

From Frustrated and Discouraged to Confident and Content: Smartphone Captioned Call Experiences with the InnoCaption App

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Introduction

People living with hearing loss have self-rated communication difficulties which vary dramatically with the listening environment. Many have implemented individual solutions to self-manage when communication is challenging. One example is the use of closed captions while watching television rather than increasing the volume to a level that is uncomfortable for those without hearing loss. Anecdotally, the use of the captioning option while watching television is associated with hearing aid uptake. The use of captioning is beneficial, of course, because visual input compensates for and supplements distortions associated with hearing loss. In fact, we know that when watching television, individuals benefit more from the use of closed captioning and hearing aids than from the use of hearing aids alone (Gordon-Salant & Callahan, 2010). By combining both sensory functions, listening effort and listening fatigue are likely reduced as well.

The advantages of closed captioning when speaking on the phone while using a landline are clear among persons with hearing loss and auditory processing difficulty. Smartphone use has gained in popularity for hearing aid users because of the streaming option which is often hands-free; however, challenges remain, particularly for persons with significant hearing difficulties.

In light of the reported frustration associated with voice-to-voice communication for persons with severe to profound hearing loss, new technologies have emerged that focus on providing accessibility for this population. One example is the evolution of user-friendly closed captioning apps compatible with smartphone technology. In this report, we explore and report on the experiences of a sample of persons with varying degrees of hearing difficulties who are new to the use of a mobile app called

InnoCaption which provides real-time captioning of phone calls on smartphones. InnoCaption sought to gather information from the end-user that could inform our understanding of their experience, helping us to ensure that persons with hearing difficulties find the application accessible and advantageous in the situations in which they use their captions. In addition to exploring the types of calls in which the app is being used, we investigated some of the self-rated psychosocial benefits of the use of captioning with smartphone technology.

Specifically, the survey was designed to:

- Gather baseline and follow-up information from new users of the InnoCaption app, which includes people with self-reported hearing difficulties and who were motivated to improve their access to communication.
- Assess overall InnoCaption user experience and frequency of usage.
- Explore personal feelings associated with smartphone use with and without InnoCaption.
- Identify situations in which smartphone use is a priority.
- Examine if the use of InnoCaption impacts the listening experience.

Background

InnoCaption is a mobile app that offers real-time captioning of phone calls. The app is available on iOS and Android phones and tablet devices, as well as desktop computers through the InnoCaption DeskView web portal. InnoCaption's hybrid captioning technology is unique in that it empowers users to choose between captions generated by live stenographers or automated speech recognition (ASR) software. The use of live stenographers* for human-assisted captioning significantly reduces the delay between the speech audio being heard and the captions being displayed, especially compared to many landline captioned phone companies that rely on revoicers. By design, InnoCaption users can switch freely between human-assisted and fully automated captions before or during calls. This provides total flexibility when one method of captioning is not working well (e.g., when the other person has an accent that ASR doesn't recognize well). Both the use of live stenographers for human-assisted captioning and providing users with the freedom to switch between caption modes is a unique innovation within the industry. For people with hearing loss in the United States, the call captioning service is available at no cost because it is certified and funded by the Federal Communication Commission (FCC) through the Telecommunication Relay Services (TRS) Fund. As part of the registration process, prospective users must self-certify that they have a hearing loss and provide personal information requested for identity verification purposes. This protocol is in place to prevent misuse of the InnoCaption accessibility service and to comply with federal regulations.

The goal of InnoCaption is to make smartphone calls easy and accessible for members of the deaf and hard-of-hearing community. For persons with low vision or visual loss, the font size, typeface, and colors can easily be adjusted for each individual user's accessibility needs. It is important to note that on June 16, 2004, the Federal Communications Commission (FCC) worked with the Department of Health and Human Services to release a Public Notice clarifying health information protections. The Public Notice stated that, in short, the use of Telecommunications Relay Service (TRS), such as InnoCaption, to facilitate telephone calls between health care professionals and patients, when one of the parties to the call has a hearing or speech disability, does not violate the Privacy Rule of the Health Insurance Portability and Accountability Act (HIPAA).

The goal of InnoCaption is to make smartphone calls easy and accessible for members of the deaf and hard-of-hearing community.

Methodology: The Survey Instrument

This longitudinal two-survey design used convenience sampling to invite new users of InnoCaption to take a pre-and post-survey. The online survey was developed by a group of professionals in the fields of deafness, audiology, hearing assistive devices, and captioning services. The initial survey was distributed by email with an embedded web link to 3,606 newly registered InnoCaption users. Email addresses were captured from the users' registration information. Individuals receiving the email were informed of the nature of the study and their rights. A \$25 Amazon gift card was offered to participants who completed both the first survey and the follow-up second survey three months after the first survey had been completed. Copies of the survey questions appear in the Appendix.

The baseline survey was launched in September 2022, and was sent to 3,606 new users, with two reminders after receiving the initial invitation to participate. Of the 3,606 surveys sent, 341 were received within the three-month response deadline window (approximately a 10% response rate). The follow-up survey was sent to the same 341 baseline respondents. By the end of the response time window for the follow-up survey, 167 users completed both the pre-and post-surveys. The data presented below represents responses from the 131 individuals who completed both surveys and for whom there was no missing or duplicate data (131/341 persons who responded to the baseline survey and 131/167 persons who also responded to the post-survey).

Demographics

The pool of respondents by gender, age, work status, and hearing aid use is as follows:

Gender - 53% of respondents were female and 44% were male. Three respondents selected either non-binary or indicated that they preferred not to respond.

Age - 64% of respondents were 61 years of age and older; 35% were between 21 and 60 years of age, and one respondent was under 20 years of age.

Work Status - Most respondents indicated they were retired (61%); 23% indicated they were working full time with 16% working part-time. This suggests that the use of technology by those who are 65 and older continues to increase which reflects that the sample was representative of national samples (Pew Research Center, 2022).

Hearing Aid/Device Use - Close to 70% of respondents were hearing aid users; 13% did not use any form of hearing technology; 8 respondents on the baseline survey were cochlear implant (CI) users whereas 13 responding to the follow-up survey were CI users. Figure 1 shows the distribution of technology use in more detail.

In the baseline survey (Figure 2), only 24% of respondents reported little difficulty understanding (7 and below on a scale of 1-10) without using hearing assistive technology. After at least 3 months of InnoCaption use, the follow-up survey revealed 30% of respondents rated their degree of difficulty as 7 or below indicating the benefit of captioning alone.

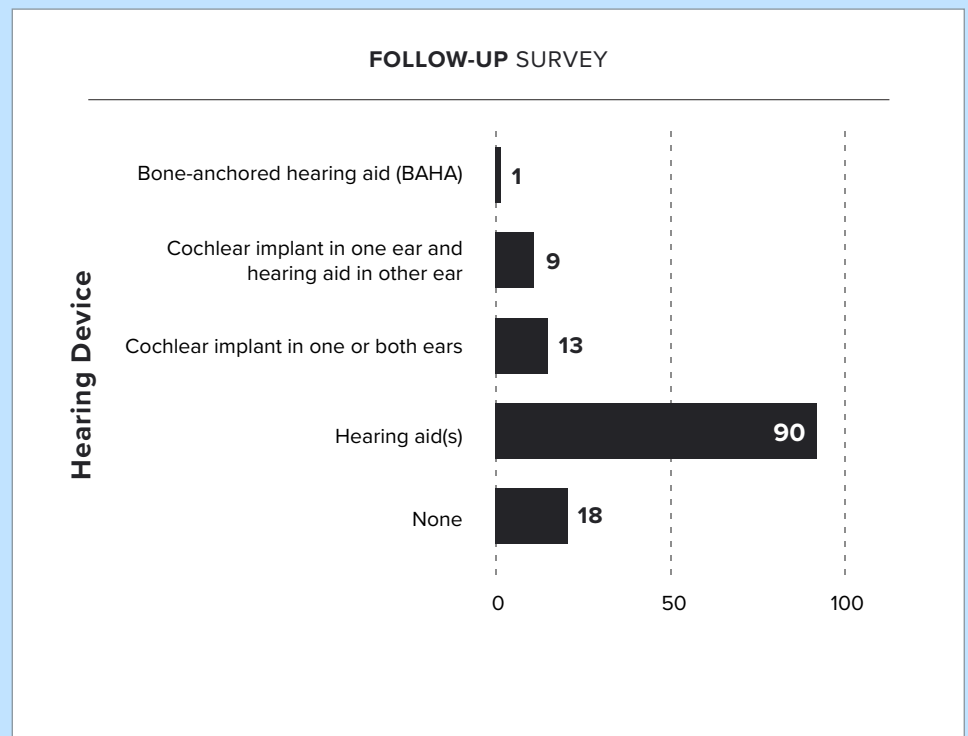
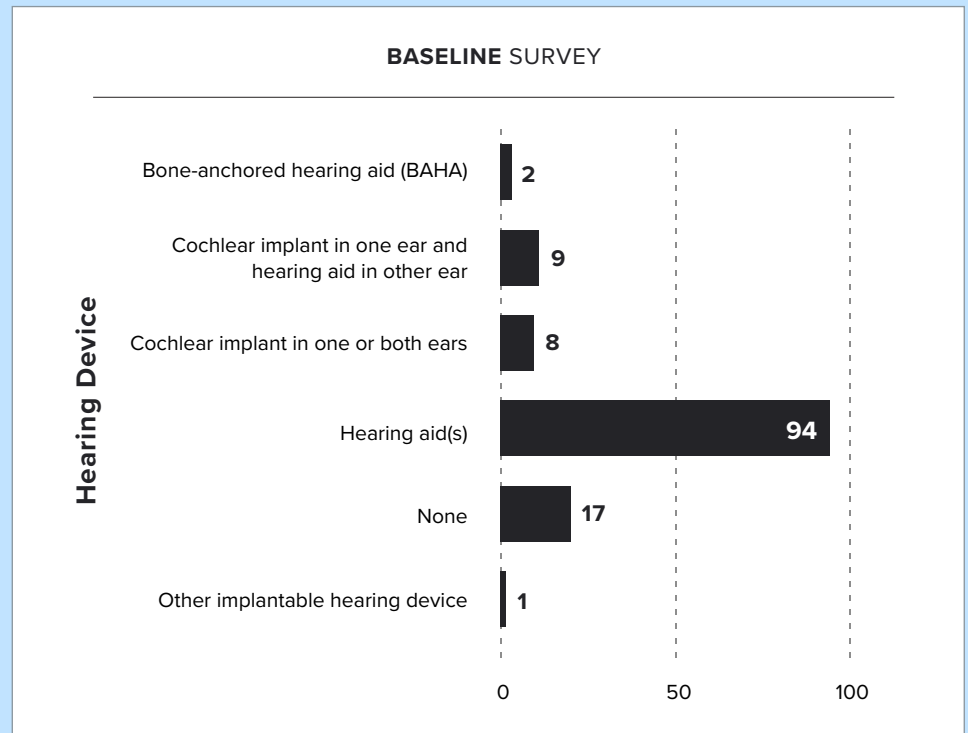
Results

A total of 131 individuals responded to both the baseline and follow-up surveys. Our sample appears to be representative when comparing self-rated severity ratings of prevalence data from epidemiological reports (Madans, et al., 2021). In the National Center for Health Statistics 2021 survey results from the hearing section, adult interviews of 31,777 respondents revealed hearing difficulties increased with age despite advancement in hearing aid technology. Individuals who were 45 - 64 of age expressed some difficulty and those 65 and older experienced even greater difficulty, (Madans, et al., 2021).

