration, some technical failures exist due to limitations inherent to mobile device interaction (i.e. need for recharging and dependence on Wi-Fi or phone reception). These comprised the two sub-categories along with "Other Technical Issues" which captured any reported technical SIE that was not an issue of power or connection.

Some excerpts from this category that illustrate this as being a *mobile* issue included:

> *"Minor frustration while trying to look at social media on the road (passenger) with slow/weak data connection- gave up and looked out the window."*

> *"I went to use my phone while driving home and didn't realize the battery had drained and had to wait until the phone was able to start while plugged into the phone charger in my car."*

5.1.2 Ambient Environmental Issues

These represent, perhaps, the most obvious contextual impairment that is associated with mobile information consumption. Natural or "meteorological" ambient issues were differentiated with those issues that would cause some signal degradation due to the introduction of "noise".

Meteorological examples often involved the sun, as in the excerpt:

> *"I attempted to show a colleague a photo taken on a smartphone but we were outside and the sun made it nearly impossible to see the photo."*

However, this was not always the case as with the excerpt:

> *"The rain also distorted the image…when taking photographs and are focused on making all of the details look nice, having little bubble- shaped distortions everywhere is, at the least, distracting, and at the most, impairing your ability to judge whether or not to take another picture."*

"Noise", in our examples, was almost always sound:

> *"…couldn't use Siri because it was too noisy."*

5.1.3 Workspace/Location Issues

This category reflected issues that were observed relating to the structure and/or confines of the physical space where a transaction takes place.

This could mean lack of available space, as reflected in:

> *"When I was at the store trying a new suit, I was unable to reach my phone out of my pocket due to the nature of the suit - I had to remove it to access my phone…"*

Or issues of asynchronous or inaccessible location:

> *"I had locked my parents out of the house by accident and when my mom tried calling my phone, I had left it in another room and thus never heard it go off."*

5.1.4 Complexity Issues

Excerpts categorized as complexity issues often reflected an added complexity that was the result of the mobile I/O transaction context as well as the added tasks that having a mobile information appliance seem to afford. For example:

> *"Attempted to use a Bluetooth speaker that I have but I had grabbed the wrong cord…"*

> *"Someone asked for my resume, but searching for it in Dropbox with the phone would be cumbersome."*

> *"Texting interrupted…by incoming text."*

5.1.5 Social/Cultural Issues

Not all actions are constrained by physical imposition, such as our adherence to the normative rules of the culture or group that we associate with (Norman, 1988). There were three distinct sub-categories related to the motivation behind the choice to not attempt or complete the I/O transaction. If the motivation was because the user feared getting in trouble somehow, this was categorized as "Fear of Reprisal from an Authority".

It could be from a legal authority such as:

"…no texting while driving"

Or it could be from an "non-legal" authority figure like a teacher or a boss:

"Busy at work. Wanted to text husband and friends about a funny work story but not allowed to use [personal] cell phones [in the office.]"

"I wanted to use my phone twice to respond to a friend who I hadn't talked to, but was restricted due to being in a classroom setting."

The motivation may also be a concern that the action may be rude or inappropriate:

"Couldn't use phone again, due to…(Mother's Day activities)"

"I had a phone call while in the library. Not wanting to disturb those around me, especially with finals…"

One excerpt incorporated both of the above sub-categories:

"I wanted to check my phone to see the time, but I was in a movie theater…I did not want to disturb others… I did not want to encourage the use of mobile devices after the request to turn off the phones…I also did not want, however unlikely it would have been, to be suspected of…preparing to illegally record the film."

Finally, the motivation may be one of personal or someone else's safety:

"I wanted to text my friend…it was unsafe to do so while at the wheel."

In some excerpts the word, "frustration" was used to describe the emotional state that resulted by encountering an SIE. This frustration did lead to abandonment in some situations, but primarily in cases of social/cultural events. Nothing physical was preventing the transaction in these cases, but because participants could not extract themselves from the social context, they felt forced by the *rules* to at least delay transaction completion. Occasionally, something other than social/cultural concerns led to abandonment, as is represented well by the quote, "…*gave up and looked out the window"*, to reflect the lack of data connection while a passenger in a car. However, in most non-social/cultural cases, there was at least the hope of a possible solution or workaround. Most of the exceptions to this were classified as SCSIs.

