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Publisher Taylor & Francis

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



Behaviour & Information Technology

Publication details, including instructions for authors and subscription information:

<http://www.informaworld.com/smpp/title-content=t713736316>

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Online Publication Date: 01 January 2004

To cite this Article Monk, Andrew, Carroll, Jenni, Parker, Sarah and Blythe, Mark(2004)'Why are mobile phones annoying?',Behaviour & Information Technology,23:1,33 — 41

To link to this Article: DOI: 10.1080/01449290310001638496

URL: <http://dx.doi.org/10.1080/01449290310001638496>

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Why are mobile phones annoying?

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Abstract. Sixty four members of the public were exposed to the same staged conversation either while waiting in a bus station or travelling on a train. Half of the conversations were by mobile phone, so that only one end of the conversation was heard, and half were co present face-to-face conversations. The volume of the conversations was controlled at one of two levels: the actors' usual speech level and exaggeratedly loud. Following exposure to the conversation participants were approached and asked to give verbal ratings on six scales. Analysis of variance showed that mobile phone conversations were significantly more noticeable and annoying than face-to-face conversations at the same volume when the content of the conversation is controlled. Indeed this effect of medium was as large as the effect of loudness. Various explanations of this effect are explored, with their practical implications.

1. Introduction

1.1. *Why are mobile phones annoying*

Like many new technologies, the mobile phone (cell phone) has engendered public concern in a number of areas. In particular, there is a common perception that mobile phones are annoying when used in a public space. To take one example, train operators in the UK have become very sensitive to this issue. Some have notices asking travellers to use their phones considerately and not to annoy others. Others have 'quiet' coaches where passengers are asked to switch off their phones. Wei and Leung (1999) conducted a large survey in Hong Kong. Amongst other things, their 800 respondents were asked about different contexts in which people using mobile phones 'got on their nerves'. High on the list were: restaurants or cafes (81%), classes or libraries (80%) and airports or train stations (79%).

These findings present something of a puzzle. In any public space there will be groups of people having face-to-face conversations. These conversations are not perceived as annoying. No one is suggesting that there should be railway carriages where people are not

allowed to speak to one another. Logically, the sound energy created by two people conversing face-to-face should be twice that created by one person conversing with an unheard partner on their mobile phone, yet the latter appears to be more annoying. There are a number of possible explanations for this puzzle.

One is that the content or the volume of the conversation tends to be more annoying in some mobile phone conversations because of the way that people choose to use their mobile phones. Some people may speak very loudly or they may have chosen loud and intrusive ringing tones. Excessive loudness is a major cause of annoyance for all sorts of sounds (Berglund *et al.* 1990). Wei and Leung also identified loud talk and ringing tones as common complaints about mobile phone usage in public spaces. It is possible that people's perceptions are coloured by just one or two bad experiences of intrusive mobile phone use, or reflect media concerns over new technology.

Another possible factor is the novelty of the technology. People are used to others having face-to-face conversations in public spaces and have learned to ignore them. The mobile phone is relatively new and hence more noticeable. In Hong Kong when Wei and Leung conducted their research 44% of the population were mobile phone users but the technology had been in widespread use for only 2 years. Similarly in the UK almost 70% of households now own at least one mobile phone (JD Power and Associates' annual mobile phone survey in the UK, cited in the Guardian May 23, 2001). However, such widespread usage is still relatively new.

More specific and theoretically interesting explanations can be constructed around the fact that one only hears half of a mobile phone conversation. For example, models of language as a collaborative activity (Grice 1957, Schegloff 1991, Clark 1996) stress how conversation depends on an underlying commitment to understand, and to make oneself understood, that is made by both parties. Perhaps this commitment to understand is

in some way automatically triggered when hearing only one side of a conversation. For example, hearing a question could be particularly intrusive if one does not immediately hear the answer of the other person. These more theoretically interesting explanations only become viable if we can rule out the simpler explanations of volume and novelty as sole causes of the effect.

This paper also has the practical aim of suggesting ways in which the annoyance caused by people using mobile phones in public spaces could be minimized. Choosing between the above explanations has implications for the measures one might take to do this. If it is solely a case of learning to use mobile phones more sensitively, by reducing the volume of ringing tones and how loudly people speak, then the remedy is relatively simple. If there is something special about hearing just one side of the conversation then it is more difficult. The purpose of the experiment described below was to explore a methodology that can be used to provide evidence for and against these and other explanations by controlling speech volume, content, and context of the conversations.