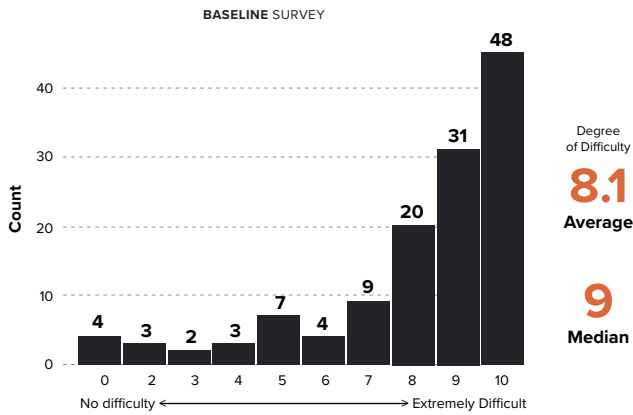
Regarding the validity of self-reported measures of hearing difficulty, many epidemiological studies use self-reported data when it is not feasible to measure hearing status using pure-tone audiometry. Self-report measures are considered valuable as they capture individuals' perception

Figure 1.

Hearing technology use by respondents to the baseline survey and follow-up survey.



How would you rate your degree of difficulty hearing or understanding **without** hearing technology assistance on a scale of 1-10?



How would you rate your degree of difficulty hearing or understanding **with** hearing technology assistance on a scale of 1-10?

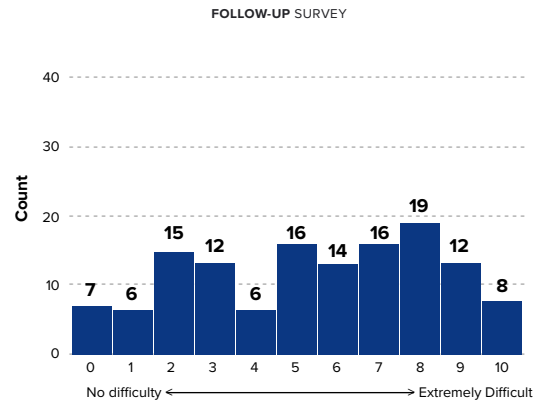
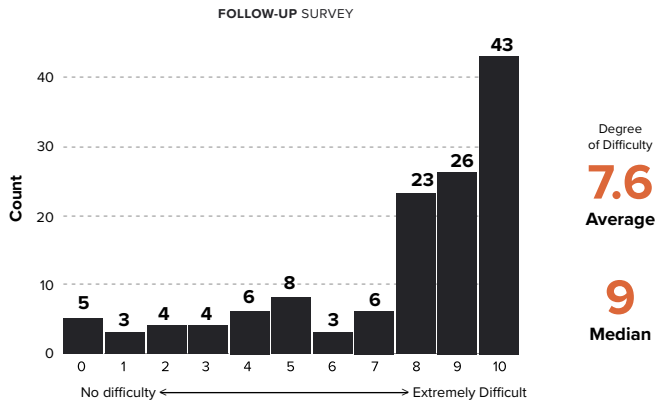
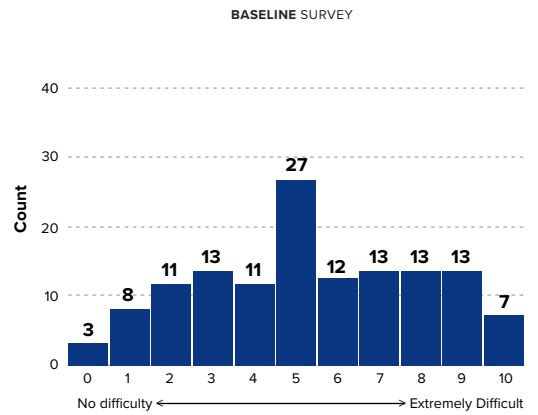


Figure 2.

Rating of difficulty hearing/ understanding without or with the use of hearing assistance technology.

of functional impairment of hearing loss (Hickson et al., 2008; Dillard, Walsh, et al., 2022; Hickson, et al., 2008). As part of the epidemiologic-based study of the Beaver Dam study of prevalence of hearing loss, Cruickshanks and colleagues (1998) noted that participants with an objectively measured hearing loss using audiometry were more likely to self-report a hearing handicap according to responses to the Screening Version of the Hearing Handicap Inventory for the Elderly (HHIE-S). The percentage of participants reporting a hearing handicap increased with the severity of loss (5.5%, 19.7%, 47.5%, and 71.4% for persons with none, mild, moderate, and severe losses, respectively).

As is evident from Figure 2, the breakdown of respondents by self-reported hearing difficulty is comparable to the data of Madans, et al., (2021). The majority of respondents reported considerable difficulty hearing or understanding (7 or greater) when not using hearing assistance (baseline – 82%; follow-up – 75%) whereas when using hearing assistance the responses were more evenly distributed with only 35% of baseline responders reporting extreme difficulty when using technology as compared to 42% at the follow-up. One possible reason we surmise for this discrepancy could be that between the baseline and follow-up survey, five more people reported having a CI. These people may be new to CI use and that could account for their difficulty. It is notable that the majority of respondents to the baseline and follow-up survey reported using closed captioning when watching television. The majority of respondents to each survey reported that they directly stream audio during smartphone conversations to either their CI or their hearing aid(s).

Prior to using the InnoCaption app, 59% of respondents said that they used a smartphone frequently, whereas 70% of respondents to the follow-up survey who started using the InnoCaption app reported that they were using their smartphone frequently.

Responses to the question regarding the use of a smartphone were of interest. Prior to using the InnoCaption app, 59% of respondents said that they used a smartphone frequently, whereas 70% of respondents to the follow-up survey who started using the InnoCaption app reported that they were using their smartphone frequently. This suggests that the use of the app increased the use of their smartphone – in turn suggesting that engagement with others increased once people began using InnoCaption. Fifty-four percent (54%) of respondents indicated that they used InnoCaption on a regular basis to make and receive phone calls, and of the 70 respondents who use multiple captioning apps, 61% responded that they primarily use the InnoCaption app. Response bias could be a factor, but this is difficult to tease out.

Figure 3.
Situational uses of smartphone
before and after use of the
InnoCaption app.

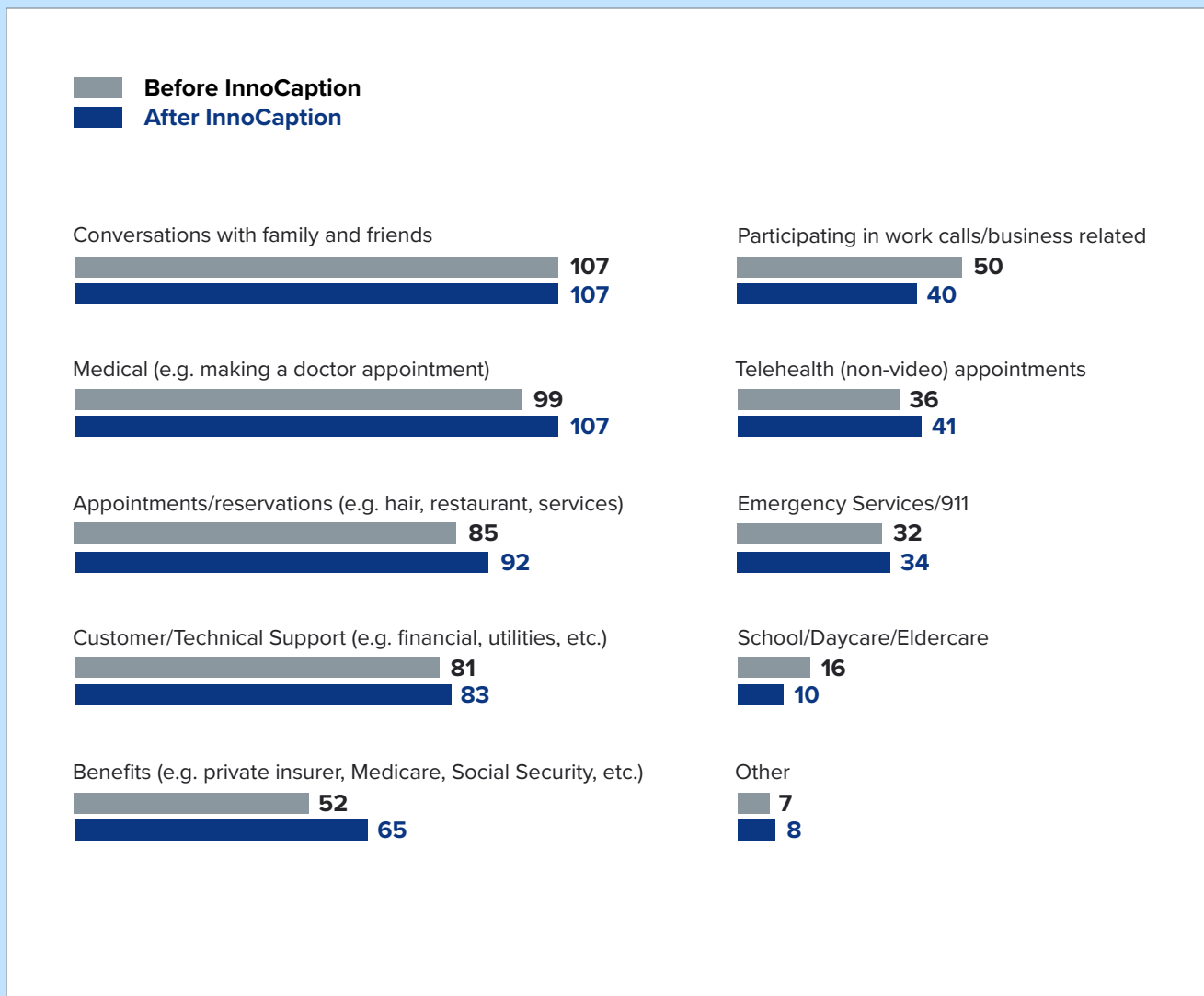
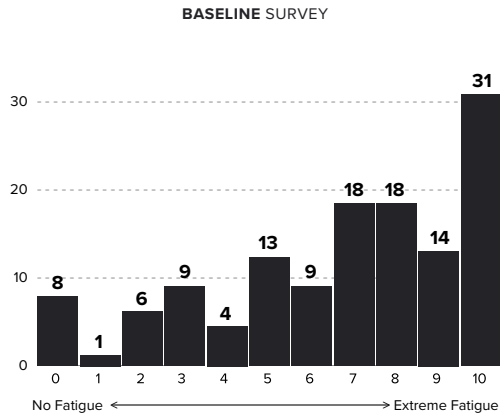


