Callers' perceptions of post-dialling delays: the effects of a new signalling technology

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Abstract. The present paper reports an investigation of the potential impact of introducing common-channel signalling (CCS) into the current telephone network. This technology would have the effect of greatly diminishing post-dialling delay (PDD). As such, its main benefits would be obtained by introducing it into the toll network, in which PDDs are much longer than in the local network. The issues examined concerned potential 'contrast' effects, in that reducing PDDs in the toll network may cause callers to be less patient with normal PDDs in the local network. Three laboratory studies were undertaken to evaluate caller impatience and abandonment under (1) the current system, (2) the current local system with a simulated new toll system and (3) the current toll system with a simulated new local system. Ratings of impatience and abandonment increased on local calls when the new technology was implemented on the toll network, but not vice versa. The explanation offered is based on a 'cognitive' contrast effect resulting from callers' expectations that toll PDDs should always be longer than local PDDs. The implications of this effect for caller behaviour with the introduction of CCS are discussed. Any negative effects on local call behaviour are outweighed by the much shorter PDDs on the toll network and should be counteracted by the gradual introduction of CCS.

1. Introduction

In recent years, a new signalling system, common-channel signalling (CCS), has been developed for telephone network applications. The new technology involves a digitally coded signal, rather than analog tones or pulses, to transmit call progress information through the network. The effect of the new system will be to diminish greatly post-dialling delay (PDD), that is, the time period between dialling the final digit in a telephone number and a system response (e.g. ringing, busy signal, etc.). In the current system, PDDs are much longer for toll connections than for local connections. As such, CCS would provide its greatest benefit in the toll network. Its introduction would make toll PDDs substantially shorter, on average, than the current local PDDs. The issues investigated here concern the impact of this altered pattern of PDDs on local call behaviour. Of particular interest is whether shorter toll PDDs will affect impatience and abandonment rates in normal local connections.

Abandonments due to caller impatience with PDDs represent an important consideration in network planning. As such, a considerable amount of research has been conducted to examine the determinants of caller abandonments (Duffy and Mercer 1978, Long and Dennett 1977, Schoeffler 1977, Szlichcinski 1979). This research was primarily motivated by the planned introduction of touch-tone telephones, with

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the question being whether the ability to dial more rapidly would create expectations of more rapid PDDs. The results indicated that touch-tone dialling did not influence caller expectations of PDD (Long and Dennett, Schoeffler, Szlichcinski).

Szlichcinski's results, which were derived from performance in the network and in the laboratory, are most informative with respect to abandonment behaviour. Szlichcinski demonstrated that in both settings callers (*a*) are more patient on toll calls than on local calls and (*b*) are sensitive to differences of PDD as small as two seconds. These effects showed up both in ratings of impatience and in ratings of quality of service. However, the effects do not seem to depend on a caller's telephone experience (presumably, within certain limits) nor, as noted, on whether the telephone is rotary dial or touch tone. Further, from interview data, Szlichcinski was able to conclude that the main reason for abandonments was fear that the call had been lost and was not being connected.

On the basis of Szlichcinski's work, it is difficult to predict whether the implementation of CCS technology in toll calls will affect behaviour in local calls. The change will certainly be noticeable since the median PDD on toll calls will drop from approximately 12 seconds (Duffy and Mercer 1977) to approximately two seconds. Further, there is some indirect evidence that improvements in certain services can influence customer expectations for and evaluations of other services (Short 1976). Thus, there would be reason to expect that the introduction of CCS in the toll network would produce a 'contrast' effect where shorter toll PDDs would make callers impatient with normal local connection times. On the other hand, if the main cause of call abandonment is simply fear of a lost call, there may be no reason to expect a change in local call behaviour. The purpose of the experiments reported here was to clarify these issues.

2. Experiment 1

The main purpose of experiment 1 was to determine empirical estimates of abandonment rates and impatience as a function of PDD for both local and toll calls. Subjects were asked to dial either local or toll numbers, wait for the connection to be made and then to indicate (*a*) their impatience on a five-point rating scale and (*b*) whether they thought they would have hung up during the PDD. Based on the second rating, abandon-time distributions as a function of PDD could be estimated for both local and toll calls.