1.2. *The experiment*

Wei and Leung's survey asked respondents to consider various contexts where mobile phone users could be a nuisance. Such a question naturally focuses attention on previous negative experiences. The approach described in this paper was quite different. It involved exposing members of the public to a staged conversation, controlled for content and loudness, and then approaching them to give six verbal ratings. In this way we were able to examine the differences between face-to-face and mobile-phone conversations that were otherwise equivalent. As well as medium (face-to-face or mobile phone), loudness and context were manipulated. This section explains the motivation for each of the manipulations and the rating scales used.

Loudness was controlled at two levels described by the actors staging the conversation as 'normal' and 'exaggeratedly loud'. This provides a comparison for the magnitude of the effect due to medium. Conversations were recorded and the volume assessed by means of the recording level indicator on the recorder (see Method). With practice, it was found relatively easy to maintain a constant loudness. The two contexts used were a bus station and a train carriage. These were similar kinds of public space and were chosen for reasons of availability. However, they did give slightly different patterns of results. It was not practical to examine the effect of the content of the conversation at the same time as these other variables, though this would be an interesting

manipulation. One script was developed. The actors, were female students, and the script was designed to be plausible for them to have and to be generally unremarkable.

The six rating scales assessed different aspects of overhearing. Two assessed how much the conversation impinged on the overhearer's consciousness: how noticeable the conversation was, and whether they found themselves listening to it; these were phrased in evaluatively neutral terms. The other items assessed the overhearer's negative feelings towards the conversation, how 'intrusive' and 'annoying' it was. One question, directed to participants in the mobile phone condition only, assessed how annoying the ringing tone was.

2. Method

2.1. *Participants*

Half of the 64 participants were members of the general public waiting at Leeds bus station on the same day in April 2001. Here there were 22 females and 10 males. The other half were passengers on eight Virgin trains travelling between York and Sheffield on a day in May 2001. Seventeen of these were females and 15 males. No personal details were elicited in order to minimize the intrusiveness of the experiment.

2.2. *Equipment*

Two Nokia 3210 mobile phones were used in the mobile phones conditions. The ringing tone was the standard Nokia tone set to a loud volume setting. A Sharp MT20 portable minidisk recorder was used with a tie clip microphone to record the conversations for subsequent analysis for loudness. The microphone was attached to the polo neck of the blouse worn by Actor 1.

2.3. *Procedure*

A short script was developed consisting of 19 turns (just less than 1 min in duration) in which the two actors looked forward to a holiday in Majorca and considered giving a friend a surprise party. The actors, who were female students, practised this around the university campus until it was natural and they could achieve consistent volume levels. 'Normal' loudness was operationalized as 1–5 on the recording level indicator and 'exaggeratedly loud' as 7–14. A total of three conversations were disregarded in the main experiment because

volume levels fell outside of these limits, all in the bus station context: one face-to-face normal loudness; one mobile phone normal loudness, and one mobile phone loud.

Participants were assigned to conditions at random. They were selected at random with the constraint that they were seated with space for the actor(s) to join them. In the train context the actors(s) sat facing the participant across the table. In the bus station context the actors sat facing the same direction as the participant, separated from them by one empty seat, or, at right angles to them and separated from them by a narrow aisle. Actor 1 was the only one to join the participant in the mobile phone conditions. In the face-to-face conditions Actor 1 joined the participant shortly before Actor 2. The conversation started 2 min after the actor(s) were seated. The phone was allowed to ring five times before being answered.

At the end of the conversation the recorder was switched off and Actor 1 approached the participant with the request:

'We are doing some research on how other people's conversations affect people in public places. I don't know whether you noticed but I just had a conversation, on my mobile phone/with my friend. I was wondering if I can ask you some questions about what you noticed about the conversation.'