Figure 3 displays the situations in which respondents primarily reported using their smartphone. Responses to the follow-up questionnaire (after InnoCaption use) clearly differ from responses prior to the use of the app. The top three situations in which the smartphone is used to make telephone calls include conversations with family and friends, making medical appointments, and making other personal appointments or reservations. As is evident in Figure 3, respondents indicated that difficulty communicating with family and friends was one of the most common complaints of those reporting situational and emotional challenges associated with their hearing difficulty. Eighty-two percent (82%) of respondents noted that the latter is their primary situational use of the phone with or without captioning. The use of the smartphone for making medical appointments and for making other appointments such as restaurant reservations emerged as primary situational uses of the smartphone. It is notable that when using the InnoCaption app, a slightly higher percentage of respondents used their smartphones for the latter two situations. Another finding that emerged (Figure 3) is that a higher percentage of respondents used their smartphones for accessing information for benefits including Medicare and Social Security.

Evidence is mounting linking listening fatigue to self-rated hearing difficulty and well-being (Holman, et al., 2021). Associated with the effort it takes to remain focused while communicating, listening fatigue can contribute to social withdrawal which has many negative quality-of-life correlates. Our findings suggest that prior to using captioning with their smartphones, 62% of respondents experienced considerable listening fatigue, whereas only 14% of respondents indicated that they were experiencing listening fatigue while using captions (Figure 4). Similarly, the distribution shifted for the domain of listening effort. Prior to using captions, 66% of respondents indicated that they had to put in considerable effort when speaking on their smartphones, whereas following the use of the captions, only 19% of respondents reported that speaking on their smartphones required considerable listening effort. Clearly, less cognitive effort is required when combining visual input with auditory input when speaking on the smartphone using InnoCaption.

82%
of respondents noted that communicating with family and friends is the primary use of their phone.

Level of fatigue when making calls on smartphone or tablet **without** using InnoCaption



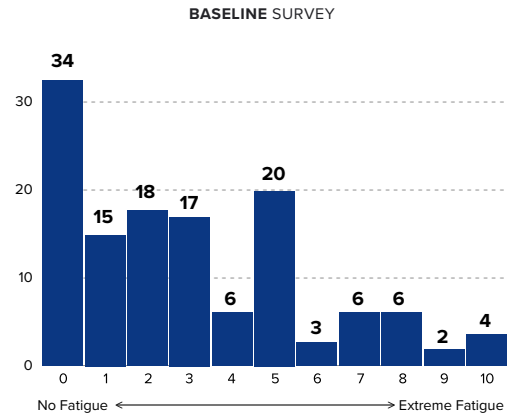
Level of Fatigue
6.7
 Average

7
 Median

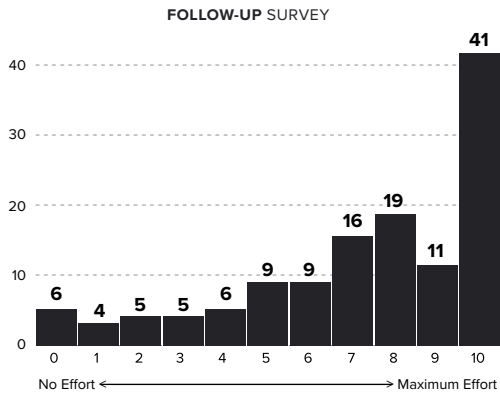
Level of Fatigue
3.0
 Average

2
 Median

Level of fatigue when making calls on smartphone or tablet **with** using InnoCaption



Degree of difficulty when making calls on smartphone or tablet **without** using InnoCaption



Degree of Difficulty
7.1
 Average

8
 Median

Degree of Difficulty
3.6
 Average

3
 Median

Degree of difficulty when making calls on smartphone or tablet **with** using InnoCaption

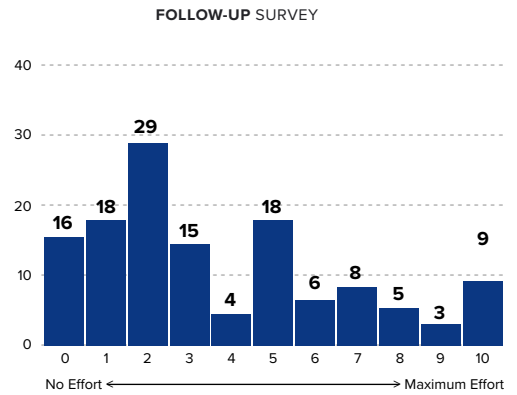


Figure 4.

Listening fatigue and listening effort without and with the use of InnoCaption.

Figure 5.

Level of success and overall satisfaction without and with the use of InnoCaption.