Potentially, one may want to obtain network data on abandon-time distributions as a function of PDD in order to demonstrate that the distributions derived in the laboratory match the network distributions reasonably well. Unfortunately, reliable network data are difficult to obtain because callers abandon so infrequently. However, even if network data were available, it is quite unlikely that this data would match the data collected in experiment 1 because of a number of uncontrolled variables which affect caller behaviour in normal usage situations. For example, one reason for abandonment, especially in local calls, is callers simply changing their minds about completing the call (for any number of reasons). On the other side of the coin, abandonment rates may decrease whenever the waiting intervals are filled with the noises associated with the call passing through various switches. This factor may be especially important for toll calls with their longer PDDs. Since factors like these can be controlled in a laboratory setting, we would actually expect that our data would provide 'purer' estimates of abandonment rates as a function of time than one could get from the network data.

The PDDs used in experiment 1 were chosen to be reasonably representative of the normal PDDs with one small exception. As noted above, abandonment rates in the network are rather low (e.g. if one adds up all the percentages reported in Duffy and Mercer that would seem to callers to represent abandonments, the rate is between 4% and 6%). Thus, obtaining a stable distribution of abandonment times required changing the sampled PDDs slightly for both local and toll calls. This was not done by increasing the range of network PDDs but by overestimating the probabilities of the longer PDDs. The anticipated result was better estimates of abandonment rates at some of the longer PDDs and, hence, better estimates of the cumulative distribution functions for abandonment times.

2.1. *Method*

2.1.1. *Subjects*

Forty subjects (nine males and 31 females) participated in this experiment. Thirty were paid observers while the other 10 were BNR employees. Subjects ranged in age from 18 to 51 years.

2.1.2. *Experimental materials and equipment*

The apparatus consisted of a 2500-type (touch-tone) telephone, a response box and a small video monitor. The telephone set was wired to a signal source that could reproduce a dial tone, a ringing tone and a busy tone. The set itself produced the tones which are heard when touch-tone buttons are pushed. The monitor was used to display the experimental instructions and rating questions. The response box contained buttons labelled with the digits 1 to 5 as well as a button labelled READY.

The PDD distributions for the 40 calls in experiment 1 are listed in table 1. As noted, the range of these PDDs is reflective of network PDDs; however, higher probabilities are placed on longer PDDs.

Table 1. Post-dialling delay distributions for normal local, normal toll and CCS systems.

Local		Toll		CCS	
PDD (in sec)	Freq	PDD (in sec)	Freq	PDD (in sec)	Freq
1·5	4	8·0	1	0·5	1
5·5	5	9·0	2	0·75	2
8·0	4	11·5	4	1·0	4
9·0	3	15·0	5	1·5	6
9·5	2	16·5	4	2·0	4
10·5	1	17·5	3	2·25	2
12·0	1	19·5	1	2·5	1

Twenty different local numbers were used, each with a different three-digit exchange number and four-digit line number. The 20 different toll numbers contained '1' followed by a three-digit area code, a three-digit exchange number and a four-digit line number. Each of 10 different area codes was used twice while each exchange and line number was unique.

2.1.3. *Procedure*

Each subject was tested individually in a small, sound-attenuated room. A verbal description of the experiment was given before the trials began (including an orientation to the two ratings questions). To begin the session, the READY button on the response box was illuminated. The first trial began when the subject pressed this button. The monitor then instructed the subject to lift the handset and dial the first number. The order of the 40 trials was randomly determined for each subject.

When the last digit of the number was pressed, the PDD appropriate to that trial began. At the end of the delay, the subject would hear a ringing tone and see a message on the monitor, 'replace the handset before continuing'. When the handset was replaced, the monitor would clear and the impatience rating scale would appear. This consisted of the question, 'How impatient would you normally be if you had to wait the length of time you did here for a call to complete?', and a scale from 1 to 5 with '1' marked as 'not at all' and '5' marked as 'extremely'. At the same time, buttons 1 to 5 would be illuminated on the response box.

After the subject responded by pressing the appropriate button, the monitor would again clear and the second rating question would be displayed. This read, 'Under normal circumstances, do you think you would have hung up before you heard the phone ring?' Below this question a three-point scale was shown with response '1' labelled 'Not likely', response '2' labelled '50/50' and response '3' labelled 'Quite likely'. Only response '3' was counted in estimating abandonment probability. After the subject responded, the next number to be dialled appeared on the monitor. Subjects could dial and respond at their own pace throughout the experiment.

