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AN EVALUATION OF THE AUSTRALIAN CAPTIONED TELEPHONE TRIAL

Luke B Connelly

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Australian Centre for Economic Research on Health

An evaluation of the Australian captioned telephone trial

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Executive Summary

This study was commissioned by the Australian Communication Exchange Ltd , to evaluate its Australian trial of captioned telephone services (CTS). Two surveys and five focus groups were conducted for the study to produce quantitative and qualitative indicators of the effect of CTS on the health-related quality of life and well-being of people who have a hearing deficit. In addition, a contingent valuation study was conducted to estimate the monetised value that CTS users place on the service.

The main results consist of comparisons of baseline and followup responses to a range of hearing-related questions about using a telephone. At the baseline, no respondent had access to a captioned telephone. At followup, all respondents were captioned telephone users. The results of multivariate regressions suggest that access to a captioned telephone was associated with:

- a large reduction in the chance that a high-range hearing handicap was reported to be associated with telephone use including:
  - a 56% lower chance of reporting a hearing handicap in the top six categories on the Hearing Handicap Index for Telecommunications (HHIT); and
  - a 17% lower chance of reporting the maximum (worst) hearing handicap on the 19-point HHIT;
- a 40% reduction in the likelihood a respondent felt upset by his/her hearing problem when using the phone;
- a 34% reduction in the likelihood a respondent felt frustrated while trying to communicate with his/her family on the phone;
- a 28% reduction in the likelihood a respondent felt frustrated while talking to friends on the phone;
- a 20% reduction in the likelihood a respondent felt embarrassed by his or her hearing problem when using the phone.
- A 25% reduction in the likelihood that a hearing problem moderately or greatly affected the way that respondents feel about themselves.

A small number of respondents had used a captioned telephone at work. The results of its use in the workplace are also remarkable:

- 75% of these respondents indicated that the phone had improved (i) work satisfaction, (ii) communication with colleagues, coworkers and customers, (iii) work-related satisfaction and (iv) their ability to fulfill the expectations of clients and customers;
- 88% also indicated that the phone had changed the range of tasks they could perform at work;

- 69% believed that the phone had both changed the way that they worked, and the range of tasks that they actually performed at work; and
- more than half of these respondents believed that access to the phone, in the workplace, could enable them to retire later in life.

Two-thirds of respondents were either satisfied, or very satisfied with the captioned telephone service. The major source of dissatisfaction for most respondents was the limited hours of operation of the captioning service during the trial: only 28% of respondents were satisfied or very satisfied with the hours of operation. The other primary source of dissatisfaction concerned teething problems with the setup of the technology which often were attributable to an inadequate internet connection.

The qualitative results derived from open-ended comments by survey respondents and from focus group meetings are consistent with the quantitative evidence obtained from responses to the survey items. Respondents were generally enthusiastic about CTS and a number described its impact on their home and work life in terms that may be described as transformational or profound.

Participants in the contingent valuation study were willing to forgo, on average, 9.5% of their incomes to use CTS. This result is remarkable given the fairly low household incomes of many respondents.

Acknowledgement

This study was commissioned and received financial support from an unrestricted grant from the Australian Communication Exchange Ltd (ACE). The author gratefully acknowledges the assistance of ACE personnel in the recruitment of the samples used for this research and for assistance with the conduct of the contingent valuation interviews and focus group meetings.

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1 Introduction

In January 2011, a trial of captioned telephone services (CTS) was conducted in Australia, by the Australian Communication Exchange Limited (ACE).[1] The research contained in this report was commissioned by ACE to examine the effect of CTS on telecommunications for people with hearing problems. It reports the results of two national, web-based surveys of people with hearing loss, as well as the results of face-to-face interviews and focus group meetings that were held in Brisbane, Sydney and Melbourne. The focus of the report is on the way that CTS affects the health-related quality of life (HRQoL) of people with hearing problems. Both qualitative and quantitative methods are employed to analyse data collected via two national, web-based surveys and from face-to-face interviews and focus group meetings that were conducted in Brisbane, Sydney and Melbourne. Both the quantitative and qualitative results suggest that CTS is associated with substantial reductions in reported indicators of hearing-related handicap. The results of contingent valuation interviews also reveal that respondents place substantial value on the CTS. Individuals who had used the CTS in the workplace also reported improvements in communications, productivity, success and satisfaction with work. More than half of those respondents believed that having access to the telephone could enable them to defer retirement from the workforce, should they choose to do so.

The report is arranged as follows: the following section provides a brief Background; then the Data, Methods and Measures, Results and Conclusion are presented.

1.1 Background

A captioned handset of the kind that was used in the ACE trial is displayed below. Briefly, in addition to the features of a standard telephone, a captioned telephone has a screen that displays the other caller's speech as text. The captioned telephone user makes or receives calls in the usual way, with a telephone operator supplying captions in real-time as the hearing party speaks. The operator "re-voices" the hearing party's conversation into voice-recognition software, which converts the audio signal to text. The operator then corrects the resulting text for translational errors, using a computer keyboard, and the text is displayed on the CTS user's handset. This technology has numerous advantages. One of these is the high-speed text support that can be achieved by highly-trained and experienced operators: speeds of approximately 180 words per minute are possible [1]. By comparison, users of text/telephone typewriters (TTYs)–which can also be used to connect to a standard telephone using the ACE-operated National Relay Service (NRS)–can be used with text support of approximately 45 words per minute. The technical requirements for the CTS are (i) access to a standard analogue phone line, and (ii) a broadband internet connection. For a more detailed description of how the CTS works, see [1].

An important precursor to the trial of CTS using the handset pictured above, was

[1] ACE is a not-for-profit Australian organisation that was established "...to facilitate equity of access to the telecommunications network for people who are Deaf, or have a hearing or speech impairment". For further details see `http://www.aceinfo.net.au/`.

Figure 1: A Captioned Telephone Handset

Source: Australian Communication Exchange (2011).

ACE's 12-month trial of a web-based CTS in 2009-2010. In that trial, users of CTS viewed captions on their computer screens. A study using a web-based survey was conducted in conjunction with that trial and the results were reported in Connelly (2010). The purpose of that study was (i) to provide baseline data about the health-related quality of life (HRQoL) of people who might benefit from the use of CTS, (ii) to provide information about the specific effects of hearing loss on the social integration of this group of potential CTS users, and (iii) to collect pilot data on the benefits that are created by a CTS. As with the present study, the survey was conducted in two waves.

That study found that the target user group for CTS recorded poorer levels of HRQoL than the general population. On an HRQoL utility scale where zero represents death and one represents perfect health, an Australian population study recorded a mean (i.e., average) utility value of 0.83, while the mean for the ACTS sample is only 0.49. Indeed, the mean HRQoL utility of the ACTS sample was almost as low as a value that was obtained in a sample of hospital inpatients and is lower than values recorded for samples of people with influenza, depression, major depression and psychosis, for example.

Measures of hearing-related social handicap showed that the sample respondents were severely adversely affected by hearing losses. For example, 72% of respondents reported that their hearing problem caused them to talk to family members less often than they would like to; 90% of respondents reported that they feel "handicapped" by their hearing loss; and 90% of respondents reported that their hearing loss limits or hampers their personal or social lives. Measures of the social handicap that is experienced by this group placed 97% of the sample in the "marked" (i.e., highest) hearing loss range. According to a large Australian study, approximately 1.9% of the population has hearing problems of this severity.

Thus, the report by Connelly (2010) provides useful background to this report. In addition, its results were used to refine the methodological approaches that were applied in the current study, especially with respect to the contingent valuation part of the study. In addition, a pilot survey was conducted in mid-2010 as a further precursor to this study, the results of which were used to make further refinements to survey items. Specifically, sources of ambiguity and item insensitivity were identified and refined for use in the baseline and followup studies.

Henceforth, the acronym "CTS" will be used to refer exclusively to CTS via a captioned telephone handset, which was the only type of CTS supplied to respondents during the recent trial.

2 Measures and Methods

2.1 Measures

2.1.1 Health-Related Quality-of-Life (HRQoL)

In previous work Connelly (2010) applied both a general measure of HRQoL, the Assessment of Quality of Life (AQoL) instrument [3], and long-standing measures of hearing handicap called the Hearing Handicap Inventory for the Elderly (HHIE) [7, 6] and a

derivative of it, the Hearing Handicap Inventory for Adults (HHIA) . That work indicated that the target population for CTS experiences considerable hearing-related handicap and lower HRQoL than the general Australian population.

Connelly (2010) showed that the target population for CTS generally suffers from considerably poorer HRQoL than the general Australian population and reports high levels of hearing-related handicap. This was shown using both the Australian Quality of Life (AQoL) instrument [3] and the Hearing Handicap Inventory for Adults (HHIA) . It was also argued that few existing and general measures of HRQoL are likely to be sufficiently sensitive to measure changes in life quality that may arise due to CTS. Indeed, even a hearing-specific scale such as the HHIA may not be sensitive to quality of life improvements that are brought about by an intervention such as CTS because although the HHIA is hearing-focused, few of its items directly address the way that a hearing problem affect telecommunications.