5.2 Severely Constraining Situational Impairments (SCSIs)

Within the categories listed above, several excerpts described events that went beyond a simple solution. These extreme cases led to frustration and often abandonment, more so than was the case with other SIEs. It was clear from reading and analyzing the excerpts identified as SCSIs that these were worthy of different consideration.

Many SCSI occurrences seemed to be the result of multiple SIEs rolled into a single event creating a sort of *Super SIE:*

"Thought of something I wanted to search the web for while I was cutting grass, but couldn't use phone because it was too bright out and couldn't use Siri because it was too noisy- By the time I reached a shady area, I ended up forgetting what the task was."

"For the presentation, I opted to wear a tie…Thus, I brought up a picture of a quick, simple way to make one…on my phone while riding [as a] passenger in the car. As I was trying to manage the tie, I was using both hands…I couldn't zoom or change the picture to see the next step closer without removing a hand from the process of tying. I also had to leave the phone on my knee and crane my neck to see the screen."

"Was at desk drawing with phone nearby - however, it was charging, so I couldn't reach it properly, and my hands were occupied (pencil / sketchpad). Therefore, could not switch songs & easily reply to texts without setting down my current activity."

"During the ride, I couldn't use the phone comfortably, due to the restricted space with everyone in the car, as well as handling a water bottle."

"Eating wings (dinner) and was unable to answer a text message"

Others reflected an almost sense of *pre-abandonment,* as if failure was assumed and therefore the transaction was not attempted:

"Wanted to reply more thoroughly to a friend, but doing it on the phone (quickly) was not feasible. The more involved an email, then less likely it is that I will do it on the phone if that's my only option. I'd rather wait to get to a computer."

"Operation to get files from a secured "cloud" service, download them to my phone with an app, then upload them to a web service is simply too cumbersome to do on the phone... If even possible at all. I'll wait until I'm back home."

Some reflected a growing dependence for access to workplace information from mobile appliances and the situational impairments that can make the interaction difficult:

"Needed to look up my employee ID stored in my phone but was at patient's bedside gowned up for contact precautions."

Then there were SCSIs that involved a singular problem but multiple tasks were desired that required using the same I/O channel:

"Listening to audiobook - interrupted by telephone call over Bluetooth in car."

The examples above demonstrate that not all SIIDs are created equal. Individuals do experience some SIIDs that are more extreme than others and there are fundamental and unique aspects with events that are classified as SCSIs. Whereas some SIIDs have at least a theoretical if not actual solution, the solution in the examples above are not as obvious, or do not exist at all.

For example, in the non-SCSI excerpt, "*I attempted to show a colleague a photo taken on a smartphone but we were outside and the sun made it nearly impossible to see the photo*", a workaround solution to the problem would be to find space in the shade nearby, or to walk temporarily in a building. A technological solution, would be to develop a display that is not affected by bright light. Even in the case where abandonment occurred due to poor data connection and as a result the participant, "…*gave up and looked out the window*", there still exists the theoretical solution of either getting a plan with better data coverage or eventual data infrastructure growth.

But there is no simple workaround for the scenario of needing to use the phone while cutting the grass. The primary modality of typing was not available due to the hands being occupied (Workspace/Location Issues: Unavailable Resources). Nor could the secondary modality of voice interface be deployed (Ambient Environmental Issues: Ambient "Noise" Conditions). And even if these two issues could somehow be resolved, any content that needed to be read would not have been possible due to bright sunlight (Ambient Environmental Issues: Meteorological Conditions).

Nor is a solution apparent for the case where the audiobook was interrupted by a phone call (Complexity Issues: Walking Over Tasks). Mobile devices facilitate multi-tasking and even though only one I/O channel is blocked, because it is the only channel that can accommodate either task, the result is the inability to accommodate both tasks to the user's satisfaction. This may even be more important, for example, if the user had a specific preference as to which task should become primary at that moment and if that preference might change in future examples based on context.