If the subject made a dialling error, a busy tone was presented over the handset. Subjects were instructed to redial if they ever heard a busy tone. Subjects were also told to hang up and redial immediately whenever they detected their own dialling error. Otherwise, they were to wait until a ringing tone was received before replacing the receiver. The 40 trials took approximately 30 minutes to complete.

2.2. *Results and discussion*

Figure 1 contains the average impatience ratings as a function of PDD. The relevant data points for experiment 1 on this and all subsequent figures are represented

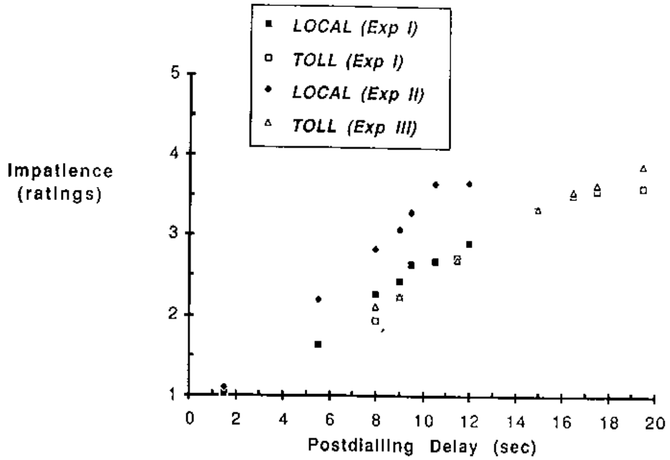

Figure 1. Average impatience ratings as a function of post-dialling delay in experiment 1 (local and toll calls), experiment 2 (local calls) and experiment 3 (toll calls).

by squares. As shown in the figure, impatience increased with PDD and callers generally showed less impatience on toll calls than on local calls with equal PDDs. In order to look more closely at this second result, impatience ratings for local and toll calls were compared at the two points where identical PDDs were used, 8 and 9 s. The difference at 8 s was significant ($t(40)=2{\cdot}585$, $p<0{\cdot}005$, one-tailed) while the difference at 9 sec was marginally significant ($t(40)=1{\cdot}798$, $p<0{\cdot}05$, one-tailed).

Abandonment ratings, defined as the percentage of the time subjects responded 'most likely' when asked if they would abandon, are plotted as a function of PDD in figure 2. These results are quite similar to those for impatience although there is no real separation of local and toll calls until PDDs of 11 to 12 s.

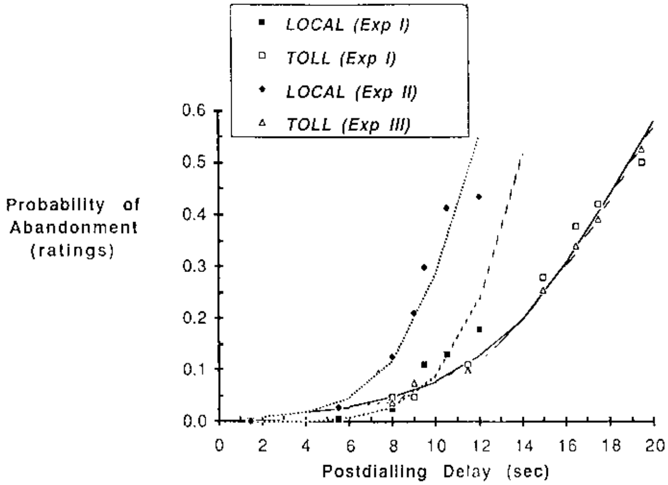

Figure 2. Average abandonment ratings as a function of post-dialling delay in experiment 1 (local and toll calls), experiment 2 (local calls) and experiment 3 (toll calls).

The relationship between the abandonment probabilities and PDD were fit by the function

$$F(t)=\frac{1}{1-e^{-k(t-m)}} \tag{1}$$

where the values of the constants k and m were estimated using a least squares procedure. The fits are quite good with r-squared values of 0·84 for the local function and 0·98 for the toll function. These functions, which are also shown in figure 2, represent empirical estimates of the cumulative distribution functions of abandonment times for local and toll calls. From the distribution functions it is a simple matter to determine theoretical density functions for the two call types. Estimated means of these distributions (the constant m in the equations) are 13·9 s for the local calls and 18·8 s for the toll calls, a difference which, again, is as expected.