This presents a difficulty: ideally one would wish to use a validated and sensitive instrument to test hypotheses about the effect of an intervention on HRQoL. A pragmatic solution to this problem was employed for this study. A variant of the HHIE/HHIA, which has been labelled the Hearing Handicap Index for Telecommunications (HHIT) was created using a subset of items from the HHIE/HHIA as well as a suite of modified HHIE/HHIA items. The benefit of this approach is that the resulting questions have greater face validity with respect to the intervention of interest: CTS. Of course, this modification also involves a trade-off inasmuch as it represents a departure from the validated and well-known HHIE and HHIA instruments. In the interests of greater specificity and sensitivity of the resulting items to changes in how people with hearing problems experience telecommunications in particular, this trade-off was considered worthwhile. Furthermore, a range of additional measures were used to corroborate the evidence collected via this new instrument. The analyses suggest agreement between the HHIT and other qualitative and quantitative measures of individuals' experiences with telephone and CTS use.

The advantage of the foregoing approach is an improvement in face validity: the items on the instrument apply, directly, to telecommunications.

2.2 Web-Based Surveys

Baseline and followup surveys were administered, via the web, in October 2010 and January 2011, respectively.

The sample for the baseline survey was recruited using a list of individuals, age ≥ 17 who had (i) indicated their willingness to participate in the trial and (ii) consented to their contact details being provided for the purposes of participating in this, related, study. One hundred and seventy-seven individuals were contacted and 117 responses were received, resulting in a response rate of 66%.

The followup sample was recruited using a list of individuals who had indicated their willingness to participate in the trial. Willing participants were allocated identification (ID) numbers which were then randomly allocated—by the researcher—to the intervention (i.e., CTS) and control groups (i.e., non-CTS group). ACE then supplied and

installed handsets to subjects who were allocated to the intervention group. The followup survey was sent to 77 individuals, 44 of whom responded, resulting in a response rate of 57%. Twenty-one respondents to the followup survey also indicated that they had participated in the baseline survey, although participation could be confirmed for only 20 of these respondents. Nevertheless, this small sample who completed both surveys provides a useful mechanism for testing hypotheses about response bias: in particular, whether or not the results for this sub-sample differ from the results from the full sample of 161 respondents across both waves of the survey.

Based on the previous work of Connelly (2010) and feedback received by respondents, extensive use was also made of open-ended or "free-comment" fields in the web-based surveys. In conjunction with the focus group meetings of CTS users, a contingent valuation study was conducted via individual, face-to-face interviews with focus group participants.

2.2.1 The Hearing Handicap Index for Telecommunications (HHIT)

Items on the HHIA were that were considered relevant to telecommunications were preserved for the HHIT. In most cases, though, items from the HHIA that could apply, with modification, to telecommunications were amended to place the respondent's focus on hearing-related handicaps that were associated specifically with telephone use. 2.2.1contains nine original items from the HHIA (Column 1) and, alongside these, the nine items that were used in the instrument that was used in this study. On the HHIA, for example, the item "Does a hearing problem cause you to be nervous?" captures the effect of a hearing loss on nervousness in general. This item was modified to read "Does a hearing problem cause you to feel nervous while using the phone?" to direct the respondent to consider his or her experiences using the telephone. In addition, captioned telephone users each of the HHIT items were asked to consider the period since they had received the captioned telephone.[2]

The HHIE and HHIA have 50 items with a trichotomous responses: "No", "Sometimes" or "Yes", that are scored as 0, 1 and 2, respectively. Summary scores are generated by summing the responses across all items, thus resulting in a zero-to-100 overall scale, upon which zero indicated no hearing-related handicap, and 100 indicated the maximum possible hearing-related handicap.[3] In this study, the same response and scoring scheme was applied. On the HHIT, the minimum score–indicating no hearing-related handicap– is zero; but since there are nine items on the instrument the maximum value of the HHIT is 18. Thus, the HHIT theoretically takes on 19 values from and including zero (no handicap), to 18 (maximum possible level of handicap).[4] In addition to the analysis of summary scores, a breakdown of responses across the HHIT items is also analysed for users and non-users of CTS.

[2]Each item for this group was prefixed by the following text: "Thinking about the period SINCE you received the captioned telephone, does a hearing problem cause you..."

[3]See Connelly (2010) for a more extensive discussion of the HHIE and HHIA.

[4]Although it is straightforward to re-transform the response data to (e.g.) the 0-100 range, simply by multiplying the scores by a scalar. Given, however, that this has no effect on the substantive analytical results, no re-transformations are undertaken herein.

Table 1: Original Hearing Handicap Inventory for Adults (HHIA) Items and Modified Items Used to Create the Hearing Handicap Index for Telecommunications (HHIT)

Items from the HHIA	Items on the HHIT
Does a hearing problem cause you to use the phone less than you would like?	Does a hearing problem cause you to use the phone less than you would like?
Does a hearing problem cause you to be nervous?	Does a hearing problem cause you to feel nervous while using the phone?
Does a hearing problem cause you to have arguments with family members?	Does a hearing problem cause you difficulty communicating with family on the phone?
Does a hearing problem cause you difficulty when visiting with friends, relatives or neighbors?	Does a hearing problem cause you difficulty communicating with friends on the phone?
Does a hearing problem cause you to feel frustrated when talking to members of your family?	Does a hearing problem cause you to feel frustrated talking to family on the phone?
Does a hearing problem cause you to feel frustrated when visiting friends,?	Does a hearing problem cause you to feel frustrated talking to friends on the phone?
Do you feel handicapped by a hearing problem?	Does a hearing problem cause you to feel 'handicapped' while using the phone?
Does any problem or difficulty with your hearing cause you to feel upset at all?	Does a hearing problem cause you to feel upset while using the phone?

2.3 Other Web Survey Items

In addition to the HHIT, the web surveys collected demographic data, a 10-point measure of overall hearing (ranging from "1–I am completely deaf" to "10–I have perfect hearing"), experiential data on the use of TTY and CTS, employment-related questions (including several from the HHIA) for respondents who were in the workforce, and data from five-point Likert-scale responses to questions about satisfaction, the effect of hearing on feelings about oneself and the effect of hearing on telephone use.

2.3.1 Focus Groups

Focus groups were conducted to collect further qualitative information about CTS with a captioned handset. Five focus group meetings were held, as follows:

1. Three focus group meetings (Brisbane, Sydney and Melbourne) comprised CTS users;
2. one focus group meeting comprised potential CTS users (Brisbane); and
3. one focus group meeting comprised businesspeople (Brisbane).

Focus group members were made aware of the purpose of the meeting *a priori* and were told that that their responses were being transcribed. For CTS users and potential CTS users, captioned text of the discussion was displayed on a screen in real-time, to enable all attendees to follow and contribute to the discussion. For CTS users, the focus group discussions centered on participants' experiences and preferences with respect to CTS and alternatives to it (e.g., TTY). The focus group for potential CTS users commenced with a demonstration of the captioned telephone handset, which included discussion group members participating or witnessing a real-time call using the phone, followed by discussion. The focus group with businesspeople involved a demonstration of TTY and CTS using a business-like script. The businesspeople received calls from a person using both devices, but were blinded to which technology was used for a particular call. The discussion focussed on their experiences receiving both calls.

In each focus group, the discussion was allowed to range with minimal prompting by the facilitators. Prompts included an opening question about people's experiences using the CTS, and questions about functionality and whether people had used the phone for work. The meetings were allocated up to two hours but, in each case, were concluded within 45-60 minutes.

The results of focus group meetings are summarised in this report by reviewing the transcripts of each session and identifying the themes that emerged in these discussions.

2.4 Contingent Valuation

Participants in focus group meetings for CTS users also participated in a contingent valuation (CV) study. The purpose of the CV study was to estimate the value that users place on the CTS by asking them about their willingness to pay (WTP) to use

that service. The maximum amount a person is prepared to pay for CTS represents the maximum value of other goods and services that the person would be willing to go without in order to have CTS.

A brief explanation of CV was provided to each group, and an example from environmental economics was used to familiarise participants with the valuation of a non-market good. The purpose of the introduction was to help respondents understand the way that a CV study works and to minimise the chance of "protest votes" or other forms of strategic behaviour that may lead to exaggerated statements of WTP. Connelly (2010) has previously found evidence of probable protest votes in online CV work with the CTS target group, although he did not find no evidence of other forms of strategic behaviour (e.g., bid inflation). Furthermore, open-end commentary by respondents in that work, and a subsequent pilot, suggested that a substantial number of respondents did not completely understand the task that they were being asked to perform. A non-health example was chosen to illustrate the purpose of a CV to minimise the chance that the introduction itself would bias behaviour and to minimise the chance respondents would refuse to participate and in an attempt to avoid introducing response bias.