They were then read six statements and asked to give a rating on a scale from 1–5 where one corresponds to 'strongly disagree' and five 'strongly agree'. A card displaying this Likert scale was shown to help them make this judgement. Finally, they were asked whether they thought the conversation was staged (none did) and any questions they had were answered. The high turnover at Leeds Bus Station, and testing only one participant in each carriage in the train, made it unlikely that the participant could have observed the procedure being carried out with someone else.

3. Results

Results are given separately for each rating scale. Scales are numbered in the order in which they were presented to the participant but are given here in a different order that is convenient for presentational purposes. In each case the question is how the three independent variables, context (bus station or train), medium (mobile phone or face-to-face) and loudness (normal or loud), affect the ratings. This is assessed by carrying out a three-way between-subjects analysis of

variance. Levine's test for heterogeneity of variance was used to test whether the assumptions of the analysis of variance were met. This indicated a need for alternative analyses only in the case of Scales 3 and 6.

3.1. Scale 1: 'The conversation was very noticeable'

Scale 1 was expected to give the highest ratings as it had no additional negative connotations. Figure 1 gives mean ratings for the two media of communication in the two contexts and loudness conditions. Looking at the slope of the lines in figure 1, it can be seen that there is a consistent effect of medium. In all cases the mobile phone conversations give higher ratings than face-to-face conversations at the same volume when the content of the conversations is controlled. Looking at the separation between the lines, it can be seen that the exaggeratedly loud conversations are more noticeable than the normal ones, and there is a smaller effect of context, such that conversations in trains are more noticeable than conversations in the bus station.

A three-way between subjects analysis of variance gave main effects for context, loudness and communication medium ($F(1, 56) = 4.387, p < 0.05$; $F(1,$

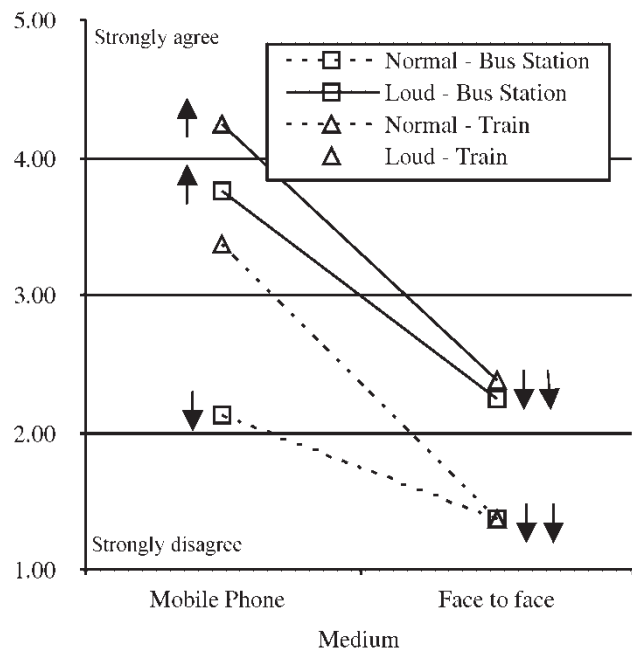


Figure 1. Mean ratings for Scale 1, 'The conversation was very noticeable', for the two media of communication in the two contexts and loudness conditions. A rating of 1 indicates the participant strongly disagrees with the statement, a rating of 5 that they strongly agree. Arrows indicate a mean is significantly different from 3.00, at 0.05 level, by two-tailed t -test.

56) = 23.886, $p < 0.01$; $F(1, 56) = 46.816, p < 0.01$) but no higher order interactions. As noted above, ratings were significantly higher in the train context than the bus station condition (means 2.84 and 2.38) and mobile phone conversations were more noticeable than face-to-face conversations (means 3.38 and 1.84). As would be expected, the loud conditions gave rise to significantly higher ratings than the normal volume conversations (means 3.16 and 2.06). It is striking that the effect of medium is slightly larger than that of loudness and much larger than that of context. Possible explanations for these findings are considered in the discussion.

3.2. Scale 3: 'I found myself listening to the conversation'

Scale 3 relates to the possibility that one-sided mobile phone conversations will be more likely to capture someone's attention than two-sided face-to-face conversations. Figure 2 depicts these means. The graph has a similar shape to figure 1. There was a considerable difference between mobile and face-to-face conditions particularly for the loud conversations.