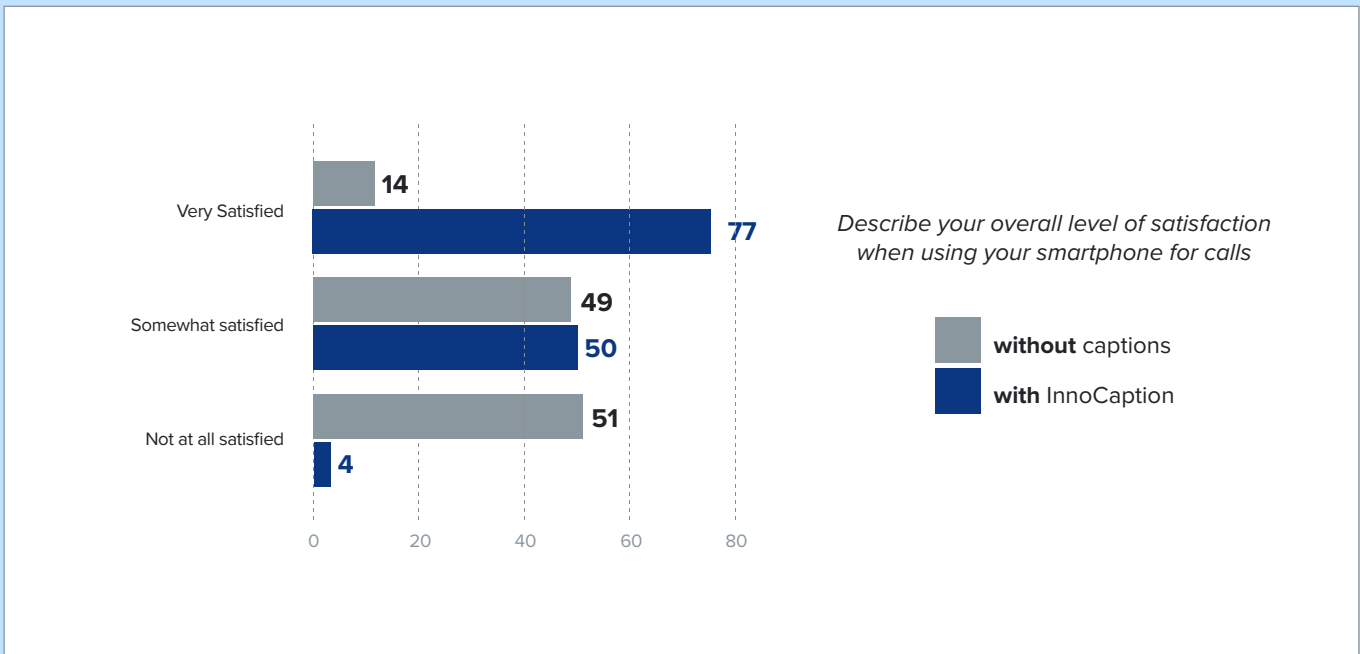
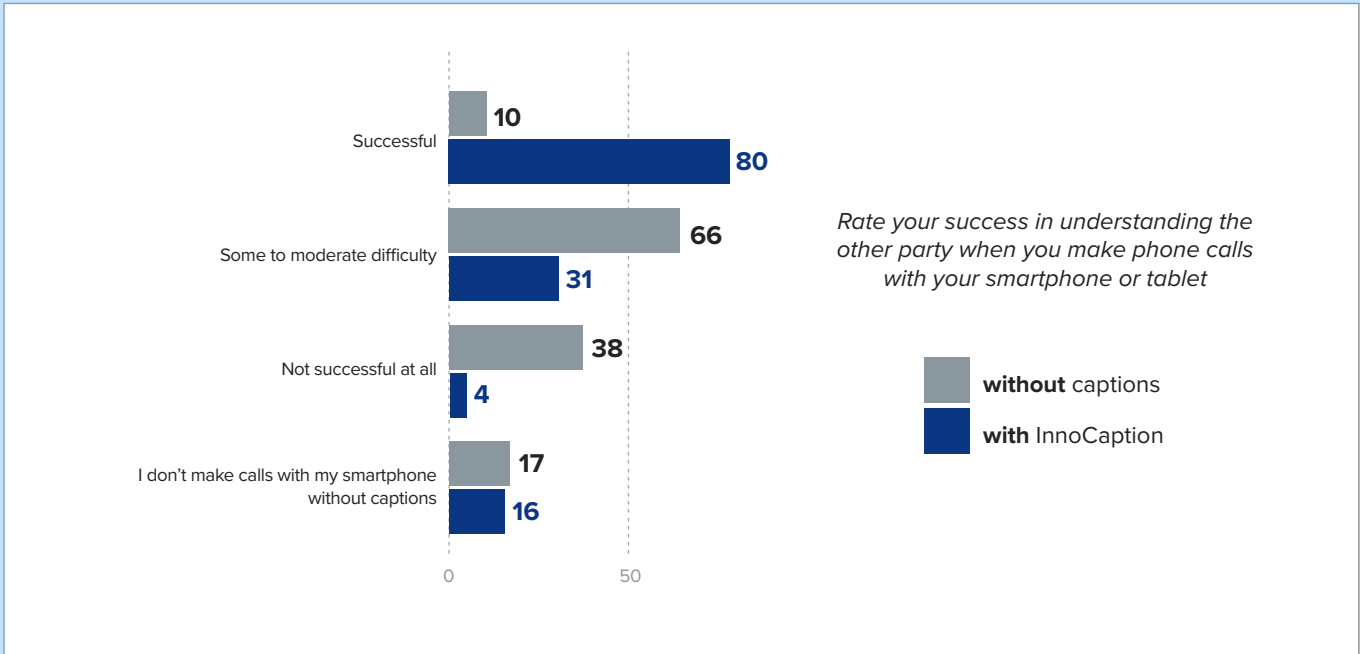
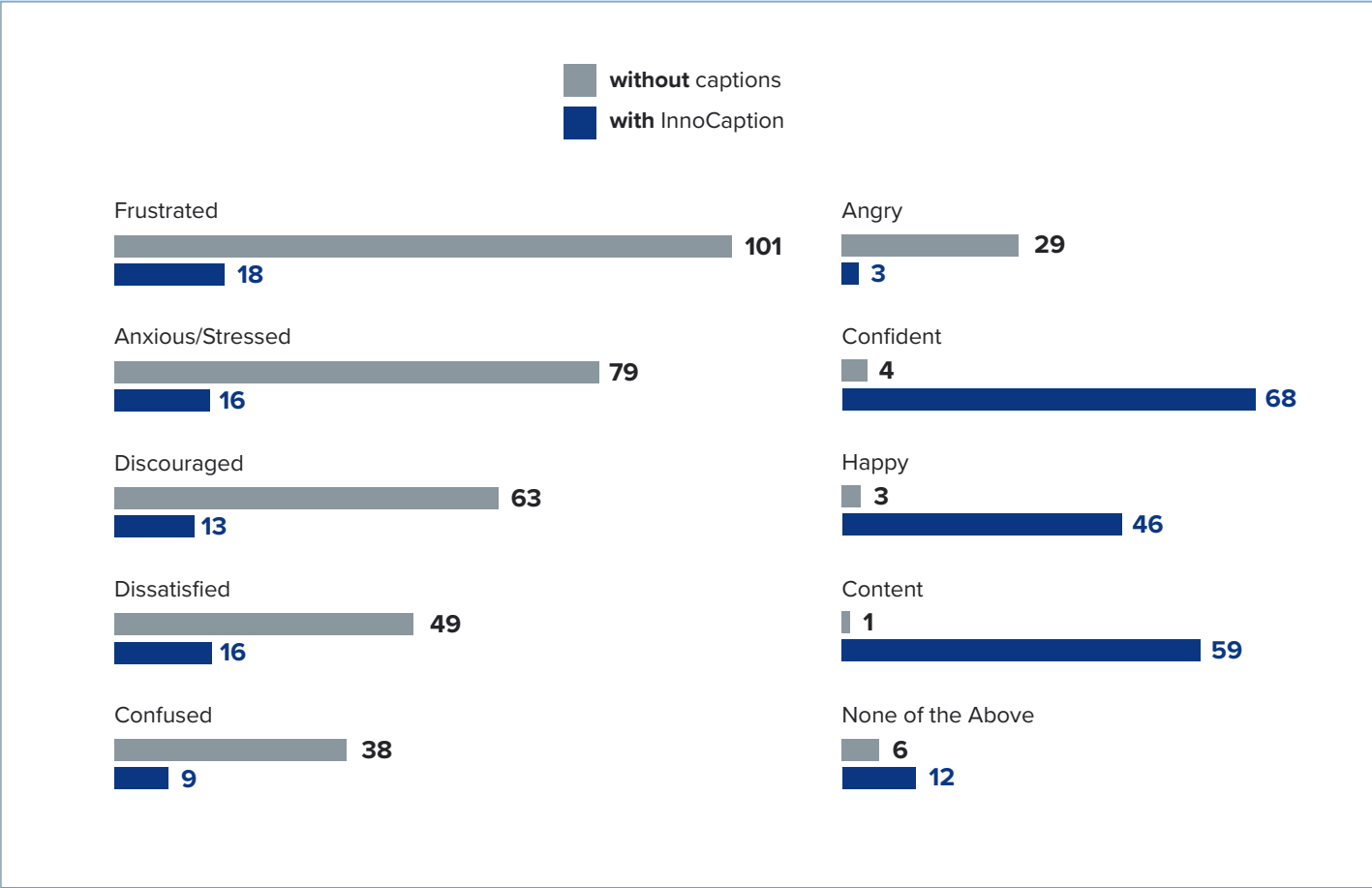


Figure 5 highlights that the majority (61%) of respondents experienced considerable success when using their smartphone or tablet with InnoCaption. Similarly, the majority (59%) of respondents were very satisfied when using their smartphones with InnoCaption. In contrast, 39% of respondents were not at all satisfied when using their smartphones without InnoCaption as compared to only 3% of respondents who expressed dissatisfaction when using captions. Hence, the data in Figure 6 should come as no surprise in terms of the emotions respondents associate with using captions. The majority of respondents expressed frustration, anxiety, and feeling discouraged when using their smartphones without captions. Very few respondents (between 10% and 14%) said they were frustrated, stressed, or discouraged when using the InnoCaption app. Respondents overwhelmingly reported feeling confident, happy, and content when using InnoCaption.

Figure 6.
Psychosocial reports associated with use of the InnoCaption App.



We were curious to uncover whether the severity of perceived hearing difficulty influenced the benefits reportedly experienced by respondents. We divided respondents into four categories based on their responses to the question: “How would you rate your degree of difficulty hearing or understanding without hearing technology assistance on a scale of 1-10. Table 1 displays the four groups by self-rating of hearing difficulty. Figures 7-10 display the degree of listening fatigue and self-rated social/emotional sentiments by self-rated hearing difficulty with and without the use of InnoCaption. It is clear that respondents with the most significant self-rated hearing difficulty benefitted profoundly in terms of listening fatigue and psychosocial function.

Table 1. Respondent groupings by self-rated difficulty hearing and understanding.
0 = No Fatigue, 10 = Extreme Fatigue

Group 1	Rated 0-6	n = 23
Group 2	Rated 7-8	n = 29
Group 3	Rated 9	n = 31
Group 4	Rated 10	n = 48

It is evident from Figure 7 that in groups 1 and 2 the ratings of the degree of listening effort and fatigue improved dramatically when using InnoCaption, and both groups reported significantly less listening effort and fatigue when using the app. The difference in the distributions pre and post are quite dramatic. These trends hold up for groups 3 and 4 as well as can be seen in Figure 8. It is evident that respondents who rated their level of hearing difficulty as considerable reported having to put in an extreme amount of listening effort when captions were not available. The significant decrease in listening effort in both groups when using InnoCaption is noteworthy. The level of fatigue was considerable for respondents in Group 4 and these respondents rated their level of fatigue as much less when using the app. The data in Figures 7 and 8 highlight that despite hearing aid and/or CI use, difficulty communicating over the telephone remains when audio streaming to the smartphone. The benefits derived from the use of InnoCaption when audio streaming with the smartphone were dramatic and were more significant than expected.

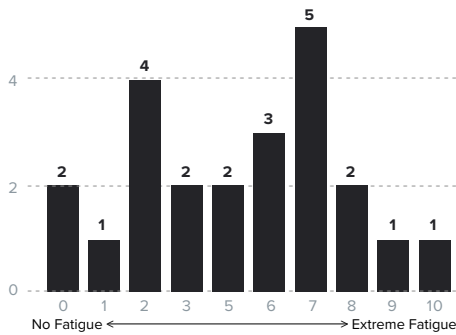
Figure 7.

Ratings of levels of fatigue without and with the use of captions by respondents in Groups 1 (n=23) and Group 2 (n=29).