In addition, a bidding game approach was employed with a randomised starting bid that, based on pilot data, took values of $30, $50 and $80 per month for CTS services, including handset rental. The bid was increased or decreased in $10 units, depending upon whether the respondent indicated willingness or unwillingness to pay. For increasing bid sequences, bidding stopped when the respondent indicated that he/she was unwilling to pay the amount bid. For decreasing bid sequences, bidding stopped when the individual answered that he/she was willing to pay a bid amount. A challenge question was then asked: respondents were asked whether or not they really would be willing to pay the highest bid they had accepted. At this point, respondents had the opportunity to amend their highest bid. A further challenge question was also asked to encourage respondents to consider whether or not they could afford to pay their highest bid, per month, for CTS. A final bid was recorded when affirmative responses were received for both challenge questions.

An important consideration in the current setting concerns the price of CTS calls by comparison with substitute services, such as TTY. The CTS service, including the installation of handsets, was supplied free of charge to users during the CTS trial. CTS users were, however, charged the standard carriage rates for all calls that used the captioned handset. The CV scenario that was described to respondents involved

- the availability of CTS, on a commercial basis (24 hours a day, 7 days a week); and
- standard local, national and international call charges for all calls made using CTS.

The latter is a particularly important assumption because, at present, individuals who make calls using a TTY, via the NRS, are charged the price of a local call for STD as well as local calls.

To estimate the additional out-of-pocket costs associated with CTS, aggregate call data from TTY users were obtained from the ACE. These are added to the CV survey responses to produce an estimate of each user's marginal WTP for CTS.

Specifically, ACE supplied the call volumes, durations and estimated costs of calls made by the top 500 (by frequency) NRS users in the first 6 months of 2010. Estimated call costs were estimated by taking data on the actual number and duration of calls, by type (local, national, mobile, international) and applying the standard call charges levied the largest telecommunications company in Australia, Telstra. The mean marginal call cost, per month, for NRS users was estimated to be $12.81, after the local call charges that NRS users pay were subtracted. Applying this estimate to augment stated WTP essentially assumes that the own-price elasticity of demand is zero. If call volumes and/or durations fell as a result of the imposition of charges for CTS users, this sum would thus represent an underestimate of total call costs.[5] Conversely, though, CTS may increase the demand for calls, in which event this estimate may be too low. Given the relatively small sum involved, this is not a particularly serious concern, although it is an issue upon which further light may be shed at the trial's conclusion.[6]

2.5 Quantitative Methods

The analytical method that is used to produce most of the results is multiple regression analysis, primarily using limited dependent variable models.

Binary variables were created from each item on the HHIT. Recall that there are three possible responses to each of the HHIT items: "No", "Sometimes" and "Yes". These were used to create dichotomous variables =1 if the respondent answered "Sometimes" or "Yes" and =0 if the respondent answered "No". These dichotomous measures were used to estimate equations of the following form:

$$DVUSEP = \beta_0 + \beta_1 CTS + \beta_2 AGE + \beta_3 GEN + \beta_4 HEARING + \beta_5 TTY + \epsilon \quad (1)$$

where the dependent variable ($DVUSEP$) is the dichotomised item response =1 if "Sometimes" or "Yes" to the question "Does a hearing problem cause you to use the phone less than you would like?", =0 otherwise; CTS_i=1 if the respondent is a captioned telephone service user, =0 otherwise; AGE is the respondent's age, in years; GEN=1 if the respondent is male, =0 otherwise; $HEARING$ is the reported level of hearing loss; TTY=1 if the respondent has ever used a TTY, =0 otherwise; $\epsilon$is a well-behaved error term; and the βs are parameters to be estimated. In empirical specifications, the variables AGE and $HEARING$ were used to create a series of binary variables. The survey responses for age fell into eight categories (1=17-24 years, 2=25-34 years,...,8=85+ years) and these were used to create seven dummy variables for age. Upon inspection of $HEARING$, a

[5] More specifically, if NRS users prefer CTS to TTY the demand for calls may increase (i.e., the demand curve for calls shifts to the right). The increased price of calls may also, however, decrease the quantity demanded (i.e., to result in a shift along a downwards-sloping demand curve) provided the price-elasticity of demand is <0. Whether the total call charges would exceed, be equal to, or less than those estimated above depends on the magnitudes of these two effects, the size of which is not yet known.

[6] Note that one would, in theory, also like to ask members of the general public about their WTP for CTS in the event that they experienced a hearing loss. To do so was beyond the scope of this study.

number of binary variables (up to five) were created to model the relationship between self-reported hearing loss and the dependent variables. Ultimately, in most specifications, a binary indicator of hearing loss was used as the coefficients for other specifications of hearing tended not to be statistically significant.

The sign and statistical significance of the coefficient on β_1 is of primary interest: a statistically significant, negative coefficient on $\beta_1$in Equation (2) may be interpreted as evidence that CTS users are less likely than non-CTS users to use the phone less often than they would like. Nine binary logit models like Equation (1) were estimated: one for each item on the HHIT.

For the HHIT summary measure, models of the following form were estimated:

$$HHIT = \beta_0 + \beta_1 CTS + \beta_2 AGE + \beta_3 GEN + \beta_4 HEARING + \beta_5 TTY + \epsilon \quad (2)$$

where $HHIT$ is the ith respondent's HHIT score and all other notation is as previously defined. The focus of the study is on the null hypothesis of no difference between the HHIT scores of CTS users and non-CTS users. A fixed-effects specification of Model (2) was also estimated on 20 respondents who participated in both the baseline and followup surveys.

Regressions such as the following were also estimated:

$$FSLF = \beta_0 + \beta_1 CTS + \beta_2 AGE + \beta_3 GEN + \beta_4 HEARING + \beta_5 TTY + \epsilon \quad (3)$$

where $FSLF$ is a variable created from the item "Does a hearing problem affect the way you feel about yourself?" and takes on values from zero "Never affected" to four "Greatly affected".

Equations (2) and (3) were estimated using ordered logit models.[7] The ordered logit approach is predicated on the view that the dependent variables are categorical, ordered indicators of a latent variable (e.g., feelings about oneself). Formulations like Equation (3) were also used to estimate the correlation of CTS with how often respondents kept in touch with friends and relatives and how often they conversed with friends.

The coefficient estimates from Equations (1) through (3) are reported in the Appendix. The results that are reported in the body of this document are the average discrete effects (ADEs) of a change from CTS=0 to CTS=1. These effects are estimated probabilities, but they are presented as predicted percentage changes in the likelihood of the outcome of interest.

For models with binary dependent variables (such as those for the individual items on the HHIT), these effects represent the probability (represented as a percentage change) in the likelihood that a respondent who uses CTS answered "Yes" or "Sometimes" to the item

[7] Equation (2) was also estimated via ordinary least squares and quantile regression, but the results were not substantively different from those obtained via ordered logit analyses. The results are not reported here, but are available from the author upon request.

on the HHIT.[8] Negative and statistically significant changes in these percentages indicate that CTS is associated with a change in the likelihood that a respondent answered "Yes" or "Sometimes" to a question about hearing-related handicap.

For ordered logit models, the discrete effects are reported for each value of the dependent variable. For example, the results of Equation (3) are reported as the correlation of CTS use with the chance of reporting a particular outcome on the ordered scale of the dependent variable. If CTS use were correlated with lower levels of reported hearing-related handicap, one would expect the chances of reporting higher levels of handicap to decrease, while the chance of reporting lower levels of handicap should increase.

The contingent valuation results are also analysed using ordinary least squares (OLS) multiple regression analysis. The regression takes the following form:

$$WTP = \beta_0 + \beta_1 INCOME + \beta_2 BID + \epsilon \tag{4}$$

where *INCOME* is gross annual household income and *BID* is the starting bid. The null hypotheses of no relationship between WTP and income or WTP and the starting bid will be rejected if statistically the coefficients on $\beta_1$and β_2, respectively, are statistically significant.

Descriptive statistics and a panel data (fixed effects) analysis of a small subset of the sample (n=20) that completed both the baseline and followup surveys is also conducted, mainly to test concerns that sample selection problems may influence the results. The panel data analysis is effectively a "before-and-after" study of 20 subjects. The small sample size and the availability of only two waves of data limits the utility of panel data analysis in this study. Its main purpose is to test the hypothesis that unobserved heterogeneity may be responsible for the effects that are reported in the main analysis.

Finally, a small subset of individuals in the followup study (n=17) had experience of using the CTS for work. The results of questions that were specific to this group are also presented. Given the small number of observations, these data are mostly presented as descriptive statistics.

2.6 Qualitative Methods

The outcomes of focus group meetings are summarised using the transcriptions of the sessions. The presentation of results focuses on the recurrent themes that arose during meetings with CTS users and on the reactions of potential CTS users and businesspeople to the captioned handset and CTS.

3 Results

This section commences with a discussion of the main results, which focus on HRQoL, and are based on data collected in the baseline and followup web surveys. The quantitative analysis in this section ends with a sub-group analysis of people who had used the

[8] To convert these percentages back to probabilities, simply move the decimal two places to the right.