A three-way between subjects analysis of variance was not appropriate for these data as Levine's test for heterogeneity of variance was found to be significant ($F(7,56) = 5.649, p < 0.01$). A Mann-Whitney U -test

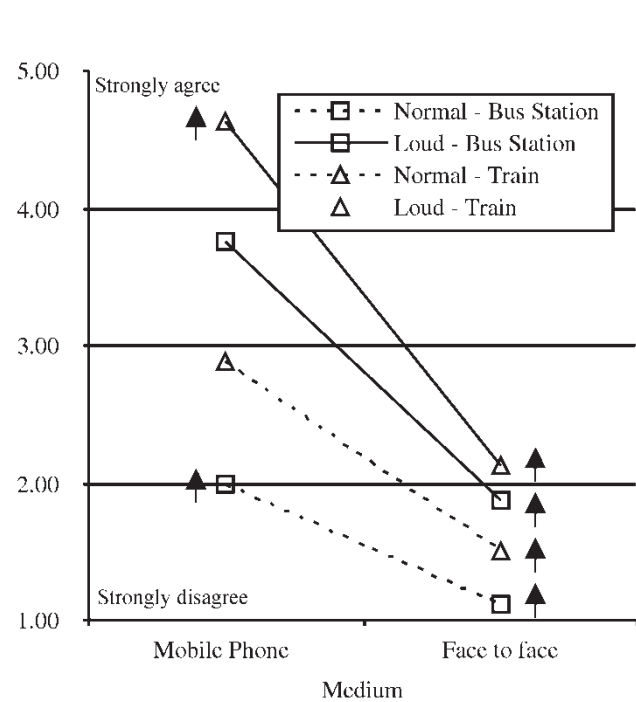


Figure 2. Mean ratings for Scale 3, 'I found myself listening to the conversation'. See legend to figure 1 for further explanation.

was performed to compare the 16 participants hearing loud mobile phone conversations with the 16 participants hearing loud face-to-face phone conversations, i.e., collapsing across contexts. This was significant ($U(16, 16) = 20, p < 0.01$). The same test applied to the normal loudness conversations also indicated a significant difference ($U(16, 16) = 60, p < 0.01$) even though here the means are all below 3.00.

3.3. Scale 2: 'The conversation was intrusive'

Scale 2 was intended to assess general negative feelings about the conversation. Figure 3 depicts these mean ratings. Most of the ratings were very low, indicating general disagreement with this statement. It should be said at this point that there is a problem interpreting the absolute level of these means. Actor 1 was asking the questions. Even though she had just explained that it was an experiment and that the conversation was staged, she was effectively asking 'did you find *my* conversation intrusive, annoying etc.' It is possible that this has depressed the ratings. While this is not relevant to the main question concerning the relative effects of loudness context and medium, it does make the interpretation of the absolute value of the means questionable.

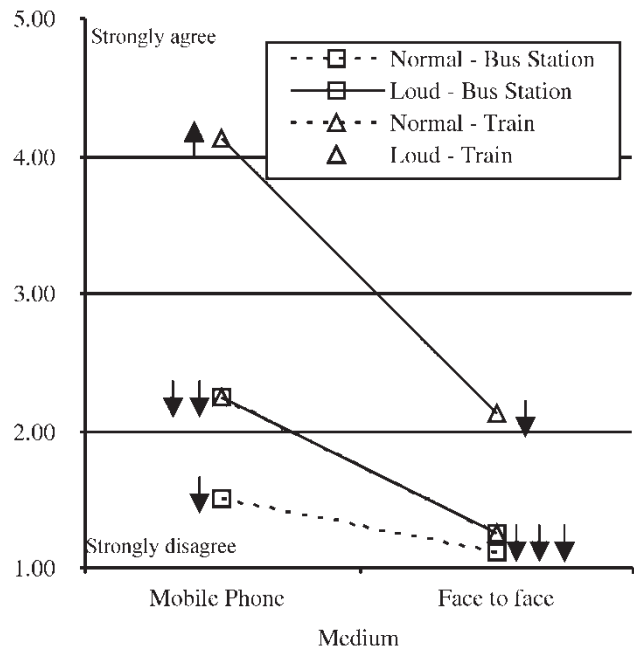


Figure 3. Mean ratings for Scale 2, 'The conversation was intrusive'. The means for loud conversations in the bus station are coincidentally the same as those for the normal conversations in the train, hence these two lines coincide. See legend to figure 1 for explanation of other features of this graph.