GROUP 1

Rated 0-6 (n=23)

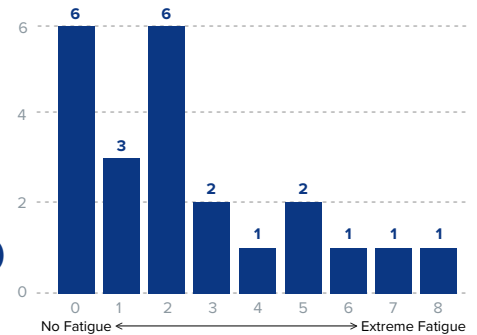
Level of fatigue
when making calls on smartphone or tablet
without using InnoCaption



4.9
Average
6
Median
2.9
Standard Deviation
4.9 ± 1.2
95% CI

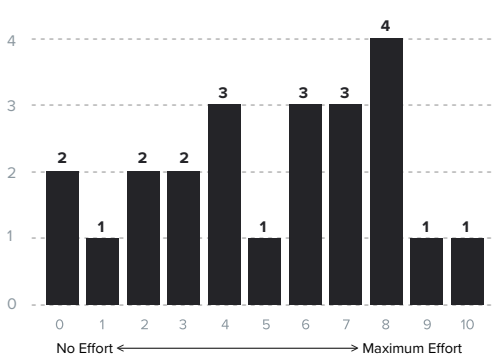


Level of fatigue
when making calls on smartphone or tablet
with using InnoCaption



2.4
Average
2
Median
2.3
Standard Deviation
2.4 ± 1.0
95% CI

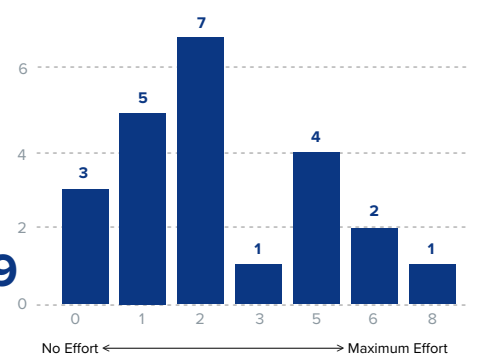
Level of effort
when making calls on smartphone or tablet
without using InnoCaption



5.1
Average
6
Median
2.9
Standard Deviation
5.1 ± 1.2
95% CI



Level of effort
when making calls on smartphone or tablet
with using InnoCaption



2.7
Average
2
Median
2.2
Standard Deviation
2.7 ± 0.9
95% CI

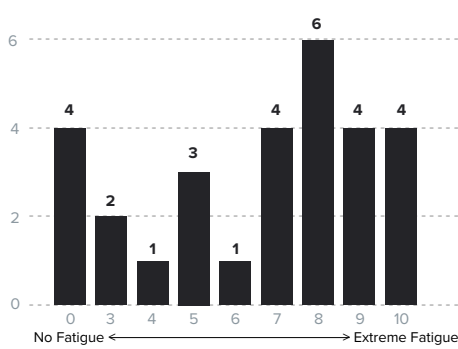
Figure 7. (cont.)

Ratings of levels of fatigue without and with the use of captions by respondents in Groups 1 (n=23) and Group 2 (n=29).

GROUP 2

Rated 7-8 (n=29)

Level of fatigue
when making calls on smartphone or tablet
without using InnoCaption



6.3
Average

7
Median

3.2
Standard Deviation

6.3 ± 1.2
95% CI



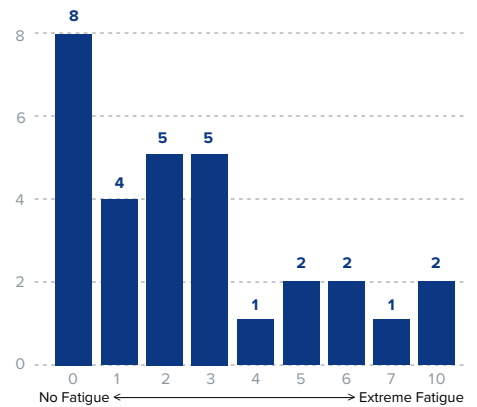
2.7
Average

2
Median

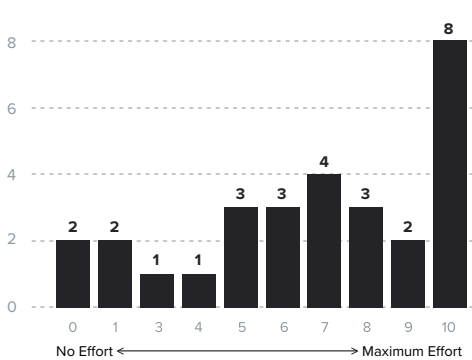
2.8
Standard Deviation

2.7 ± 1.0
95% CI

Level of fatigue
when making calls on smartphone or tablet
with using InnoCaption



Level of effort
when making calls on smartphone or tablet
without using InnoCaption



6.6
Average

7
Median

3.2
Standard Deviation

6.6 ± 1.2
95% CI



3.5
Average

2
Median

2.9
Standard Deviation

3.5 ± 1.1
95% CI

Level of effort
when making calls on smartphone or tablet
with using InnoCaption

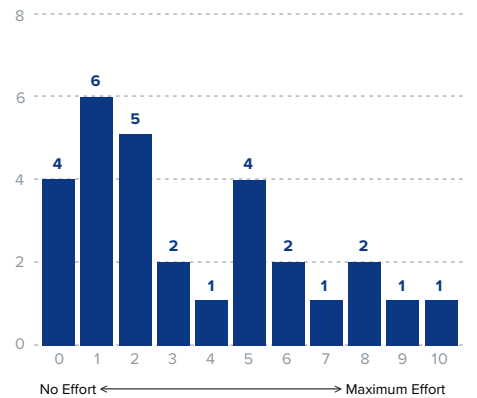


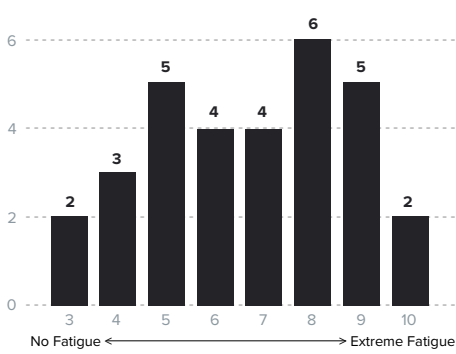
Figure 8.

Ratings of levels of fatigue without and with use of captions by respondents in Group 3 (n=31) and Group 4 (n=48).

GROUP 3

Rated 9 (n=31)

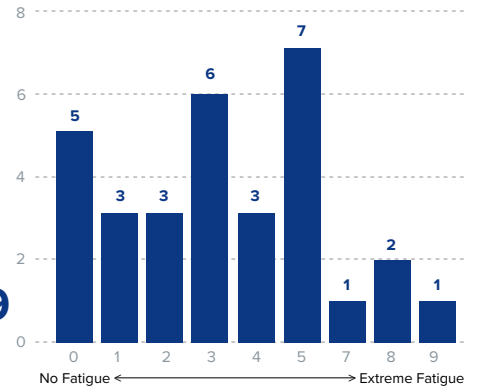
Level of fatigue
when making calls on smartphone or tablet
without using InnoCaption



6.7
Average
7
Median
2.0
Standard Deviation
6.7 ± 0.7
95% CI

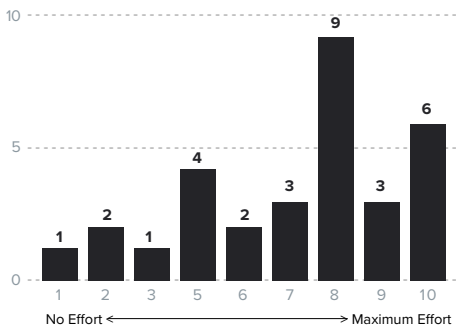


Level of fatigue
when making calls on smartphone or tablet
with using InnoCaption



3.4
Average
3
Median
2.5
Standard Deviation
3.4 ± 0.9
95% CI

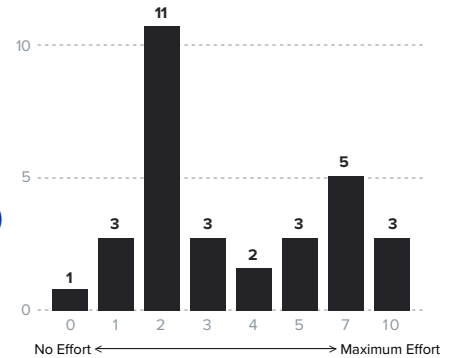
Level of effort
when making calls on smartphone or tablet
without using InnoCaption



7.1
Average
8
Median
2.5
Standard Deviation
7.1 ± 0.9
95% CI



Level of effort
when making calls on smartphone or tablet
with using InnoCaption



3.9
Average
3
Median
2.8
Standard Deviation
3.9 ± 1.0
95% CI

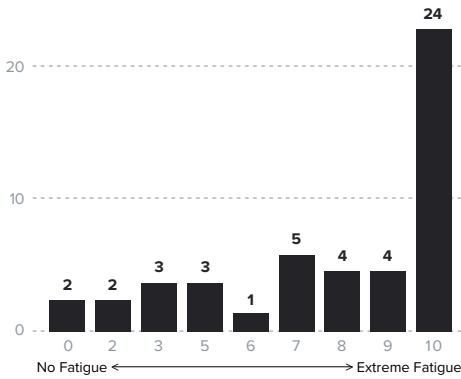
Figure 8. (cont.)

Ratings of levels of fatigue without and with use of captions by respondents in Group 3 (n=31) and Group 4 (n=48).

GROUP 4

Rated 10 (n=48)

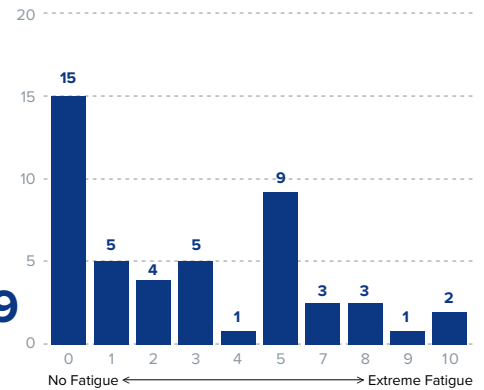
Level of fatigue
when making calls on smartphone or tablet
without using InnoCaption



7.9
Average
10
Median
2.9
Standard Deviation
7.9 ± 0.8
95% CI

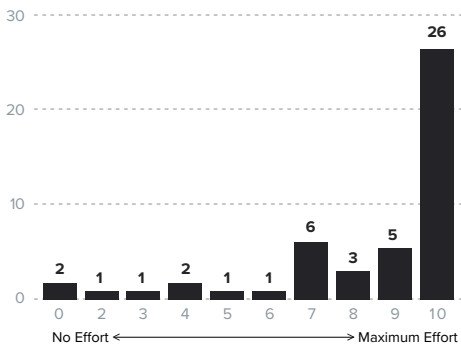


Level of fatigue
when making calls on smartphone or tablet
with using InnoCaption



3.2
Average
3
Median
3.1
Standard Deviation
3.2 ± 0.9
95% CI

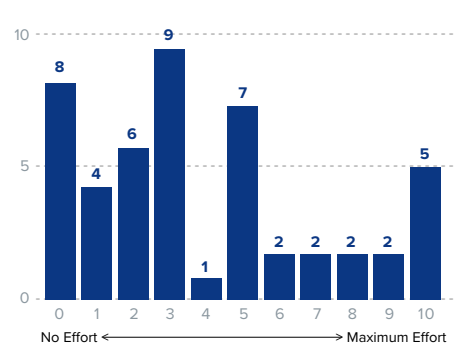
Level of effort
when making calls on smartphone or tablet
without using InnoCaption



8.2
Average
10
Median
2.7
Standard Deviation
8.2 ± 0.8
95% CI



Level of effort
when making calls on smartphone or tablet
with using InnoCaption



4.0
Average
3
Median
3.2
Standard Deviation
4 ± 0.9
95% CI

Figure 9 depicts the self-rated emotions participants experience by self-reported degree of hearing difficulty (groups 1 and 2) with and without the use of InnoCaption. Clearly, respondents in both groups expressed feeling less frustrated, less stressed, and more confident and content when able to use the service to supplement their conversations. The same trend was apparent for the respondents with more significant self-rated hearing difficulties (Figure 10).