Table 2: Descriptive Statistics

Variable	Baseline		Followup	
	Mean 95% CI	***n***	**Mean (95% CI)**	***n***
Age	5.66 (5.29 6.02)	190	5.23 (4.77 5.68)	44
Hearing	2.46** (2.17 2.75)	185	2.27 (1.92 2.65)	44
Employed	0.43** (0.34 0.52)	190	0.68** (0.53 0.82)	44
Male	0.70 (0.62 0.79)	190	0.72 (0.59 0.86)	44

Notes: (i) Age =1 if 17-24, =2 if 25-34, =3 if 35-44, =4 if 45-54, =5 if 55-64, =6 if 65-74, =7 if 75-84, =8 if 85+;
(ii) Hearing =1 "I am completely deaf" to 10 "I have perfect hearing";
(iii) Employed =1 if employed, =0 otherwise;
(iv) Male =1 if male, =0 otherwise.
(v) Significance levels: †10% : * 5% : **1%
for t-tests of the hypothesis of no statistically significant differences between the means of these two groups, with unequal variances.

captioned telephone for work. Then, the qualitative results from focus group meetings and the contingent valuation results are presented.

3.1 Results from Web Surveys

Table 2 presents descriptive statistics on demographics, hearing and employment for the baseline and followup studies and the results of t-tests of the hypothesis of no difference between the means of the two groups. There are no statistically significant differences between the samples on demographic variables (i.e., age and gender). The rate of employment, however, does differ between the groups: 43% of baseline respondents were employed, and 68% of respondents to the followup survey were employed. Furthermore, although the mean values of the ten-point hearing index are numerically close, they are nevertheless statistically significantly different.

3.1.1 Health-Related Quality of Life (HRQoL)

As was indicated in the Methods section, for limited dependent variable models, this report focuses on the ADEs on *CTS*. These were derived from the coefficient estimates of multiple regression analyses, as reported in Tables A.1 to A.10 of the Appendix. It is worth noting here that, aside from the binary *CTS* indicator, the only regressor that was statistically significant in most regressions was a binary indicator of the variable *HEARING*. No gender-, age- or employment-related effects were detected when *HEAR-*

ING was included in the regression formulations and a decision was taken to drop those variables from the specifications, in the interests of parsimony. In all regressions, though, the binary *HEARING* variable has been retained on theoretical grounds. Specifically, one would expect a person's reported ability to hear to affect their responses to many of the questions that were asked about hearing-related problems. For this reason, the estimated coefficients on *HEARING* are reported in the Appendix whether or not they were statistically significant.

Table 3 reports the ADEs and 95% confidence intervals ("95% CIs") for those effects, derived from nine binary logit regressions on the items that comprise the HHIT. First, note that all of ADEs have negative signs and that eight of them are statistically significant at the one per cent level, while one is statistically insignificant at conventional levels. Thus, CTS use is correlated with lower levels of hearing related handicap on every item of the HHIT. Starting with the first row of results in Table 3, the interpretation of the ADE is as follows: CTS users were approximately 13% less likely than non-CTS users to report that a hearing problem caused them to use the phone less than they would like to. The 95% CI suggests that 95 out of 100 samples drawn from this population would result in CTS users being between approximately 3% and 24% less likely than non-CTS users to report using the phone less often than they would like to.

It is noteworthy that, on every item with a statistically significant effect, the chance a respondent answered in the affirmative was was at least 10% lower than the chance a non-CTS user would do so. Furthermore, on seven of the nine items, that chance is at least 20%, with CTS users reporting an almost 40% lower chance of reporting feeling upset while using the phone. The association of CTS with reductions in feelings of frustration and difficulties communicating were of similar magnitudes whether or not the question pertained to family or friends.

Table 4 presents the ADEs derived from an ordered logit model of responses to the question "Does a hearing problem affect the way you feel about yourself?". The regression results from which they are derived are presented in the Appendix as Table A.10. In this model, the ordered outcome variable takes five values (0-4), and higher values of the dependent variable represent a higher level of the latent problem. Recall that, in such models, an intervention that is correlated with reductions in the problem should have a negative effect on the chance a respondent records a larger affects on their feelings, and a positive effect on the the chance a respondent records smaller affects. This is what is shown by the results in Table 4: CTS users are approximately 19% less likely than non-CTS users to report that they are "Greatly Affected" and six per cent less likely to report being "Moderately Affected". They are more likely to report being "Never Affected", "Marginally Affected" or "Slightly Affected" and these differences are statistically significant at conventional levels. The odds ratio (0.36) that is reported in the final row of Table 4 suggests that CTS users are about a third as likely as non-CTS users to report more negative affects on the way their hearing problem affects feelings about themselves.[9]

Table 5 contains the ADEs derived from an ordered logit regression analysis of *CTS*

[9]This interpretation of the odds ratio is the "relative risk" interpretation that is conventionally used in health sector applications. See [2] for a discussion and critique.

Table 3: Captioned Telephone Use and Indicators of Hearing Handicap

Dependent Variables (0=No; 1=Sometimes or Yes)	**Average Discrete Effects (%)**	**95% CI (%)**	
Does a hearing problem cause you to use the telephone less often than you would like?	-13.06**	-23.52	-2.61
Does a hearing problem cause you to feel nervous while using the telephone?	-9.82	-24.96	5.31
Does a hearing problem cause you to feel embarrassed while using the phone?	-20.45**	-36.84	-4.06
Does a hearing problem cause you to feel upset while using the phone?	-39.54**	-58.41	-20.67
Does a hearing problem cause difficulty communicating with family on the phone?	-34.25**	-47.93	-20.57
Does a hearing problem cause difficulty communicating with friends on the phone?	-28.64**	-40.93	-16.35
Does a hearing problem cause you to feel frustrated when talking to family on the phone?	-33.91**	-47.93	-20.57
Does a hearing problem cause you to feel frustrated when talking to friends on the phone?	-28.27**	-40.93	-16.35
Does a hearing problem cause you to feel handicapped while using the phone?	-24.91**	-38.35	-11.46

Significance levels: †10% : * 5% : **1%

Table 4: Does a hearing problem affect the way you feel about yourself? Ordered Logit Results

Response	**Captioned Telephone Use: Average Discrete Effects (%)**	**95% CIs (%)**	
=4 Greatly Affected	-19.14**	-32.02	-6.28
=3 Moderately Affected	-6.36*	-12.19	-0.52
=2 Slightly Affected	4.76†	-0.003	9.55
=1 Marginally Affected	6.21*	0.09	11.51
=0 Never Affected	14.53**	4.34	27.42
Odds Ratio (Odds of More Adverse Affects)	0.36**	0.18	0.71

Significance levels: †10% : * 5% : **1%

and *HEARING* on the *HHIT* index. The regression results from which these results are derived appear as Table A.11 in the Appendix. The pattern of effects is similar to that which was witnessed in Table 4: CTS users are less likely to register higher HHIT scores, and more likely to register lower HHIT scores than non-CTS users. The odds ratio of 0.09 is remarkably low. Applying the relative risk interpretation, this suggests that, holding hearing level constant, non-CTS users are approximately one-tenth as likely as CTS users to register high-end (i.e., the worst) HHIT scores.

Applications of the ordered logit model depend on the so-called proportional odds or parallel lines assumption. Essentially, in the ordered logit model the estimated coefficients model are constrained to be the same across all categories of the dependent variable. This assumption, which is often violated (albeit sometimes without serious consequences), can be tested with a Brant test using a procedure written by Long and Freese [4]. If the parallel lines assumption is breached, the solution may include adopting a less restrictive model, such as the generalised ordered logit, of which the ordered logit is a special case. For this analysis, the parallel lines assumption was tested and was found to have been violated. A generalised ordered logit was estimated using the user-written gologit2 [8] command in STATA 11.0, and the results of the regressions were compared. The main difference between the two sets of estimates is that the generalised ordered logit results produced negative and statistically significant coefficients for more of the HHIT categories with higher values. In addition, though, this formulation led to numerous predictions where probabilities were negative. This can arise for a variety of reasons, one of which is that some values of the dependent variable are rarely observed (e.g., in this data set HHIT=1 is observed for only three respondents). One solution to this problem is to

Table 5: Hearing Handicap Index for Telecommunications: Ordered Logit Results

Dependent Variable: Hearing Handicap Index (=0 No handicap; 18=highest-level handicap)	**Captioned Telephone Use: Average Discrete Effects (%)**	**95% CIs (%)**	
18	-16.94**	-25.51	-8.38
17	-7.10**	-12.52	-1.68
16	-5.87**	-10.71	-1.04
15	-11.75**	-18.77	-4.73
14	-6.89**	-11.96	-1.81
13	-7.39**	-12.67	-2.12
12	1.29	-3.14	0.57
11	1.00	0.41	0.70
10	4.60	-1.74	2.65
9	5.73†	-0.45	11.90
8	4.87*	0.42	0.09
7	6.01*	1.10	10.93
6	5.99*	0.90	11.07
5	3.10	-0.63	6.83
4	7.32**	1.77	12.87
3	8.21**	2.33	14.09
2	5.62**	1.09	10.16
1	1.78	-0.68	4.24
0	8.57**	3.26	13.88
Odds Ratio (Odds of More Adverse Affects)	0.10**	0.05	0.19

Significance levels: †10% : * 5% : **1%

Table 6: Hearing Handicap Index for Telecommunications (HHIT), Six-Point Scale, Ordered Logit Results

Response	**Captioned Telephone Use: Average Discrete Effects (%)**	**95% CIs (%)**	
=5 ($HHIT \geq 17$)	-26.32**	-36.73	-15.91
=4 ($15 \leq HHIT < 17$)	-4.51*	-8.48	-0.55
=3 ($10 \leq HHIT < 15$)	-18.03*	-29.81	-6.26
=2 ($5 \leq HHIT < 10$	21.23**	8.06	34.41
=1 ($1 \leq HHIT < 5$)	19.54**	10.34	28.74
=0 ($HHIT = 0$)	8.09**	3.21	12.98
Odds Ratio (Odds of More Adverse Affects)	0.14**	6.80	28.12

Significance levels: $^{\dagger}10\%$: * 5% : **1%

collapse the dependent variable into fewer categories.