Despite the much lower ratings, a three-way between subjects analysis of variance shows a similar pattern of results to Scale 1. There were main effects for context, loudness and communication medium ($F(1, 56) = 21.253, p < 0.01$; $F(1, 56) = 21.253, p < 0.01$; $F(1, 56) = 30.957, p < 0.01$). Ratings were significantly higher in the train context (means 2.44 vs. 1.53), for mobile phone (means 2.53 vs. 1.44) and loud conversations (means 2.44 vs. 1.53). All three two-way interactions were also significant. The effects of medium and loudness are significantly greater in the train context (two-way interactions, $F(1, 56) = 4.271, p < 0.05$; $F(1, 56) = 5.686, p < 0.05$). Also the effect of loudness is significantly greater in the mobile phone condition (two-way interaction, $F(1, 56) = 4.271, p < 0.05$). It would seem that participants were less sensitive to intrusive loudness in the bus station context and the face-to-face condition, probably due to floor effects.

3.4. Scale 5: 'I found the volume of the conversation annoying'

Scale 5 was similarly designed to assess how annoying the conversations were. None of the conditions resulted in mean ratings indicating agreement with this statement (see figure 4).

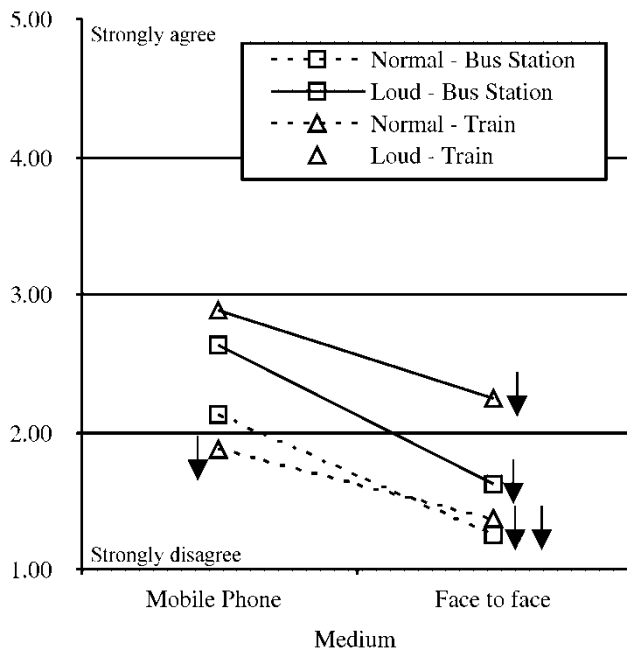


Figure 4. Mean ratings out of 5 for Scale 5, 'I found the volume of the conversation annoying'. See legend to figure 1 for further explanation.

Again, despite the much lower absolute ratings the pattern of results is similar to that for Scale 1. A three-way between subjects analysis of variance gave main effects for loudness and communication medium ($F(1, 56) = 15.158, p < 0.01$; $F(1, 56) = 12.737, p < 0.01$) but not for context ($F(1, 56) < 1, n.s.$) Louder conversations resulted in higher ratings (means 2.34 vs. 1.66) as did mobile phone conversations (means 2.38 vs. 1.63). There were no significant higher order interactions. Though these results parallel those for Scale 1, the lower levels of agreement appear to have reduced the sensitivity of the test to a degree where the effect of context is no longer significant.

3.5. Scale 6: 'I found the content of the conversation annoying'

Like Scale 5, Scale 6 was also designed to directly assess how annoying the conversations were. The ratings for this questions were uniformly low, indeed two of the means were 1.00 indicating that all the participants gave the minimum rating (see table 1). This results in no variance for these conditions. Because of this overall floor effect, the small differences between means are not interpretable and the scores were not statistically evaluated. In hindsight, the neutral content of the conversation and the low mean ratings given to Scale 3 'I found myself listening to the conversation' make this result unsurprising.

3.6. Scale 4: 'I found the ring tone of the phone annoying'

Ratings for the annoyance caused by the standard Nokia ringing tone set to loud ranged around the neutral point indicating that participants did not strongly agree or disagree with this statement (see table 2).