Finally, abandonment probabilities and impatience ratings are related as shown in figure 3. Two points should be noted here. First, there is no difference between local and toll calls. Abandonments seem to depend totally on how impatient the caller gets (with impatience growing more slowly for toll calls than for local calls – see figure 1). Second,

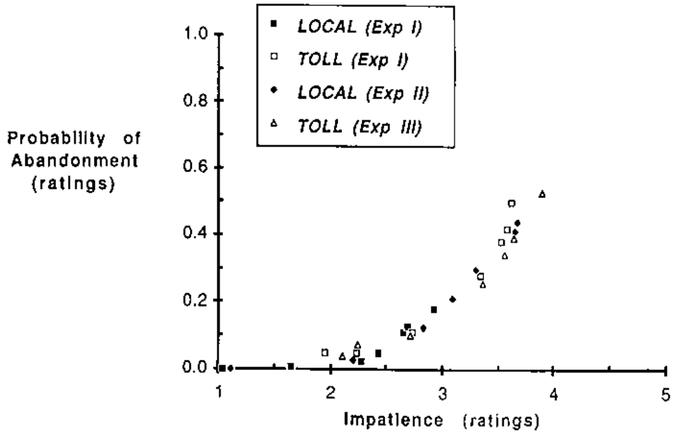

Figure 3. Average abandonment ratings plotted as a function of average impatience ratings for the seven post-dialling delays in experiment 1 (local and toll calls), experiment 2 (local calls) and experiment 3 (toll calls).

the curve appears to have two parts. Below an impatience rating of 2·5, there seems to be little relationship between the two variables. Above 2·5, abandonment probability is essentially a monotonic function of impatience. In essence, 2·5 seems to be something of an impatience threshold for call abandonments.

3. Experiment 2

Having established empirical estimates of impatience and abandonment rate as a function of PDD for both local and toll calls, the question is whether these estimates for local calls will be affected by converting the toll network to the CCS system. Experiment 2 is based on this idea. Experiment 2 was like experiment 1, except that the distribution of PDDs for toll calls was based on a simulated CCS system. Mean connect times were approximately 2 s and PDDs were generally much shorter on toll calls than on local calls.

3.1. *Method*

3.1.1. *Subjects*

Forty subjects (six males and 34 females) participated in this experiment. As before, 30 were paid observers and 10 were BNR employees, although none of these subjects participated in experiment 1. The subjects ranged in age from 18 to 51 years.

3.1.2. *Experimental materials and equipment*

The apparatus, telephone numbers and PDD distribution for local calls were the same as in experiment 1. The PDD distribution for toll calls (the CCS system) is contained in table 1.

3.1.3. *Procedure*

There were two differences between the procedure for this experiment and that for experiment 1. First, instructions to the subjects indicated that they would be experiencing a new set of PDDs on toll calls that would be appropriate to a new system that was to be implemented. Second, there were two blocks of 40 trials. The pairings of telephone numbers and PDDs and the order in which the calls were made varied randomly from block to block. The purpose of the first block was to acclimate the callers to the new system and, thus, our original intention was not to include the data from the first block in the analysis. However, because the data from the two blocks were virtually identical, all the data were included in the analysis.

3.2. *Results and discussion*

As anticipated, subjects showed virtually no impatience with nor any tendency to abandon toll (CCS) calls. The impatience ratings for local calls as a function of PDD are plotted in figure 1. Local call data in all figures are represented by filled points. These data, along with the corresponding local call data from experiment 1, were submitted to a 2 (experiment) $\times$ 7 (PDD) ANOVA with the second factor being a within subjects factor. As expected, the PDD effect was highly significant ($F(6,468)=10{\cdot}33$, $p<0{\cdot}001$) with longer delays producing more impatience. More relevant to the central question, both the experiment effect ($F(1,78)=5{\cdot}66$, $p<0{\cdot}05$) and the experiment by PDD interaction ($F(6,468)=2{\cdot}48$, $p<0{\cdot}025$) were also significant. Subjects showed more impatience with local calls in the context of experiment 2, a difference which seems to increase with PDD.