Thus, a six-point scale for the HHIT was derived, based on an inspection of the distribution of the HHIT.[10] While this form led to a considerable decrease in the number of observations with negative predicted probabilities, the parallel lines assumption was also no longer rejected, so the ordered logit model was applied and the regression results appear in the Appendix as Table A.12. The discrete effects are reported in Table 6, below, and follow the same pattern that has been demonstrated in each of the preceding analyses: CTS is associated with lower reported levels of hearing-related handicap. The likelihood that the hearing-related handicap is reported to be in the upper three (i.e., more severe) categories is lower for CTS users and hence their chances of reporting lower levels of hearing-related handicap are higher. The odds ratio agrees with previous findings too: CTS users are about one-tenth as likely as non-CTS users to record hearing related handicap, related to telecommunications, at the upper levels of the index.

Table 7 presents a simple ordinary least squares (linear) regression of *HHIT* on *CTS* and *HEARING*. The results suggest that *CTS* is associated with a mean difference of almost seven points on the *HHIT*. Although the limited dependent variable models are to be preferred on theoretical and statistical grounds, the OLS results tell a similar story about the association between CTS and HRQoL.

Recall that 20 participants in the followup survey had also completed the baseline survey. Table 8 reports the results of a fixed effects panel data regression on this sub-sample.

[10] The HHIT condensed scale, *HHITC*, =0 if HHIT=0; =1 if 0<HHIT<5; =2 if 5<HHIT<10; =3 if 10<HHIT<15; =4 if 15<HHIT<17; =5 if HHIT≥17.

Table 7: Hearing Handicap Index for Telecommunications: Ordered Least Squares Results

Variable	Coefficient	(Std. Err.)
Captioned Telephone	-6.66**	(0.75)
Hearing	-0.74	(0.76)
Intercept	12.39**	(0.60)
N	150	
R^2	0.29	
$F_{(2,147)}$	40.59	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

The model also included hearing, but that variable was dropped due to collinearity. Note that the coefficient on *CTS* is very similar in magnitude to the OLS estimate presented in Table 7. Additionally, it is worth reporting that an F-test of the hypothesis that individual fixed effects was zero could not be rejected, even at the ten per cent level ($F_{(20,18)}$=1.19; $p = 0.36$). This result provides reassurance that unobserved heterogeneity is not the source of the correlations that have been demonstrated using non-panel approaches.

Table 8: Hearing Handicap Index for Telecommunications: Fixed Effects Results

Variable	Coefficient	(Std. Err.)
Captioned Telephone	-6.47**	(1.37)
Intercept	11.39**	(0.95)
N	40	
R^2	0.55	
$F_{(21,18)}$	22.44	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

3.1.2 Captioned Telephone at Work

A small subset of respondents (n=17) had used the CTS for work. These respondents were asked a number of questions to explore the impact the CTS may have made on their productivity, communications, work-related satisfaction and so on. The results are presented in Table 9 as the proportion of this sample that answered in the affirmative.[11] It shows that three-quarters of this sub-sample felt that their work-related satisfaction and ability to meet the expectations of customers and clients had improved as a result of having access to the CTS at work. In addition, approximately 87% of the sample believed

[11]Specifically, this is the proportion of the subgroup who selected "Yes, probably." or "Yes, Definitely".

Table 9: Impact of Captioned Telephone at Work

Questions	Yes (%)
Would you say that access to a captioned telephone in the workplace has had a favourable impact on your...	
productivity at work?	62.50
ability to communicate with suppliers and/or customers?	50.00
ability to communicate with colleagues, workmates or staff under your supervision?	75.00
work-related satisfaction?	75.00
ability to fulfill the expectations of your customers/clients?	75.00
Would you say that the availability of a captioned telephone at work...	
has changed the range of tasks you ACTUALLY perform at work?	69.00
has changed the range of tasks you COULD perform at work?	87.50
has had any effect on the WAY you work?	68.75
could allow you to retire LATER in life, if you chose to do so?	56.25

that the CTS had changed the range of tasks that they *could* perform in the workplace, although a smaller proportion—approximately 69%—reported that actual changes had been made to the way they worked, or to the tasks they actually performed. Almost 60% of the sample thought that the availability of CTS in the workplace could enable them to retire later in life, should they choose to do so. Further information on the impact of CTS at work was generated by the focus group discussions and is reported below.

3.2 Qualitative Results from the Followup Survey

The web-based survey provided numerous opportunities for respondents to write additional comments about the questions they were asked. Respondents were also prompted with open-ended questions such as "Is there anything else you would like to tell us about your experience with the captioned telephone?". They were also asked why they had answered a question in a particular way (e.g., stated that they preferred CTS to TTY). The following is a selection of direct quotes from survey respondents:[12]

[12]In some instances, typographical errors have been corrected and punctuation has been added. Where necessary, replacement text has been inserted in square brackets to clarify the statement.

3.2.1 General Impact

[M]y parents are so thrilled that I can talk to them on the captioned telephone. My mum usually send me a fax to tell me the news but not now. she is so happy to talk with me on the phone anytime.

I think its good how you don't need relay operator just talk on phone just like everyone else.

[I like it because it feels] direct, no third-person involved [in the conversation].

It empowers [people with a hearing problem] to feel independent and that is important.

It is the only phone available where both sides can hear voices with the help of relay officer to type text on the screen.

[I]t makes it so much easier to have conversations!

[H]aving the captions as backup is very comforting. It means if you can't understand what the other person is saying you can read the words, instead of having to abandon the call.

You can make appointments. You need to have some hearing to be able to have a conversation so you get speech as well as words that way you can make up for the time delay or when they just stop typing.

I...think it improves [my] quality of life.

It is much easier to have conversations.

Before I got the captioned phone I sometimes received calls & because of my hearing either had difficulty hearing or a few times had no idea who was calling now I can read the captions it is easier.

[I]t makes hearing-impaired people [able] to connect with people from all walks of life at home and at work.

Because its a BIG solution for people that has hearing lose without feeling incapacitated, because you make the calling and you are speaking directly.

It is absolutely wonderful and removes the feeling that the telephone is the 'enemy'! I can now relax while using it and understand the other person completely.

It has given me confidence back again, it's now allowed me independence now that I can make my own calls and the ability of friends and family to call now who did not or could not use the TTY service.

It is excellent technology. At the moment I prefer calling family and friends who understand my situation and they are patient waiting for my response after reading the text. I have not called government departments (etc.) yet, but will do so in the future.

[I] feel independent by making own calls and chat to people directly and personally.

I do find it really useful when making appointments or speaking to government offices etc. Dates and times can be understood because I can read them instead of having to ask three or more times to repeat.

I cannot recommend highly enough the captioned telephone. I can now do my own business marketing on the telephone whereas before, I had to get other people to do my own marketing. It has given me back my independence!

I have already recommended the phone to a deaf colleague who works [as] well, he has applied to have the trial too. I think it is a great piece of technology...

3.2.2 Functionality

The sheer flexibility of the [captioned] phone allows the user to change tone, volume as well as read the captions covering most if not all hearing problems. Also it is easier for the person calling you not to have to use the cumbersome and frustrating TTY service of which most elderly people cannot cope with.

The screen is very helpful you have the volume control easy to adjust in front of you to see and reading of the screen printing is very clear and big is very easily to switch the mode from caption to normal or back again if another person is helping to hear the conversation...Takes the fear [out] of not being able to communicate because of word discrimination. [Reading the other party's words] on the screen takes that fear out of [making calls, it removes the hearing-related] handicap . There so many different types of hearing problem. With me it [is] word discrimination...I hear the voice but never...understand its pronunciation: say 500 words [and] I will tell you 5; but with the screen [on the captioned telephone] there [is] not [any] worry of not understanding [what was said]. [I] have no problem same as reading the screen: [it] is almost as fast [as hearing] what words were spoken.

It's groovy ! I love the lights- the green is beautiful. It is nice to use, lots of text, more like a normal call so less intimidating to your caller, what's not to like...?

3.3 Results from Focus Groups—CTS Users

Sixteen CTS users participated in focus group meetings in Brisbane (n=8, including one hearing family member), Sydney (n=4) and Melbourne (n=4). Nine participants were female and seven were male. A number of participants were currently employed and several were recently retired. At least one person in each group had used the captioned telephone for work.

The dominant sentiment was enthusiasm for CTS. Most participants expressed concerns that CTS was being provided only on a trial basis and were concerned about the service being unavailable at the end of the trial.