Which of the following best describes your feelings when making phone calls on your smartphone or tablet without captions/with InnoCaption?

■ without captions
■ with InnoCaption

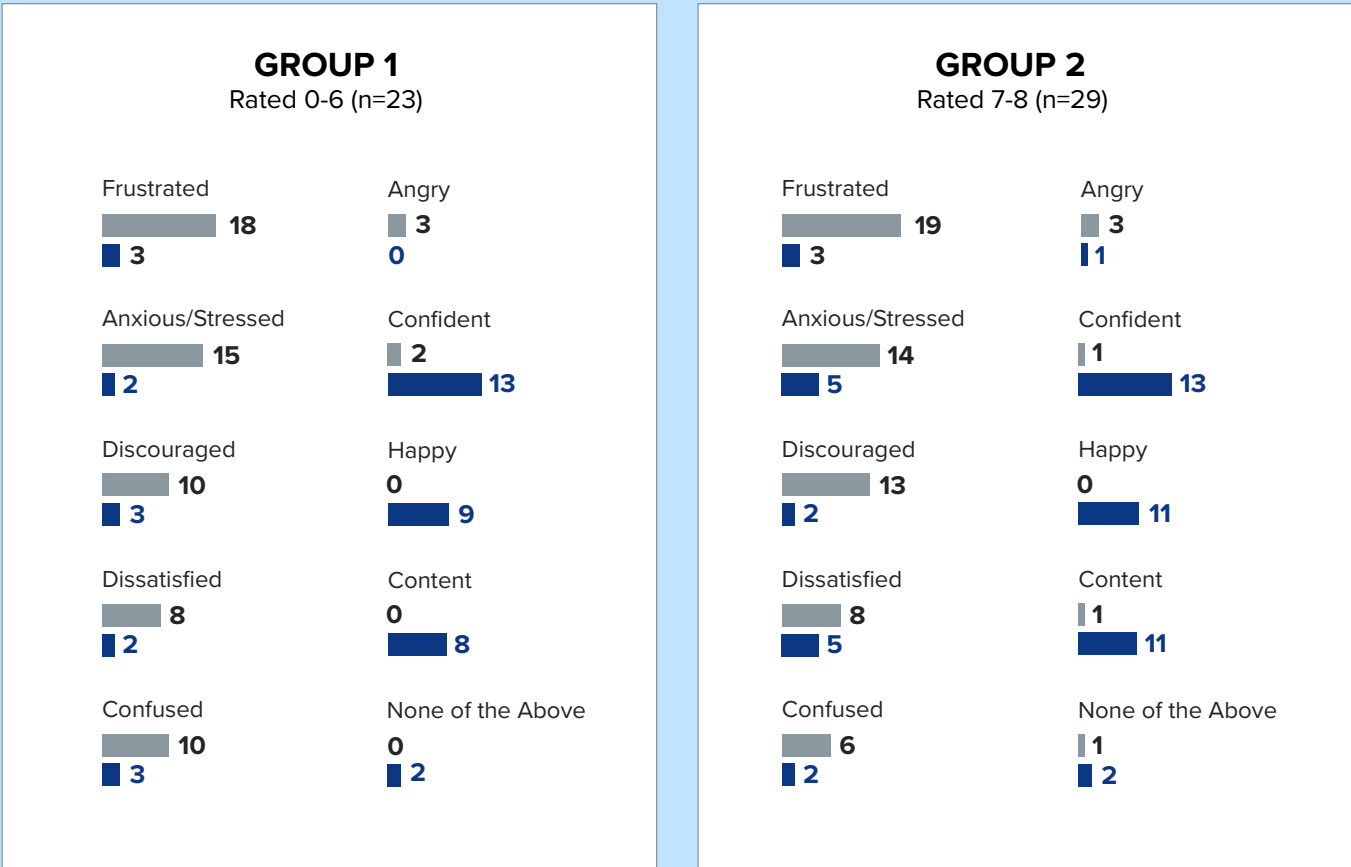


Figure 9.

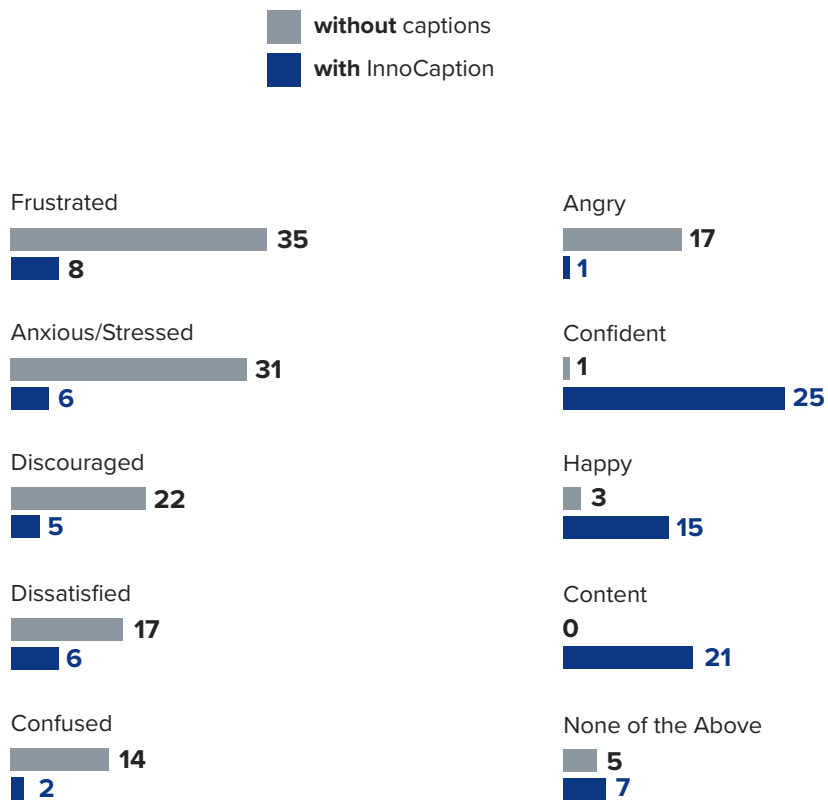
Ratings of how respondents in groups 1 and 2 felt when using the InnoCaption app.

Respondents in both groups expressed feeling **less frustrated, less stressed, and more confident** and content when able to use the service to supplement their conversations.

Figure 10. Self-rated emotions experienced by degree of hearing difficulty (groups 3 and 4).

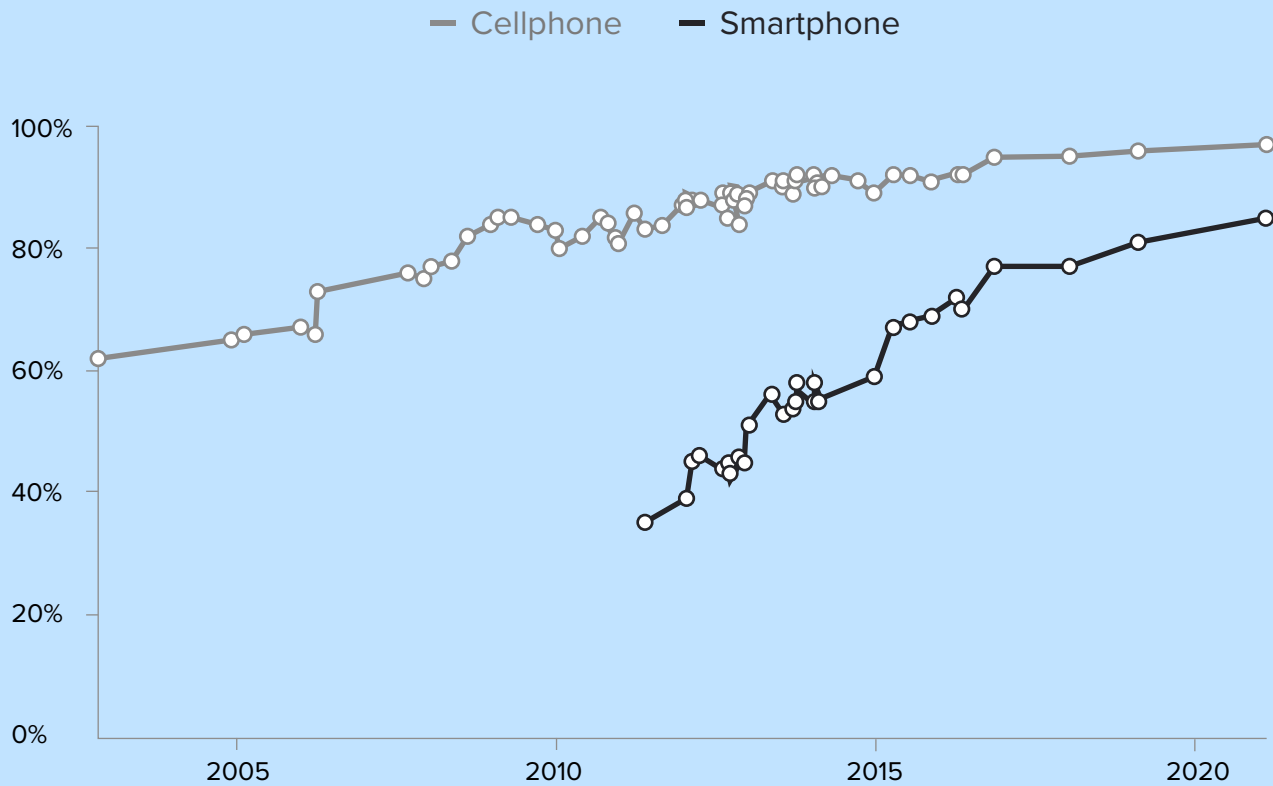
GROUPS 3 AND 4

Which of the following best describes your feelings when making phone calls on your smartphone or tablet without captions/with InnoCaption?