The loudness of the conversation should not have an effect on the ratings of how annoying the ring tone was as it was the same loudness in all conditions. This scale can thus be used as a test of halo effects and sampling

Table 1. Mean ratings for Scale 6, 'I found the content of the conversation annoying', and (standard deviations).

	Mobile phone	Face to face
Bus station		
Normal	1.00 (0)	1.00 (0)
Loud	1.38 (0.74)	1.50 (0.76)
Train		
Normal	1.13 (0.35)	1.13 (0.35)
Loud	1.38 (0.52)	1.25 (0.46)

Table 2. Mean ratings for Scale 4, 'I found the ring tone of the phone annoying', and (standard deviations) for the mobile phone conditions in the two contexts and loudness conditions.

	Bus station Mobile		Train Mobile
Normal	3.13 (1.64)	Normal	2.63 (1.41)
Loud	2.38 (.92)	Loud	2.75 (1.17)

error. It is thus gratifying that there are no significant differences between these four conditions and a two-way analysis of variance did not demonstrate any significant effects.

4. Discussion

To summarize, the results from Scale 1 'the conversation was very noticeable' demonstrated main effects of medium, context and loudness that were mirrored in all the other scales. Interestingly, the difference between mobile phone and face-to-face was generally greater than the difference between normal and exaggeratedly loud.

4.1. *Quantitative experiments outside of the laboratory*

The study described here is unusual as it involves quantitative data collected in an experiment run outside of the laboratory. More usually in the HCI literature quantitative experiments like this one, where participants are assigned at random to different experimental conditions, are run inside the controlled environment of the laboratory. This may be acceptable in the study of technology for supporting work. The laboratory is not unlike the workplace and being asked to do some plausible but arbitrary task is not unlike work. It is thus reasonable to generalise from the experimental setting to other work settings and from the experimental task to other work tasks.

When we consider technologies like the mobile phone that are widely used for leisure purposes the generality of an experiment performed in the laboratory becomes more questionable. While one can set out a laboratory to be like a street or a home the very fact that participants have to be invited there (and most probably be paid as an incentive to come) may subtly change the setting. Similarly, the task instructions 'behave as you would at home' or 'behave as you would in the street' are not likely to be meaningful to participants. More specific tasks such as games may be criticised as being

artificial and unrepresentative of real recreational activities.

For this study real settings were selected to be representative of public spaces where mobile phones are thought to be a problem. The task was made representative by letting participants do whatever they normally do in these settings. Thus in the experimental design adopted here task is effectively a random variable deliberately confounded with participant. Participants were selected at random from the people who happened to be on the train or in the bus station at the times of testing. As the participants were assigned at random to experimental conditions so were the tasks that they were doing. We do not know much about this population as we did not feel comfortable asking them for personal details, however they were surely more representative of the general population than the usual population of students that investigators sample from.

In the laboratory, environmental conditions are relatively constant. In these real settings they changed quite considerably. At different points on the train journeys, for example, there may have been more or less people sitting near to the participant, more or less background noise, and so on. Again, by randomly assigning participants to experimental conditions we can insure that this lack of control only adds to the general level of error variance. While this may make it harder to achieve statistical significance it has the advantage of further bolstering the generality of the findings.

The problem with an uncontrolled experimental environment is that some environmental condition may become correlated with the experimental conditions. For example, it would have been quite unacceptable to assign participants to the normal loudness condition only when there was relatively little environmental noise. Even with strictly random allocation there is the possibility that environmental conditions could effect the manipulations in subtle ways. For example, it is conceivable that the actors talked louder in noisy conditions and that this was more pronounced when they were on the phone. To guard against effects of this kind the actors practiced in relatively constant and relatively quiet conditions around the campus. The loudness of speech was measured during these practice sessions as well as in the main experiment and the two levels of loudness operationalised as average levels on the recording level indicator (see Method). This is an admittedly crude measure. However to measure the physical loudness of the voice of an actor, as it reaches the participant, would be intrusive and require more sophisticated equipment than was available to us. The case to be made is that the actors were aware of this potential problem and took all possible means to avoid confounding loudness with medium. If there were such effects then they were surely

much smaller than the deliberate manipulation of loudness, i.e., the difference between normal and exaggeratedly loud. Yet, the effect of medium was generally as large or larger than the effect of the loudness manipulation. It is thus most unlikely that the effect of medium is an inadvertent confounding of this variable with loudness.