Participants' experience with the setup and use of the phone varied across users, but the majority of attendees indicated a strong preference for CTS over both a standard telephone and TTY. The reasons for that preference tended to be that conversations were quicker and more natural on a captioned telephone, because the hearing party does not have to engage directly with a third-party operator. Participants also liked the functionality of the phone, including its large screen, the ability to scroll up and down the captioned conversation, good volume control and auto T-switch. Many described the impact of being able to communicate via a "normal" telephone again in profound terms (e.g., "changed my life"; before it, I felt "paralysed").

Critical comments about CTS largely concerned its limited hours of availability or setup problems that were often, upon discussion, revealed to be concerned with an inadequate internet service or other technical problem. Most users were aware only of the basic functions of the telephone and many were surprised to learn of additional functionalities that were highlighted by ACE personnel in response to questions or discussion about how the phone can be configured. Some users also reported that hearing parties were sometimes confused by a delay between the end of their speech and the CTS user's response (due to a short delay between speech and captions). Experienced users of CTS indicated that they had overcome this problem either by telling the hearing party he/she has a hearing problem and is using captions or by adopting other strategies that minimised confusion (e.g., anticipating the end of a statement and starting to respond before the final captions arrived.)

An interesting aspect of the discussion in each location is that, unprompted, several participants reported a sense that the CTS had actually helped them to recognise vocal sounds better, especially from people with whom they communicated on a regular basis. Several participants indicated that they felt their ability to recognise words had improved as a result of using the captioned handset.

Some long-term TTY users expressed a preference for TTY for particular work-related tasks, or functions (e.g. ability to generate a print-out of the conversation); although most indicated that they were using CTS (e.g., talking to family and friends) and planned to expand their use of it as their confidence with the technology improved. One participant indicated a preference for using TTY when communicating with Deaf friends and colleagues (i.e., with people who cannot hear at all), but for CTS to communicate with hearing parties.

Indicative, direct quotes from participants are provided below under several themes: General Impact, Functionality, Comparisons with TTY, and CTS in the Workplace; although some of the participants' statements touch on several of these issues but are included under one sub-heading only.

3.3.1 General Impact

> *I think it's fantastic. I don't think there's any other item like that. I use it for talking to my friends and family at the moment. I talked to a Government Department using it, and big companies. It has taken the stress out of my life. There was a lot of. Stress if that phone rang; I used to want to smash it*

sometimes, "Don't you speak to me at all. Don't even bother to ring me." I do have one son who is hard of hearing as well so we can just about have fisticuffs over the phone. Other people who have rang and that have been delighted that I have this [captioned] phone. They hope it will stay around and that. I was delighted that you had [extended the trial hours] from [9am to 5pm] to 7[am] 'til 7[pm]. Because most of my calls usually take place around about 6 at night. That was fantastic. I don't have problems with the two phones ringing. I tell everybody, 7[am] 'til 7[pm] is [when the] caption [service is available]. After that it's the old phone; don't call me.

I now realise how much we rely on the telephone. People in the doctors surgery tell me to ring. They say, "Ring me or I'll ring you." People don't understand. They don't readily understand that you can't answer the phone. But everything is on the phone. I am trying to buy a hot water service at the moment. It's absolute hell because nobody wants to come out to see you. You have to do it all over the telephone. [CTS] is helpful. Really for me, someone at my age, it's really a means of retaining my independence. That goes for anybody my age. We did need to have a telephone. And the security that it gives.

Great for voicemail. I used it a few times to check mobile phone messages. That's amazing! Never had that before. Can't get that with TTY - that's phenomenal.

3.3.2 Functionality

Volume is beautiful. It's unreal, for me anyway. It's hard on a phone to be able to understand and more so because if it's somebody you know, and the conversation flows so well.

There's a lot of pluses. I can go on and on about pluses. They are very, very good.

3.3.3 Comparisons with TTY

TTY has lots of problems because general public are scared of it.

I owned [a] TTY before but I miss what they say from the start. With the captioned telephone, it's much better...

[I prefer] the captioned telephone .. TTY helped me a lot, don't have any problems, but also don't have any problems with the captioned telephone. With the relay service there is a time delay. It's fast , but when I speak someone else hears me ... I'm trying to speak directly to the person, not the relay [officer].

TTY server can be time consuming compared to captioning telephone ...for some unknown reason, people don't like to use TTY phones. They get scared of it, they don't want to talk to you.

[I find the captioned telephone quicker than TTY] by a long shot. [With the captioned telephone] the words are coming up quicker. I think the TTY phones are quite slow in terms of the transmission technology, so there's a limit on how quickly that comes up. That is my perception.

With the TTY phone, the third person, they have to get used to talking to a third person too. That is what slows it down, the other person, not the operator cuts in between. With captions I'm not too sure because the person you talk to doesn't know there is another third person. So I think that is where that has an advantage over the TTY phone.

I like the big screens, you can adjust the size of the words coming in. It has a lot of advantages. TTY has the one thing.

3.3.4 CTS at Work

. . . at my work, people just ring, they don't understand captioning. It's a big organization and people don't know that I'm deaf. When someone rings me, it's so quick [with CTS].

[Has it changed the way I work?] Definitely, [now I am] talking to people, [whereas before I] would just email or [use] instant messaging—MSN or Two Talk—now I can ring them up for a 5 minute chat. Often I have a 45 minute chat with clients, it makes a huge difference. They see you being proactive and talking to them. It's showing leadership. In my world it's important. . . ringing up and doing things.

Before, I was paralysed, I couldn't you want to talk to this person over the other side of the city, and you have to email them, but they don't respond, because they don't look at it quickly, they listen to phone calls, you know they pick up and TTY, and you know they hate it, it's like, "Aghh", with this, it's different. No problem. Nothing stopping me.

For myself, the biggest thing has been I am quite often in the office by myself. Previously I wouldn't touch the phone. It would go to the answering machine. Now I would answer it. I find myself getting more involved in what is going on because I'm talking to people who are asking questions and wondering what can be done and everyday problems and so on. So it's opened up a new world for me. Very much so because as you can imagine not having the confidence to, you know, pick up the phone and talk to somebody, and now you can. It's a big thing, a very big thing.

I said also you build up a rapport with the people. Email it's there's no emotion, you can't hear their voice, you ring up and have another level of communication. You it's easier to build relationships with clients now... [I have a very supportive employer] but I'm starting to think about leaving [my employer]; because of [market] conditions, I need to get out. My fears [are that there is talk of the CTS trial] ending. Can I leave [my employer]? I

feel trapped in the mould, because I won't get the continued service [that my employer provides and if the trial ends]... That is the feeling I have. That kind of traps me into [staying with my current employer/] position. I retired in 2004, and I did not even know that NRS existed where I worked in [a Commonwealth Government Department]. Just didn't know about it. So I depended on others to take calls for me and so on. Looking back on it, if I had the [captioned] phone it would have been a completely different world altogether. I'm coming up to a second retirement. It's all going past. I think for the future, people like us it's going to be really good, much better, much better.

3.4 Results from Focus Groups—Potential CTS Users

The focus group for potential CTS users commenced with demonstration of TTY and CTS. Then, one participant volunteered to make a call on CTS, with other members of the group watching the technology at work. Following the demonstration, the group was asked whether they would like to use TTY or CTS. The participants agreed, unanimously, that they preferred the captioned telephone. The following quotes from participants indicate the reasons for their preference, and enthusiasm for CTS:

I would like to use [the captioned telephone]. It would have been good, something like that. On the telephone one night, to cut a long story short, I was talking to a woman which I thought was my daughter and I thought she said she had lost her keys but it was a woman from Melbourne who was trying to sell cheese. And the difference between cheese and keys was very similar on the phone. Now, if I had [a captioned telephone], I could have read it and seen that the woman was selling cheese.

It was great. What I liked about [the captioned telephone is that] you could go back to the text, it was all there on the screen, there was a lot of the conversation, whereas that it was too small, you are only getting like a sentence at a time and some of the words went on to the next line, which was a bit confusing. I liked the idea I can still speak, I can still practise because I don't want to lose I don't want to lose my hearing ability on the phone which is a lot better since I have gone cochlear than I was in hearing aids I don't want to give up. I get so embarrassed. That situation with you with the keys and the cheese, I would have been so embarrassed and I would have almost shut down and not been able to continue the conversation, wanted to get off the phone as quickly as I could. Because you just get tired of asking people to repeat it. I made a couple of medical calls last year and when they talk through those headsets, it is even harder to hear. And I got those times wrong and she had to repeat it three or four times for me. I thought if it was there, not only could I there it is and query it if I wasn't sure. I could then save it, which I liked. Just reassure you that you are still part of the world. That's why I would be going by that. I will have one right now, thanks. Forget the trials.

To me it is good enough.

I prefer [the captioned telephone], because I am old and I am not so quick usually the lines [disappear before I can read them with TTY]. If you see the lot [of text, as on the captioned telephone's screen] then it is a lot easier.

Participants were also asked if there were any tasks that they don't currently use the telephone to do, but would feel comfortable to do with CTS.