Even in the case of not being able to use the phone while eating chicken wings can demonstrate the severity of a SCSI. Since only one modality (touch) is blocked, a solution might be to use or design a voice interaction. However, if one is eating, one's mouth is full and therefore cannot vocalize. The user may be tempted to eat with one hand, to control the device with the other. However, sauce/oil present on the fingers may impact interaction with the touchscreen. Cleaning the device afterwards would involve time and effort.

In addition, whereas some SIEs might result in abandonment, some that are classified as SCSIs appear to create a learned *pre-frustration* that leads to *pre-abandonment*. The users previous experience with a myriad of interaction issues (i.e. fear of mistyping or perhaps concern that the input will take too long or be inaccurate) might result in the user coming to the conclusion that it is simpler to just forego attempting the task.

There are many matters worthy of consideration that might be inferred from these observations. As access to information becomes more omnipresent, it seems so does the human desire to consume more and more of that information. It may not be dissimilar to the tendency, after getting a big promotion, of wanting a more expensive car or a larger house. As humans get more value from greater access to information, the more information we desire. SIEs can happen to anyone regardless of ability. This seems to be more of a challenge currently as expectations seem to have changed and users are expected to address calls/messages quickly. Therefore, we must now find ways to manage the rapidly increased

levels of new stimuli. If the amount of stimuli is increasing much faster than our ability to adjust, disconnects such as SIIDs and SCSIs begin to surface.

Perhaps also, the onset of more severe and multi-modal I/O interference is the result of the increased number of I/O devices that are possessed. Users now have, in the mobile realm alone, the ability to possess and use a smartphone, a tablet, a wearable smart device (i.e. smartwatch), just to name a few, where as little as 10 years ago the range of portable/wearable technologies available were not so extensive.

These types of SIEs, represent a potential major challenge confronting the design of mobile technology. And if rapid growth is causing a disconnect, then it is important to search for a deeper understanding of the phenomena that are the cause of this disconnect.

6 Limitations and Future Work

The authors see this work as a first step towards identifying and classifying SIEs, the phenomena that occupy the SIID problem space. As this is an initial foray, there were some limiting factors and areas for future work that need to be considered.

This was a short term study with a limited group. Confirmation of the categories presented here, or perhaps better and more robust classifying systems can be developed with a larger sample size and a longer time frame from which data can be gathered.

This was a phenomenological study, and not knowing in advance what themes the data would reveal, led to ambiguous results as motivation was not always apparent. For example, if a participant reported that they were not able to respond to a text message because they were driving, was that because they (1) feared being caught by the police, (2) had concern for their safety or the safety of others, or (3) felt compelled by cultural norms not to engage in the interaction? Future work must account for this, now that a base set of classifiers exist, and incorporate more detailed questions and motivation data.

Most participants reported at least one day where they experienced no SIEs. The authors began to realize that the number of events may have been underreported. This may be due to the fact that participants were ask to calmly and efficiently report events that occurred often while things were most likely neither calm nor efficient. Or perhaps the data is suggesting that SIEs may have been encountered but because the participants have become so efficient at creating workarounds, they did not notice that an SIE was occurring and therefore, did not report it. Future work might address this by somehow incorporating a wearable camera to record and better understand the context faced by users while maintaining the natural setting that the present study afforded and assuming that issues of privacy could be properly accounted for.

7 Conclusion

This study was an initial examination towards a rethinking of the situational impairment problem space. Through the examination of actual situational impairment events, experienced in the wild by users of mobile smartphone technology, the authors created the beginnings of a categorization scheme for classifying SIEs to assist in the development of guidelines and heuristics that can better influence the design of mobile technology. In addition, this study demonstrated the existence of SCSIs, which while part of the generalized SIID problem space, warrant special attention.

Consuming mobile information is becoming a more prominent feature of our everyday lives and taking more of our time and attention. This time and attention can be utilized to increase our productivity and generally improve the quality of our lives, or it can lead to increased obsession, frustration, abandonment, and even danger. If humans cannot learn to effectively interact, not only with the new portable information appliances they possess, but the context in which they are used, the disconnects currently being experienced could grow wider.

Researchers have begun to look at possible design solutions to aid in more effective and desirable mobile I/O transactions. This study attempted to add a piece to this conversation. The value gleaned can offer a new and different perspective to SIIDs to inspire new and unique solutions to the brave new world of always available information consumption.

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