Abandonment ratings for local calls in experiment 2 are also plotted in figure 2. These data, along with the corresponding local call data from experiment 1, were submitted to the same ANOVA as the impatience data. The pattern was virtually the same. As anticipated, there was a highly significant effect of PDD ($F(6,468)=7{\cdot}31$, $p<0{\cdot}001$). More importantly, both the experiment effect ($F(1,78)=6{\cdot}58$, $p<0{\cdot}025$) and the experiment by PDD interaction ($F(6,468)=2{\cdot}64$, $p<0{\cdot}025$) were significant. These results suggest that the context of experiment 2 also produced a higher rate of abandonment, a difference which again increased with PDD.

As before, equation (1) was used to produce the best-fitting distribution function for the local abandonment data in experiment 2. This function is also plotted in figure 2. (A good fit was again obtained, r-squared was 0·88.) A calculation of the associated density function produces an estimated mean of 11·6 s, over 2 s less than the estimated mean for local abandonments calculated for experiment 1 (13·9 s).

On both measures, impatience and abandonment, a contrast effect was observed. Subjects were more impatient with and more likely to abandon local calls when toll calls went through the CCS system. The relationship between impatience and abandonment, however, did not change from experiment 1 to experiment 2. That is, as shown in figure 3, abandonment probability tends to be virtually 0 until an impatience level of 2·5 is reached. Only after this point do increases in impatience produce increases in abandonment. The difference between experiment 1 and 2 is simply that this level of impatience for local PDDs was reached much faster when toll calls went through the CCS system.

4. Experiment 3

The close, and consistent, link between impatience and abandonment rates in experiments 1 and 2 suggests that impatience may be the prime determinant of whether a caller will abandon. What changed between experiments 1 and 2 was the relationship between the passage of time and the growth of impatience, with the context of experiment 2 producing a faster growth. The idea of context affecting impatience is, obviously, not a new one. Everyone realizes, for example, that waiting 10 minutes for a bus when one is in a hurry is much more annoying than waiting 10 minutes for a table in a favourite restaurant. The issue then becomes, what is it about the context which produces changes in the growth of impatience?

The obvious difference between experiments 1 and 2 is that in experiment 2 there were a reasonably large number of very short PDDs. However, the context in which these PDDs appeared might also be crucial. In particular, as is now well established (e.g. Szlichcinski 1979), callers expect longer PDDs for toll calls than for local calls. The CCS implementation used in experiment 2 completely violated that expectation. One could certainly hypothesize then that the shift in the local data from experiment 1 to experiment 2 was not simply due to intermixing a number of short PDDs but also to this violation of expectations.

This hypothesis can be evaluated in a very straightforward fashion. Theoretically, the CCS system could be implemented only on local signalling systems. If so, the local distribution of PDDs would be essentially the same as the toll distribution in experiment 2, while the toll distribution would be essentially as portrayed in experiment 1. The result would be a set of short local PDDs intermixed with a set of normal toll PDDs. Here, while the shorter PDD distribution would again be experienced, the ordinal relationship between the toll and local PDDs would be in the expected direction. This is the situation created in experiment 3. If the effect on local call behaviour observed previously was due to the introduction of a number of short PDDs, a similar effect should obtain here for the toll call behaviour. That is, the toll data in experiment 3 should show more impatience and higher abandonment rates than the toll data in experiment 1. However, if the difference between experiments 1 and 2 also depended on the fact that experiment 2 created a situation completely contrary to expectations, there should be little difference between the toll data in experiments 1 and 3.

4.1. *Method*

4.1.1. *Subjects*

Forty subjects (11 males and 29 females) participated in this experiment. Of these, 32 were paid observers and eight were BNR employees. Five of the paid observers had participated in either experiment 1 or 2. Subjects ranged in age from 15 to 55 years.

4.1.2. *Experimental materials and equipment*

The apparatus, telephone numbers and PDD distribution for toll calls were the same as in experiment 1. The distribution for local calls was the same as the distribution for toll calls in experiment 2.

4.1.3. *Procedure*

The only differences between experiments 2 and 3 were the use of the different PDD distributions and the fact that subjects were told that they would be experiencing a PDD distribution on local calls that would be appropriate to a new system that was to be implemented some time in the future.

4.2. *Results and discussion*

As in experiment 2, subjects showed virtually no impatience nor any tendency to abandon CCS (here, local) calls. The impatience ratings for toll calls in experiment 3 are plotted in figure 1. Toll call data in all figures are represented by open points. These data, along with the corresponding toll data from experiment 1, were submitted to a 2 (experiment) × 7 (PDD) ANOVA with the second factor being a within subjects factor. As expected, the PDD effect was highly significant ($F(6{,}468) = 166{\cdot}11$, $p < 0{\cdot}001$) with longer delays producing more impatience. However, there was absolutely no evidence of either an experiment effect nor an experiment × PDD interaction (both Fs $< 1{\cdot}00$). As is obvious from figure 1, impatience ratings for toll calls in experiments 1 and 3 are virtually identical.