Medical appointments. I drive to the place to make a medical appointment...because it is just embarrassing. And if we get any a year or two ago we got [to spouse:] what was it? Some business call from a bank and I had to speak because I have notified people that my husband will speak for me because I have trouble hearing and I had to get on the phone, [to spouse:] didn't I, remember? She insisted I get on the phone to tell her and tell her who I was before she would speak to you, and that was so embarrassing because they kept saying "Look I am speaking to you through a cochlear." She was from another country so her accent was difficult and I was having so much trouble hearing and I kept saying, I am sorry, I am having trouble hearing you. And she was very patronising "Oh, no, you are doing very well." She was so patronising. It was so embarrassing. "I am putting you on to my husband now, no, I can't do this any more." That situation, I won't answer the phone. If anyone else is home I won't answer it.

The same thing as like you were saying. They won't talk to me. I have just about got everywhere that I am authorised to speak on his behalf because he usually doesn't do it but it is the same you know, just in reverse. But, yeah, he has to get to the phone and he says, "Yeah, do whatever the wife says."

Yeah, but then still that "No, we have to know it is you."

That's right. "What's your name, your [date of] birth?"

I would take those phones with that. I would confidently take that message because it is there. Sometimes they quote off a lot of numbers like your bank account, whatever it is, I would confidently take that.

The facilitator then asked participants if they would consider using TTY instead of a captioned telephone:

I would use this one. I like the size of that screen. To me that's the winner.

The facilitator then asked whether participants would consider using TTY first, or whether they would go straight to CTS:

This one [CTS]. Simply because I can hear and I want to hear phone calls as well. I don't want to give up that that's one less ability and I want to keep that going and that just backs [me] up.

The facilitator then pointed out that the newer TTY machines are much more compact than their predecessors and showed participants an example of an older TTY machine. One of the participants who had used TTY responded as follows:

> *They were really cumbersome things. Really old, old TTY. Very similar to that... Very, very heavy. Very cumbersome. I never had the patience for it. I found that I just didn't... it didn't appeal to me. I just stopped using it. I found it took up too much time by the time trying to get the message that I wanted to get out there, over, GA [i.e. "Go Ahead"] and then back. It was taking up too much time. So in the end I just gave up. But with [the captioned phone] it is a completely different story because it is double the independence, using captioning than it was with a TTY. And with a [captioned phone], you can control a conversation, but more than what we could with a TTY. And what comes up with the captions you get a better understanding of what someone is saying over the phone, more than what you could with a TTY. Some people like a TTY, prefer a TTY. That's not me. Not TTY.*

The group then engaged in a free-flowing discussion about the effect of hearing problems on telephone use. Recurrent themes were problems of safety, social connectedness, independence, autonomy, isolation and frustration:

> [Spouse of CTS user:] *It is a safety issue, too. When I am not home [my wife] has no way of communicating. And with that captioned phone she can make her own phone calls.*
>
> *[CTS] gets you out of isolation a lot. Takes all your isolation away. Makes you feel a bit more like part of the community in things like that. You can do your own thing, you can contribute to things. You don't have to hang around and wait for someone to make the calls or something. You can go straight to it and do it yourself. It is a good feeling an accomplishment when you can do something like that.*
>
> *Half the time I can hear it but I don't want to be frustrated all the time so better not to do anything. So I turn the answering machine on and I can't hear the answering machine at all. I have no idea what they are saying if [my partner is] not home, so I just don't know. You miss out on connection. It can be important if you have a lot of grandchildren and children. It is hard to hear them. So it will be a big help.*
>
> *It is nice to know there is something down the track. When I first got my cochlear, I thought I would just go into old age deaf because my hearing aids could never cope but to hear there is a cochlear and now to hear you can still be part of the world, that's another thing that we just don't other people don't think about, how isolated we become. Yeah, without access. I mean, email is great but [the captioned telephone is] even better.*

3.5 Results from Focus Groups—Businesspeople

Recall that this focus group commenced with businesspeople receiving calls and responding according to a script. Calls were made via TTY using the NRS, and via CTS. The technology that was used for each call was not revealed to the call recipients prior to their experience of them. Participants were then asked to describe their experiences on the first and second calls.

Participants described the TTY call as being more stilted, slower and less natural by comparison with the CTS call. The following comments are direct quotes from participants:

> *Oh my God, how do people do that? It's frustrating, so slow. [CTS] is much better than [TTY].*
>
> *Because the difference is like having the same conversation, I didn't have problem with either but the [TTY] was more disjointed, and the [CTS was] easier; if you were talking to hearing impaired person you'd like to talk appropriately.*
>
> *It did seem that with the first call [CTS] it was a lot quicker and easier. Having this conversation with the person rather than third party. I prefer [CTS].*
>
> *The [CTS] you feel you can be more intuitive, the first NRS you are putting the words down and there's no expression.*

3.6 Contingent Valuation

All CTS user focus group participants agreed to participate in the CV study (n=15). Figures 2 and 3 are plots of respondents' WTP against their annual incomes and against starting bids. Neither plot suggests a strong influence of these variables on WTP, although there is some evidence that mid-to-high income earners were more likely than lower income counterparts to have a higher maximum WTP. The multivariate regression results in Table 10 control for the starting bid and income (specified as a series of binary variables) and none of the coefficients is statistically significant in this small sample.

The mean WTP for CTS in this sample was $656 per annum, with a standard deviation of $347.99. The minimum WTP was $360 per annum and the maximum was $1440.

These WTP estimates do not include the additional call charges that are also incurred as a result of using CTS, rather than TTY. Recall that CTS users pay standard call charges for all of their telephone calls, while TTY users face local call charges for both local and STD calls. While the telephone charges incurred by the participants are unknown, an estimate of total WTP may be constructed using data, supplied by ACE, on the call durations and frequencies of CTS users. Adding these to the foregoing estimates provides an estimate of the marginal cost that CTS users are prepared to incur, at the margin, to use CTS rather than TTY.

The addition of call charges results in a mean WTP of approximately $810 per annum for CTS. This represents the additional consumption that individuals are willing to forgo to use CTS, given the existence of substitutes such as TTY. On average, participants

Figure 2: Annual Income, Willingness to Pay ($) for Captioned Telephone Services

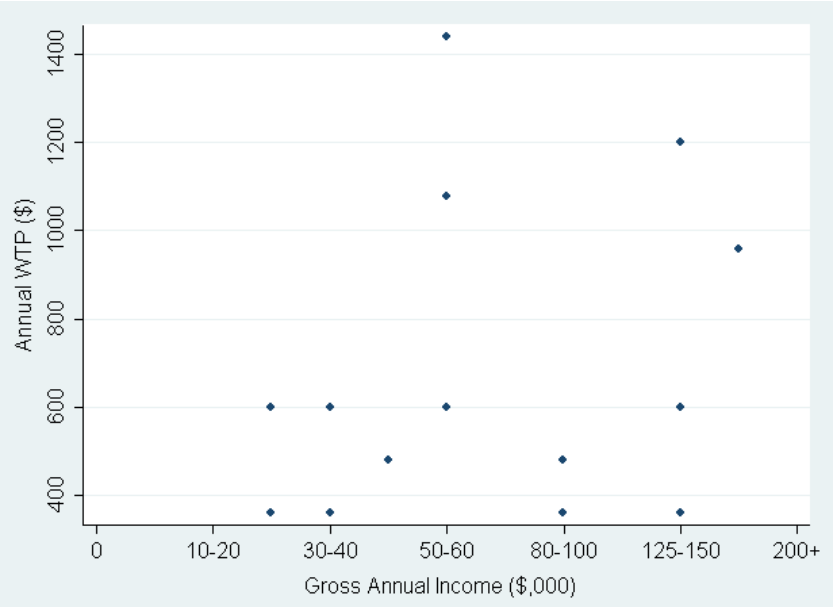

Figure 3: Starting Bid, Willingness to Pay ($) for Captioned Telephone Services

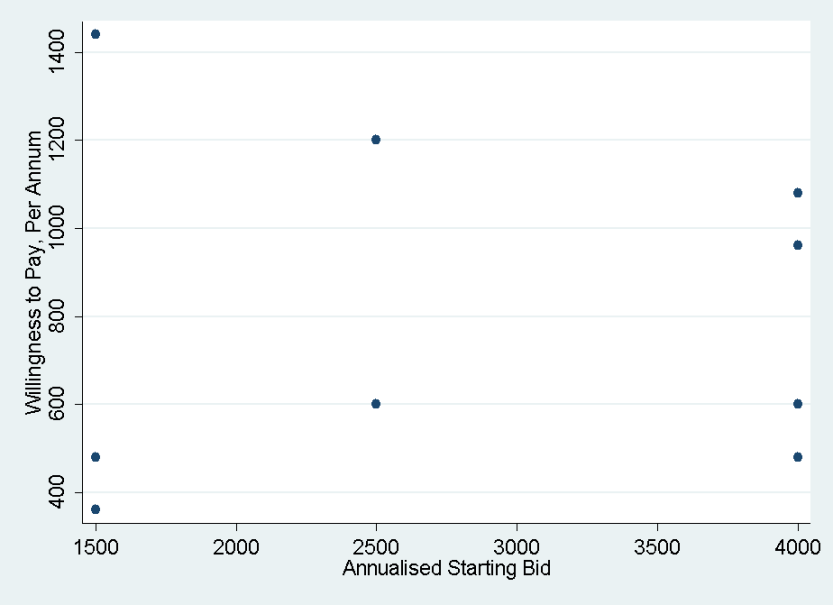

Table 10: Willingness to Pay: Ordinary Least Squares Regression Results

Variable	Coefficient	(Std. Err.)
lstart	0.23	(0.37)
Income $10,000-$19,999 p.a.	-0.63	(0.60)
Income $20,000-$29,999 p.a.	-0.61	(0.58)
Income $30,000-$39,999 p.a.	-0.69	(0.63)
Income $40,000-$49,999 p.a.	0.09	(0.53)
Income $50,000-$69,999 p.a.	-0.61	(0.66)
Income $120,000-$124,999 p.a.	-0.26	(0.57)
Intercept	$3.38^{\dagger}$	(1.68)
N	15	
R^2	0.56	
$F_{(7,7)}$	1.3	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