The lack of a definitive measure of loudness also makes it hard to define precisely what the two levels of loudness were. Here what can be said is that, in the contexts they were working in, these levels correspond to the labels given them by the actors, that is, 'normal' and 'exaggeratedly loud'.

4.2. *Explanations of the effects of medium*

None of the above considerations detract from the main contribution of this paper that has been to demonstrate that mobile phone conversations can be significantly more noticeable and annoying than face-to-face conversations at (approximately) the same volume when the content of the conversation is controlled. The public concern over mobile phones discussed in the introduction thus seems unlikely to be solely due to the anti-social behaviour of one or two loud individuals. There is something inherently more noticeable and annoying about hearing one side of a mobile phone conversation. Loudness does have an effect but there is an additional effect of equivalent size of medium whatever the loudness.

Having ruled out volume as the sole effect, how then can the large size of the effect of medium be explained? Two further possibilities were suggested in the introduction. It could be due to the obvious use of new technology (novelty), or hearing only one side of the conversation.

We cannot rule out a novelty effect from the data presented here. However, another contribution of this paper has been to set out a methodology for exploring the different effects of face-to-face and mobile phone conversations under controlled but relatively natural conditions. The relative contributions of novelty and hearing only one side of the conversation could be experimentally assessed using this methodology. Experiments comparing the face-to-face condition used here with a face-to-face conversations where one actor talks very quietly and is positioned so that the participant cannot hear them would assess how much of the effect was due to hearing only one side of the conversation. Novelty could not explain any difference detected between this condition and one where both sides of the conversation could be heard. A difference, with the one-sided conversation being more noticeable and

annoying, would be strong support for the our hypothesis that linguistically tuned attentional processes are triggered by one-sided conversations.

Further experiments could compare our mobile phone condition with mediated conversations using a novel technology such as a walkie-talkie where the remote actor can still be heard. Here the two-sided walkie-talkie condition is predicted to be equivalent to our face-to-face condition and less intrusive than the mobile phones condition.

4.3. *Explanations of the main effect of context*

While it was smaller than the effect of medium, the effect of context was statistically significant and raises interesting questions for further research. One difference was that on the train the actor(s) faced the participant whereas, in the bus station they did not. Facing someone might have exaggerated the effect of hearing only on side of the conversation. Of course, there are other differences between the two contexts such as the acoustics of the space and the fact that train passengers are much more limited in their mobility and may feel trapped with the phone user. It would be of some practical interest to know whether having a mobile phone user sitting next to you, shoulder to shoulder, is less noticeable or intrusive than having the same person sit opposite you across a table. Were this the case, there would be something to be said for facing away from adjacent others when taking a call in a public place; rather as it is considered polite in some circles to say 'excuse me' and to move out of earshot of the group you are talking to if your phone rings.

4.4. *Content and performative intent*

Goffman (1971) has drawn an analogy between social interaction and dramatic performance. From this perspective someone having a conversation in a public space is not simply addressing the person they are talking to; the conversation entails a presentation of self to a passive secondary audience (the bystanders) as well as to the active primary audience (the interlocutor). The speaker may have performative intent for both the receiver of the call and the bystander overhearing it.

For the secondary audience a mobile phone conversation is a monologue without audible response or challenge. Furthermore, the presence of the primary audience of a mobile conversation is merely implied: they are not physically there whereas the secondary audience is unequivocally

present. The saliency of the interlocutor is reduced making the bystanders more salient in comparison. This could have effects both on the bystanders and the speaker.

First, the obligation on the bystanders to act as an audience may be increased. Second, the speaker may be more likely to direct a mobile phone conversation towards the secondary audience. Through the medium of the mobile phone a self-serving and flattering presentation of self may be foisted onto an unwilling audience. Urban legends abound of people being discovered, to their public embarrassment, faking calls in order to impress others. Of course, this in turn has an effect on the bystanders. When the content of the overheard part of the mobile phone conversation is overt self-promotion this may be particularly annoying.