Abandonment ratings for toll calls from experiment 3 are plotted in figure 2. These data, along with the corresponding toll data from experiment 1, were submitted to the same ANOVA as the impatience data. The pattern was virtually the same, a highly significant effect of PDD ($F(6{,}468) = 49{\cdot}15$, $p < 0{\cdot}001$) and absolutely no effect of experiment nor an experiment × PDD interaction (both Fs $< 1{\cdot}00$).

Figure 2 also contains the best-fitting distribution function (equation (1)) for the toll abandonment data. (The r-squared value here is 0·99.) The two toll functions are virtually identical. In fact, while the estimated mean of the density function from experiment 1 was 18·8 s, the estimated mean from experiment 3 was 19·0 s.

Finally, figure 3 shows the relationship between abandonment and impatience for these data. As before, abandonment probability tends to be non-zero only after an impatience level of 2·5 is reached. In order to underline the consistency of this relationship between abandonment and impatience, the data from all four conditions producing abandonments (both types of calls in experiment 1, local calls in experiment 2, toll calls in experiment 3) were combined and a best-fitting function was estimated using equation (1). The r-squared value for this function was 0·97. This level of fit indicates that the relationship between impatience and abandonment is relatively inviolate.

5. General discussion

The major result of experiment 3 is that introducing the CCS system for local connections does not appear to affect caller behaviour in toll connections. The distribution of abandonment times was identical to that for experiment 1, as were the impatience ratings. Apparently, simply the presentation of a number of short local PDDs in the midst of a number of longer toll PDDs is not sufficient to change these ratings.

The lack of an effect on toll calls stands in marked contrast to the significant effects in both the impatience and abandonment ratings in experiment 2. The obvious question is, why was there a difference between the two call types? The best way to answer this question is to begin by discussing some of the potential explanations of the local effects in experiment 2 which can now be ruled out.

One hypothesis would be based on the idea that time is perceived like any other physical quantity (e.g. weight) and, thus, would be susceptible to typical contrast effects (Helson 1964). The short (CCS toll) PDDs intermixed with the longer (normal local) PDDs would make the longer intervals seem even longer. As such, impatience would be higher and abandonments more likely. This hypothesis, however, would lead to the prediction that the same type of effect would have arisen in experiment 3. In fact, the most reasonable prediction would be that the effect in experiment 3 would be even larger than in experiment 2 because the contrast was more pronounced. The lack of an effect in experiment 3 would appear to rule out this hypothesis.

A second hypothesis would be based on the idea that a simple improvement in service at one level creates the expectation of better service at similar levels. The short toll PDDs in experiment 2 could have created such an expectation for local PDDs. When this expectation was not met, callers may have become increasingly impatient, producing more frequent abandonments. As with the first hypothesis, however, the prediction here is that there would be a similar effect in experiment 3. Failure to obtain an effect in experiment 3 also allows this hypothesis to be ruled out.

The most viable explanation of the effect in experiment 2 would, nonetheless, be one which is based on the callers' expectations; however, these would be expectations which are more specific to the context. As demonstrated in experiment 1, as well as many times before, callers expect local PDDs to be shorter than toll PDDs. In experiment 2 the context represented a direct violation of this expectation as toll calls were being connected substantially quicker than local calls. What seems to occur is that the longer PDDs on local calls create a feeling that 'this should not be happening'. The most obvious conclusion a caller can come to is 'there must be something wrong here'. As Szlichcinski's (1979) interview data suggest, the callers probably then begin to believe that what is wrong is that their call has been lost. As a result, callers begin to get impatient, which brings a concomitant increase in abandonments.

Unlike the two hypotheses discussed above, this explanation does not lead to the prediction of a contrast effect on toll calls in experiment 3. The context of experiment 3 is, in fact, totally consistent with the expectation that toll calls have longer PDDs. As such, the toll PDDs are easily accepted and do not produce an increase in either impatience or abandonments.