were willing to forgo 9.5% of their household income to have CTS. This is a substantial sum, given the predominance of lower-income households in this sample. According to the Australian Bureau of Statistics [5], the mean gross household income in 2010 was $1830 per week ($95,160 per annum) and the mean equivalised gross income per person was $874 per week. Four respondents in this CV sample reported a household income of less than $30,000 per annum, and nine reported household income less than $50,000 per annum.

4 Conclusion

This study of the trial of CTS in Australia used a variety of measures and methods, both qualitative and quantitative, to examine the impact of CTS on the lives of people who may benefit from captioned calls. Remarkably, all of the evidence points in the same direction: CTS is strongly and positively associated with reductions in the reported feelings of handicap and frustration with telephone use; it is preferred to TTY by most people who have used both technologies; and the qualitative responses of many respondents suggest that their access to CTS has transformed the way they feel about themselves, increased their feelings independence, and has reduced feelings of social isolation. Furthermore, individuals are willing to sacrifice, on average, approximately 10% of their household incomes to have continued access to CTS. This is remarkable considering the modest household incomes of most respondents. A population-based study of WTP would likely yield greater values for CTS, given the relationship between ability to pay and WTP and the considerably higher mean income of the Australian population than of this sample.

Appendix

This Appendix presents the regression results from which the marginal effects or average discrete effects (ADEs) in the body of this Report were derived.

Specifically, Tables A.1-A.9 present the results of the binary logit regressions from which ADEs were derived for Table 3; Table A.10 reports the ordered logit regression results that were used to produce the ADEs reported in Table 5; and Table A.12 reports the ordered logit results that were used to derive the ordered logit ADEs that appear in Table 6.

Table A.1: Use Phone Less than Would Like: Binary Logit Results

Variable	**Coefficient**	**(Std. Err.)**
Captioned telephone	-1.04*	(0.45)
Hearing	-0.48	(0.49)
Intercept	2.36**	(0.48)
N	157	
Log-likelihood	-65.61	
$\chi^2_{(2)}$	5.82	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Table A.2: Nervous Using Phone: Binary Logit Results

Variable	**Coefficient**	**(Std. Err.)**
Hearing	-0.52	(0.38)
Captioned telephone	-0.49	(0.38)
Intercept	1.40**	(0.34)
N	157	
Log-likelihood	-92.23	
$\chi^2_{(2)}$	3.48	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Table A.3: Embarrassed Using Phone: Binary Logit Results

Variable	**Coefficient**	**(Std. Err.)**
Captioned telephone	-0.92*	(0.38)
Hearing	-0.65†	(0.37)
Intercept	1.35**	(0.32)
N	157	
Log-likelihood	-96.25	
$\chi^2_{(2)}$	9.27	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Table A.4: Difficulty Communicating with Family by Phone: Binary Logit Results

Variable	**Coefficient**	**(Std. Err.)**
Captioned telephone	-1.98**	(0.41)
Hearing	-0.25	(0.42)
Intercept	1.96**	(0.38)
N	157	
Log-likelihood	-76.23	
$\chi^2_{(2)}$	24.04	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Table A.5: Difficulty Communicating with Friends by Phone: Binary Logit Results

Variable	**Coefficient**	**(Std. Err.)**
Captioned telephone	-1.86**	(0.42)
Hearing	-0.50	(0.45)
Intercept	2.28**	(0.42)
N	157	
Log-likelihood	-72.14	
$\chi^2_{(2)}$	20.72	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Table A.6: Difficulty Communicating with Family on Phone: Binary Logit Results

Variable	**Coefficient**	**(Std. Err.)**
Captioned telephone	-1.98**	(0.41)
Hearing	-0.25	(0.42)
Intercept	1.96**	(0.38)
N	157	
Log-likelihood	-76.23	
$\chi^2_{(2)}$	24.04	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Table A.7: Difficulty Communicating with Friends by Phone: Binary Logit Results

Variable	**Coefficient**	**(Std. Err.)**
Captioned telephone	-1.86**	(0.42)
Hearing	-0.50	(0.45)
Intercept	2.28**	(0.42)
N	157	
Log-likelihood	-72.14	
$\chi^2_{(2)}$	20.72	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Table A.8: Feel Handicapped When Using Phone: Binary Logit Results

Variable	**Coefficient**	**(Std. Err.)**
Captioned telephone	-1.41**	(0.40)
Hearing	-0.37	(0.41)
Intercept	1.83**	(0.37)
N	157	
Log-likelihood	-81.10	
$\chi^2_{(2)}$	13.44	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Table A.9: Upset Using Phone: Binary Logit Results

Variable	**Coefficient**	**(Std. Err.)**
Captioned telephone	-2.86**	(1.03)
Hearing	0.07	(0.42)
Intercept	-0.88**	(0.33)
N	150	
Log-likelihood	-71.52	
$\chi^2_{(2)}$	7.89	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Table A.10: Hearing Problem Affects the Way I Feel About Myself: Ordered Logit Results

Variable	**Coefficient**	**(Std. Err.)**
Equation 1 : fabtslf		
Captioned telephone	-1.02**	(0.35)
Hearing	-0.37	(0.30)
Equation 2 : cut1		
Intercept	-2.08**	(0.29)
Equation 3 : cut2		
Intercept	-1.43**	(0.27)
Equation 4 : cut3		
Intercept	-0.41	(0.25)
Equation 5 : cut4		
Intercept	0.60*	(0.26)
N	149	
Log-likelihood	-228.57	
$\chi^2_{(2)}$	10.63	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Table A.11: Hearing Handicap Index for Telecommunications: Ordered Logit Results

Variable	**Coefficient**	**(Std. Err.)**
Equation 1 : hhit		
Captioned telephone	-2.31**	(0.33)
Hearing	-0.22	(0.27)
Equation 2 : cut1		
Intercept	-3.98**	(0.47)
Equation 3 : cut2		
Intercept	-3.77**	(0.45)
Equation 4 : cut3		
Intercept	-3.28**	(0.38)
Equation 5 : cut4		
Intercept	-2.77**	(0.33)
Equation 6 : cut5		
Intercept	-2.40**	(0.31)
Equation 7 : cut6		
Intercept	-2.26**	(0.29)
Equation 8 : cut7		
Intercept	-1.99**	(0.28)
Equation 9 : cut8		
Intercept	-1.71**	(0.29)
Equation 10 : cut9		
Intercept	-1.45**	(0.27)
Equation 11 : cut10		
Intercept	-0.95**	(0.25)
Equation 12 : cut11		
Intercept	-0.74**	(0.24)
Equation 13 : cut12		
Intercept	-0.60*	(0.24)
Equation 14 : cut13		
Intercept	-0.42†	(0.23)
Equation 15 : cut14		
Intercept	0.07	(0.23)
Equation 16 : cut15		
Intercept	0.40†	(0.23)
Equation 17 : cut16		
Intercept	0.94**	(0.24)
Equation 18 : cut17		
Intercept	1.24**	(0.25)
Equation 19 : cut18		
Intercept	1.68**	(0.28)
N	150	
Log-likelihood	-401.4	
$\chi^2_{(2)}$	35	50.22

Significance levels : † : 10% * : 5% ** : 1%

Table A.12: Hearing Handicap Index for Telecommunications (6-point scale): Ordered Logit Results

Variable	**Coefficient**	**(Std. Err.)**
Equation 1 : hhitcat		
Captioned telephone	-1.98**	(0.36)
Hearing	-0.03	(0.27)
Equation 2 : cut1		
Intercept	-3.68**	(0.45)
Equation 3 : cut2		
Intercept	-2.18**	(0.31)
Equation 4 : cut3		
Intercept	-0.79**	(0.23)
Equation 5 : cut4		
Intercept	0.86**	(0.22)
Equation 6 : cut5		
Intercept	1.10**	(0.22)
N	157	
Log-likelihood	-234.74	
$\chi^2_{(2)}$	29.9	

Significance levels : † : 10% * : 5% ** : 1%

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