This experiment was concerned with mobile phone users who inadvertently annoy bystanders and so a relatively innocuous conversation was used and care was taken to present it as similarly as possible in the two media conditions. Nevertheless participants may have experienced self promotional mobile phone conversations in the past leading them to question the performative intent of all mobile phone users leading to higher ratings of awareness and annoyance in the mobile phone condition.

This line of thought could be explored in experiments that manipulate the content of the conversation. Scripts could be designed to be annoying in this way and compared with scripts, like the one used here, which are not. One might predict larger differences between mobile phone and face-to-face conditions with the former type of script. The effect of narrative rich content might also be investigated. Narrative is a deeply compelling tool of communication (Bruner 1990) and can be difficult to ignore in any context.

4.5. *Are mobile phones annoying?*

A mean rating above the neutral rating of 3.00 indicates general agreement with the statement used in the rating scale. e.g., 'I found the content of the conversation annoying'. Arrows have been placed next to the points that are significantly higher or lower than this neutral value of 3.00 as assessed by a two-tailed *t*-test.

On the whole, participants disagreed with the more evaluative scales in the normal loudness conditions. For Scale 2 'The conversation was intrusive', only when the effects of loudness, medium and context are added together in the loud mobile phone condition in the context of the train is there a

mean ratings above 3.00 indicating agreement with this statement. All the other ratings are significantly less than the neutral point of 3.00. For scale 5 'I found the volume of the conversation annoying', the condition coming nearest to a mean rating of 3.00 is the loud mobile phone conversation in the train context.

As was pointed out earlier, there is a problem interpreting the absolute values of these means as Actor 1 was asking the questions. Unfortunately, practical constraints precluded having a third person to collect the ratings and so how large this effect may be remains unknown.

5. Design implications

5.1. *Encouraging considerate use*

The practical question set at the start of this paper was how to minimize the annoyance caused by mobile phones. Loudness did have an effect over and above the effect of medium and so one intervention would be to discourage phone users from talking too loudly. One can hope that as the technology becomes more familiar, and phone owners learn to use the technology more considerately, the intrusion caused by private calls in public spaces will be much reduced.

As Wei and Leung suggest, this process can be speeded up by the intervention of government and other institutions. One can view the measures taken by train companies to encourage responsible mobile phone use in this light. There is a difficult line to tread here. Wei and Leung's respondents identify public transportation (on buses, the underground and trains) as the context least likely to cause annoyance. Care must be taken to ensure that phone users understand the problem being addressed or the measures taken could be counter productive.

5.2. *Mobile phone design*

The public is still learning to use mobile phones considerately. Manufacturers have already made this easier by adding features such as vibration as an alternative to ringing. One reason that people may set the ringing tone inappropriately loud is that they find it difficult to adjust the volume to changing environmental circumstances. Similarly, phone users may not adjust the volume of the ear piece and this may lead to loud talk. This is because when co-present with someone it is reasonable to assume that if you are

having difficulty hearing because of environmental noise, then they will be having difficulty too. Raising your voice is thus a natural response to not being able to hear clearly and is commonly exhibited by Walkman users. Manufacturers can help by making volume controls for the ringing tone and ear piece salient and accessible. Brewster *et al.* (2000) have suggested that there may be advantages to adding automatic volume control. In their prototype, ambient noise levels were sampled through a microphone and used to adjust the volume of a speaker on a desktop PC. The same technique could be used to automatically adjust ringing tone and ear piece volume in a mobile phone.

5.3. Further work

The experimental method demonstrated in this paper provides a way of testing the effectiveness of these inventions and exploring the hypotheses set out above. A proper understanding of why mobile phones are more noticeable and more annoying than equivalent face-to-face conversations would inform the design of future mobile communications devices and the spaces in which they are used.

It is to be hoped that, by applying the method to other conditions and contexts, researchers can provide the insights needed to improve design and accelerate the cultural processes that will make the use of this technology less annoying.

Acknowledgements

Monk and Blythe were supported by the UK EPSRC during the period of this work. We would also like to thank Virgin Trains for their part in making the study possible. Thanks are also due to Gordon Baxter and David Grayson, for their help with previous versions of this paper.

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