Discussion

Adoption of smartphone technology has skyrocketed over the past decade with the gap between use by young adults and older adults narrowing. A recent Pew Report (2011 to 2021) revealed that smartphone ownership by older adults (aged 50 and above) has risen from 10% to 61% in just 10 years (Figure 11).



Note: Respondents who did not give an answer are not shown.
Source: Surveys of U.S. adults conducted 2002-2021.

Figure 11.

Mobile phone ownership over time.
Percent (%) U.S. adults who say they own a smartphone.

The COVID pandemic and the need for social engagement forged connections through the use of smartphone technology. It is well established that connecting was often virtual via Zoom or telephone (both landline and smartphone). Communicating using smartphone technology was in part protective against a sense of disconnection many felt during the pandemic. In short, connectivity proved essential to maintaining some semblance of a quality of life and well-being. It was also protective in warding off loneliness, a pervasive sentiment many people – but older adults in particular – experienced during the COVID pandemic (Jonnatan, Seaton, Rush, et. al., 2022).

Recognizing the importance of remaining connected, older adults with significant hearing loss use their smartphones to communicate with family, friends and for medical appointments/telehealth. Thanks to innovations in telecommunications, difficulty hearing and understanding experienced by a large proportion of older adults is no longer a barrier to the benefits provided by the use of smartphones. This is particularly relevant for the emotional gain attributed to smartphone use (Busch, et al., 2021). Our data suggest that the use of smartphone technology with a captioning application has revolutionized the communication landscape for individuals who at one time struggled to understand voice calls because of significant hearing loss or auditory processing challenges. Prior to the use of captioning, survey respondents experienced frustration, confusion, and anxiety when communicating before use of InnoCaption, especially those with significant self-reported hearing difficulty. Also communicating without the benefit of mobile captioning was fatiguing and effortful, often serving to discourage smartphone use. The benefits of combining visual and auditory input when using the smartphone with the InnoCaption app are readily apparent from our data, especially when participants are broken down by self-reported severity of hearing/listening difficulty. In fact, the data suggest that the value of adding visual input via captioning to auditory input when streaming using the smartphone is a game changer, especially for persons with significant communication challenges.

Results of our survey confirmed the benefits of InnoCaption technology, especially in situations most important to persons with significant hearing difficulty. The data underscore the high value placed on the “conversations with family and friends” situation deemed most important to respondents. The social engagement enjoyed remotely via smartphone use ranked highly in both the baseline and the post-survey. Use of the smartphone for medical appointments is an important situation in which respondents ranked high with and without captioning. Responses suggested that a large proportion of respondents felt listening fatigue, listening effort, and frustration levels were reduced when using captioning with a smartphone in the situations ranked as important. The reported psychosocial benefits of captioning make it clear that combining visual and auditory input via the use of the InnoCaption mobile app can be considered somewhat protective against loneliness experienced when people are unable to engage with others. The finding that confidence levels and self-rated happiness increased dramatically when using smartphone captioning combined with the finding that captions contributed to the ease of listening can be interpreted to suggest a boost in emotional well-being for respondents once they began using InnoCaption.

A Call to Action for Hearing Healthcare Professionals

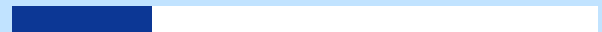
During clinical encounters, hearing healthcare professionals are consistently reminded of the isolation and feelings of loneliness experienced by our patients with varying degrees of self-rated hearing difficulty. The feelings of stress and frustration often experienced when speaking on the phone with family, friends, and colleagues can serve as a barrier to connecting. It is clear that the use of technology like the InnoCaption app dramatically reduces the sense of anger, stress, frustration, and fatigue when speaking on a smartphone. These emotions seemed to be replaced by a sense of confidence and clearly positively impacted overall quality of life. Given the value of the InnoCaption app, it is important for healthcare professionals to include information about the app in their counseling. As is shown in Figure 12, hearing healthcare professionals are not currently the primary source of information about the app. Instead, we were surprised to discover that most respondents heard about InnoCaption from direct online sources such as search engines (26%) and app stores (24%). In contrast, only 14.7% of respondents heard about it from a hearing healthcare professional and 10% from a professional hearing organization.

How did you learn about InnoCaption?

Search engine (Google Search or website)



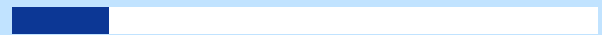
App Store or Play Store search



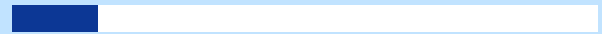
Family/friend recommended



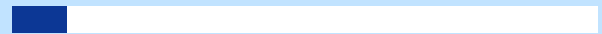
Social Media (Facebook, Instagram, LinkedIn, Twitter, YouTube)



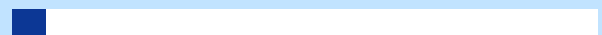
Hearing healthcare professional



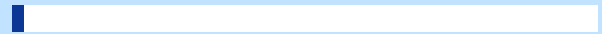
Hearing loss organization/chapter meeting (Webinar, In-Person presentation)



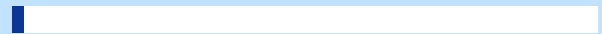
Magazine advertisement or article (Hearing Life, Hearing News, AARP)



Conference/convention



Employer or government agency



Other

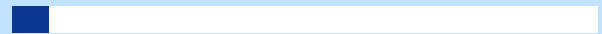


Figure 12.

Sources from which respondents learned about InnoCaption.

Individualized treatment recommendations are integral to patient-centered care. As part of our commitment to this, hearing healthcare professionals have a duty and obligation to routinely probe how well patients are communicating when wearing their hearing aids/CI and streaming to their smartphones. It is clear that mobile captioning services can serve as a bridge to better communication. To achieve this end we recommend that hearing healthcare professionals ask each patient to rate the degree of difficulty experienced when on the smartphone and when streaming with their hearing aid(s) or CI. We can also ask family members to rate the ease or difficulty their family member with hearing loss is experiencing when using a smartphone for voice calls. Healthcare professionals might also consider discussing the value of connecting with family members over the smartphone. The data suggest that for many, the use of captioning lessens the effort, increases the ease of listening, and restores the benefits once accrued from telecommunicating.

As there are no HIPAA compliance issues, we urge clinicians to recommend that their patients use the InnoCaption app for telehealth visits. Some of the advantages of the InnoCaption App are listed in Table 2.

Table 2. Advantages of the InnoCaption App

1. No cost to eligible users
2. HIPAA compliant (under review)
3. Real-time captioning
4. Dual caption modes - live stenographer (CART) or best-in-class automated speech recognition
5. In-call caption mode switching option
6. Review prior call transcripts
7. Voicemail preview and captioning
8. Ability to make 911 and 311 calls and receive captioning
9. Adjustable font size, typeface and color
10. Available on iOS and Android devices (phones, tablets, and computers)

Conclusion

A major reason people with hearing loss seek assistance from hearing healthcare providers is because of difficulty communicating in selected situations – notably with family and friends, when watching television, and when speaking on the telephone (even when wearing hearing aids or a CI). The use of captioning with television is widespread, as is the use of captions when speaking over a landline telephone. Our data suggest that the availability of captioning services with a smartphone have both created a more inclusive environment and increased accessibility for persons with hearing difficulty. The benefits span multiple generations including Gen Z and Millennials (Myers, 2023). In fact, a recent survey by Preply (2023), revealed that Gen Z and Millennials were more likely to use captioning than were Generation X and Baby Boomers. It is clear from our data that smartphone connectivity provided by the use of the InnoCaption app yielded psychosocial benefits we did not anticipate, but which were experienced by individuals with hearing loss and processing difficulties. Most notable was the stress and fatigue associated with connecting with others which was clearly lessened by the use of InnoCaption. The fact that respondents rated the quality of their interactions positively using the captioning app would suggest that subjective feelings of loneliness were somewhat alleviated; the lack of connection, often felt in the background, can also be a motivating factor in seeking out this form of hearing assistance technology.

Although hearing healthcare professionals were not the primary source for information on captioning with smartphones, given the psychosocial advantages of captions, going forward we suggest that hearing health professionals inform and educate their clients about the use of this type of service.

When presenting information on InnoCaption, it is critical to underscore that use of the app is HIPAA compliant. It is also important to underscore that age is no longer a barrier to smartphone use, as 64% of the InnoCaption baseline survey respondents were over the age of 61. We must now assume that our older patients can and should be apprised of the benefits of captioning with smartphones.

Since older adults cultivate smaller and more intimate social networks when using smartphone technology (Sims, et al., 2017) the message should be clear from the results of our survey that the use of InnoCaption technology is beneficial in situations most important to persons with hearing loss. Persons with hearing difficulty may continue to have difficulty streaming phone calls when wearing hearing aids or a CI, and the InnoCaption App should routinely be recommended during the pairing process. Finally, as part of a move toward social prescribing to reduce social and emotional loneliness, patients should be encouraged to use the InnoCaption app to remain socially connected and to maximize success when using mobile phone technology.