From a caller's perspective, however, the context of experiment 3 must be somewhat at odds with what they have come to expect about the 'quantitative' relationship between local and toll PDDs. Further, given that callers do abandon when PDDs become too long, it is obvious that expectations based on quantitative relationships do influence caller behaviour. An obvious question is why this specific relational expectation had no effect in experiment 3. The most reasonable answer to this question is that the context of experiment 3 simply did not violate this particular expectation sufficiently. Callers appear to code local PDDs simply as 'short' and toll PDDs simply as 'somewhat longer'. The PDDs used in experiment 3 actually fit this cognitive coding scheme quite nicely and, therefore, callers showed no tendency to alter their normal behaviour.

The fact that the reduction from a mean local PDD of eight seconds to one of two seconds failed to produce an effect suggests that it is unlikely that this particular expectation could ever be violated sufficiently. That is, the mean local PDD, obviously, cannot be reduced much more, 0 s representing an absolute minimum. Further, it would seem likely that any mean PDD values between 0 and 2 s would still be coded simply as 'short' just as the typical local PDDs are at present. As such, any change in this direction would not pose a problem for a caller's cognitive coding scheme.

The argument is not being made, however, that violations of quantitative relationships cannot affect behaviour in situations of this sort. Under somewhat different initial circumstances a contrast effect might be quite easy to produce. For example, if the normal local PDD were 25 s and the normal toll PDD were 50 s, these would not be coded as 'short' and 'somewhat longer' but, perhaps, as 'somewhat long' and 'long'. If a CCS system replaced this local network, the contrast between the 2 s local PDDs (which would now be coded as 'short') and the 50 s toll PDDs could very well create a significant violation of expectations. As such, it is quite likely that the result would be substantially more caller impatience and more abandonments on toll calls. The point is simply that an understanding of a user's cognitive coding scheme appears to be necessary in order to be able to predict when a change in physical parameters will produce a behavioural effect.

5.1. *Implications for implementation*

The results reported here suggest that implementing the CCS system in the toll network could increase abandonments and impatience on local calls. As a result, additional evaluations of the effects of CCS introduction have been carried out.

One important consideration is that CCS will be established gradually in the network. As such, for some period of time, a caller's experience will be that some toll calls have short PDDs while others have the longer connect times he/she is used to. The percentage of CCS calls will increase gradually as the extent of the CCS network increases. Other data collected in our laboratory suggest that if 50% of the toll calls were CCS and 50% were conventional, there would be no change in user reactions to normal local PDDs. As users then begin to adapt to some toll PDDs being faster than local PDDs, further changes to convert the entire toll network to CCS should have less impact.

A second point is that the present experiments involve a situation in which the potential impact of a contrast effect is maximized (exactly half of the calls were toll). If the proportion of toll calls had been less than 50%, the contrast effect would probably have been smaller as well. In the extreme case, where the caller makes 0% toll calls, no contrast effect could exist at all. For callers who make more than 50% toll calls, the effect could be larger. However, these individuals would then be making only a small number of local calls and, as such, would contribute little to the overall abandonment rate in the local network. In a sense then, individuals who maintain a 50:50 ratio may be those who would have the most effect on the local abandonment rate. For these individuals the size of the increase in abandonment rate can be estimated by conjoining the estimated abandon-time distributions from experiments 1 and 2 with Szlichcinski's (1979) PDD distribution. The results suggest only an approximately 2% increase in local abandonments in this worst case scenario, with an 'overnight' introduction of CCS.

Finally, it should be kept in mind that abandonment rate and impatience dropped essentially to zero with CCS in the toll network. As such, when toll and local calls are taken together, the overall abandonment rate and user impatience would be expected to decrease substantially with the implementation of CCS on the toll network. Therefore, the result should be an overall improvement in user reaction in spite of the contrast effect documented here.

5.2. *Conclusions*

The purpose of the present investigation was to evaluate a potential negative impact of the introduction of a new technology. The question was whether introducing the technology in one circumstance would produce behavioural changes in another. The conclusion appears to be that there is a potential for these types of effects when the new context which is created is a significant departure from user expectations. The context of experiment 2 (as well as, potentially, the theoretical situation discussed above) would be an example. The situation in experiment 3, which represented a change in the caller's perceptions without producing a clash with their cognitive coding scheme, would not. The feeling is that this conclusion may represent an important principle for determining the effects of introducing any new technology.

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