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APPENDIX

Q	Pre-Survey	Q	Post-Survey
1	<p>Before we begin, please read and agree to the following terms and conditions:</p> <p>By submitting my response, I acknowledge that I understand the information collected through this survey will be shared with and used for research purposes. Information will be analyzed in an aggregated form along with other responses and any personal information will be handled in accordance with InnoCaption's privacy policy.</p> <p>I agree to carefully read and answer each question. I understand that if it is shown that I sped through and/or did not carefully read the questions, I may lose my opportunity to complete the survey and receive the \$20 Amazon gift card. Only one survey response can be submitted per verified InnoCaption user.</p>	1	<p>Before we begin, please read and agree to the following terms and conditions, which are the same as the first survey you took:</p> <p>By submitting my response, I acknowledge that I understand the information collected through this survey will be shared with and used for research purposes. Information will be analyzed in an aggregated form along with other responses and any personal information will be handled in accordance with InnoCaption's privacy policy.</p> <p>I agree to carefully read and answer each question. I understand that if it is shown that I sped through and/or did not carefully read the questions, I may lose my opportunity to complete the survey and receive the \$20 Amazon gift card. Only one survey response can be submitted per verified InnoCaption user.</p>
2	<p>This email survey is intended for individuals who have registered to use InnoCaption. Are you the intended InnoCaption user?</p> <p>Y/N</p>	2	<p>This email survey is intended for individuals who have registered to use InnoCaption. Are you the intended InnoCaption user?</p> <p>Y/N</p>
3	<p>Demographics: Gender</p> <p>Male Female Binary Prefer not to answer</p>	3	<p>Demographics: Gender</p> <p>Male Female Binary Prefer not to answer</p>
4	<p>Demographics: Age</p> <p>80 and above 71-79 61-70 51-60 41-50 31-40 21-30 20 or under</p>	4	<p>Demographics: Age</p> <p>80 and above 71-79 61-70 51-60 41-50 31-40 21-30 20 or under</p>

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Q	Pre-Survey	Q	Post-Survey
		5	Which best describes your work status: Working, full-time Working, part-time (including partially retired) Not working/retired
5	Which of the hearing assistive device(s) below do you use? Hearing aid Cochlear implant in one ear and hearing aid in other ear Cochlear implant in one or both ears Other implantable hearing device Bone-anchored hearing aid (BAHA) None	6	Which of the hearing assistive device(s) below do you use? Hearing aid Cochlear implant in one ear and hearing aid in other ear Cochlear implant in one or both ears Other implantable hearing device Bone-anchored hearing aid (BAHA) None
6	Do you rely on this hearing assistive device (e.g., hearing aid, cochlear implant) to direct stream audio during smartphone conversations? Y/N	7	Do you rely on this hearing assistive device (e.g., hearing aid, cochlear implant) to direct stream audio during smartphone conversations? Y/N
7	How would you rate your degree of difficulty hearing or understanding without hearing technology assistance on a scale of 0-10? 0 (No Difficulty) – 10 (Extremely Difficult)	8	How would you rate your degree of difficulty hearing or understanding without hearing technology assistance on a scale of 0-10? 0 (No Difficulty) – 10 (Extremely Difficult)
8	How would you rate your degree of difficulty hearing or understanding with hearing technology assistance on a scale of 0-10? 0 (No Difficulty) – 10 (Extremely Difficult)	9	How would you rate your degree of difficulty hearing or understanding with hearing technology assistance on a scale of 0-10? 0 (No Difficulty) – 10 (Extremely Difficult)

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Q	Pre-Survey	Q	Post-Survey
9	<p>Are you currently using a captioned landline phone or call captioning smartphone app besides InnoCaption?</p> <p>No Yes, smartphone app-based only Yes, both landline and smartphone app Yes, landline-based only</p>	10	<p>How often do you use InnoCaption to make or receive phone calls?</p> <p>On a regular basis Only for certain calls Very rarely I no longer use this service</p>
10	<p>Do you use closed captioning when watching/streaming television?</p> <p>Y/N</p>	11	<p>Please select the main reasons that led to you no longer using the InnoCaption app:</p> <p>Too many spam calls Bluetooth connectivity issues Call audio issues I did not find captions to be helpful Inaccurate captions Slow captions Too complicated Other</p>
11	<p>Over the last 3 months, how often have you used a smartphone or tablet device to make phone calls?</p> <p>Frequently Sometimes Rarely/Never</p>	12	<p>Are you currently using a captioned landline phone or call captioning smartphone app in addition to InnoCaption?</p> <p>No Yes, smartphone app-based only Yes, both landline and smartphone app Yes, landline-based only</p>
12	<p>For what situations do you use your smartphone or tablet for phone calls?</p> <p>Conversations with family and friends Medical (e.g., making doctor appointment) Appointments/reservations (e.g., hair, restaurant, services) Customer/technical support (e.g., financial, utilities, etc.) Benefits (e.g., private insurer, Medicare, Social Security, etc.) Participating in work calls/business related Telehealth (non-video) appointments Emergency services/911 School/Daycare/Eldercare Other</p>	13	<p>Which captioning service do you primarily use:</p> <p>InnoCaption Other smartphone-based app Landline captioning service</p>

APPENDIX

Q	Pre-Survey	Q	Post-Survey
13	<p>What top 3 situations are the most important to you to be able to use your smartphone or tablet for phone calls:</p> <p>Conversations with family and friends Medical (e.g., making doctor appointment) Appointments/reservations (e.g., hair, restaurant, services) Customer/technical support (e.g., financial, utilities, etc.) Benefits (e.g., private insurer, Medicare, Social Security, etc.) Participating in work calls/business related Telehealth (non-video) appointments Emergency services/911 School/Daycare/Eldercare Other</p>	14	<p>Do you use closed captioning when watching/streaming television?</p> <p>Y/N</p>
14	<p>Rate your success in understanding the other party when you make phone calls with your smartphone or tablet without captions:</p> <p>Some to moderate difficulty Not successful at all I don't make calls with my smartphone without captions Successful</p>	15	<p>Over the last 3 months, how often have you used a smartphone or tablet device to make phone calls?</p> <p>Frequently Sometimes Rarely/Never</p>
15	<p>Describe your overall level of satisfaction about using your smartphone for calls without captions:</p> <p>Somewhat satisfied Not at all satisfied Very satisfied</p>	16	<p>For what situations do you use your smartphone or tablet for phone calls?</p> <p>Conversations with family and friends Medical (e.g., making doctor appointment) Appointments/reservations (e.g., hair, restaurant, services) Customer/technical support (e.g., financial, utilities, etc.) Benefits (e.g., private insurer, Medicare, Social Security, etc.) Participating in work calls/business related Telehealth (non-video) appointments Emergency services/911 School/Daycare/Eldercare Other</p>

APPENDIX

Q	Pre-Survey	Q	Post-Survey
16	<p>Which of the following best describes your feelings when making phone calls on your smartphone or tablet without captions?</p> <p>Frustrated Anxious/stressed Discouraged Dissatisfied Confused Angry Confident Happy Content None of the above</p>	17	<p>What top 3 situations are the most important to you to be able to use your smartphone or tablet for phone calls:</p> <p>Conversations with family and friends Medical (e.g., making doctor appointment) Appointments/reservations (e.g., hair, restaurant, services) Customer/technical support (e.g., financial, utilities, etc.) Benefits (e.g., private insurer, Medicare, Social Security, etc.) Participating in work calls/business related Telehealth (non-video) appointments Emergency services/911 School/Daycare/Eldercare Other</p>
17	<p>Rate your level of fatigue when making calls on your smartphone or tablet without using InnoCaption:</p> <p>0 (No fatigue) – 10 (Extremely fatigued)</p>	18	<p>Rate your success in understanding the other party when you make phone calls with your smartphone or tablet with InnoCaption:</p> <p>Successful Some to moderate difficulty I don't make calls with my smartphone without captions Not successful at all</p>
18	<p>Rate your level of effort when making calls on your smartphone or tablet without using InnoCaption:</p> <p>0 (No effort) – 10 (Maximum effort)</p>	19	<p>Describe your overall level of satisfaction when using your smartphone for calls with InnoCaption:</p> <p>Somewhat satisfied Not at all satisfied Very satisfied</p>
19	<p>For what situations are you hoping to be able to use your smartphone or tablet for phone calls with the InnoCaption app?</p> <p>Conversations with family and friends Medical (e.g., making doctor appointment) Appointments/reservations (e.g., hair,</p>	20	<p>Which of the following best describes your feelings when making phone calls on your smartphone or tablet with InnoCaption?</p> <p>Frustrated Anxious/stressed Discouraged</p>

APPENDIX

Q	Pre-Survey	Q	Post-Survey
	<ul style="list-style-type: none"> restaurant, services) Customer/technical support (e.g., financial, utilities, etc.) Benefits (e.g., private insurer, Medicare, Social Security, etc.) Participating in work calls/business related Telehealth (non-video) appointments Emergency services/911 School/Daycare/Eldercare Other 		<ul style="list-style-type: none"> Dissatisfied Confused Angry Confident Happy Content None of the above
20	<p>How did you learn about InnoCaption?</p> <ul style="list-style-type: none"> Search engine App Store or Play Store search Family/friend recommended Social Media (Facebook, Instagram, LinkedIn, Twitter, YouTube) Hearing healthcare professional Hearing loss organization/chapter meeting (Webinar, In-Person presentation) Magazine advertisement or article (Hearing Life, Hearing News, AARP) Conference/convention Employer or government agency Other 	21	<p>Rate your level of fatigue when making calls on your smartphone or tablet with InnoCaption:</p> <p>0 (No fatigue) - 10 (extremely fatigue)</p>
21	<p>Please provide us with the email address that is registered to your InnoCaption account for verification purposes. We will also use this address to send you the second survey.</p>	22	<p>Rate your level of effort when making calls on your smartphone or tablet with InnoCaption</p> <p>0 (No effort) - 10 (maximum effort)</p>
		23	<p>For what situations have you used your smartphone or tablet for phone calls with InnoCaption:</p> <ul style="list-style-type: none"> Conversations with family and friends Medical (e.g., making doctor appointment) Appointments/reservations (e.g., hair, restaurant, services) Customer/technical support (e.g., financial, utilities, etc.) Benefits (e.g., private insurer, Medicare,

APPENDIX

Q	Pre-Survey	Q	Post-Survey
			Social Security, etc.) Participating in work calls/business related Telehealth (non-video) appointments Emergency services/911 School/Daycare/Eldercare Other
		24	Help us identify one or more areas that we can improve (select all that apply): Captioning (accuracy, speed) User Experience (how the app looks and ease of use) Features (anything missing?) Customer Support There are no areas that need improvement Other (open text)
		25	Please provide us with the email address that is registered to your InnoCaption account for verification purposes. We will also use this address to send you the second survey.
		26	Would you be interested in participating in a paid focus group interview in the future to help us improve our service? Y/N