J. Child Lang. **21** (1994), 623–648.

The unintelligibility of speech to children: effects of referent availability*

ELLEN GURMAN BARD
University of Edinburgh

AND ANNE H. ANDERSON
University of Glasgow

(*Received* 24 *November* 1992. *Revised* 24 *May* 1993)

ABSTRACT

Speech addressed to children is supposed to be helpfully redundant, but redundant or predictable words addressed to adults tend to lose intelligibility. Word tokens extracted from the spontaneous speech of the parents of 12 children aged 1;10 to 3;0 and presented in isolation to adult listeners showed loss of intelligibility when the words were redundant because they had occurred in repetitions of an utterance (Experiment 1) or referred to an entity which was physically present when named (Experiment 2). Though children ($N = 64$; mean age 3;5, S.D. 6·1 months) recognized fewer excerpted object names than adults ($N = 40$), less intelligible tokens appeared to induce child listeners to rely on the word's extra-linguistic context during the recognition process (Experiment 3), much as such tokens normally induce adults to rely on discourse context. It is proposed that interpreting parental utterances with reference to non-verbal context furthers linguistic development.

INTRODUCTION

Children perform a remarkable bootstrapping operation when they simultaneously learn syntax and vocabulary by listening to running speech. Word tokens in spontaneous speech are often so different from their citation

[*] This work was supported by an ESRC IRC grant to the Universities of Edinburgh and Glasgow and by ESRC Project Grant HR 6130 to J. Laver and E. G. Bard. The authors are grateful to Lothian Regional Council for access to nursery schools; to teachers, informants, and subjects for their patience and good will; to Frances Macnamara for help in running Experiment 3; and to the anonymous reviewers for helpful comments. A preliminary version of this paper was presented at the XIIth International Congress of Phonetic Sciences, Aix-en-Provence, in August, 1991. Address for correspondence: Ellen Gurman Bard, HCRC, University of Edinburgh, 2 Buccleuch Place, Edinburgh EH8 9LW, UK.

forms that they have about a 50% chance of being recognized in isolation by adult listeners who share the speaker's vocabulary (Pollack & Pickett, 1963). Adults very clearly make use of surrounding linguistic context when recognizing words in running speech (Marslen-Wilson & Welsh, 1978; Cole & Jakimik, 1980; Marslen-Wilson, 1987). Yet in many cases children who are still acquiring a first language may be unable to derive an interpretation of linguistic context which is complete enough to support word recognition consistently. For them, categorizing non-canonical tokens as belonging to a particular word type or learning more about the structure of a language from strings of such tokens must be especially difficult. The means by which children overcome these difficulties should make a major contribution to language acquisition.

Children's perceptual problems might be reduced if parents habitually spoke more clearly to them than to adults. Certain characteristics of parents' speech to children (hereafter 'A–C speech') might suggest that they do just this (Broen, 1972; Remick, 1976; Fernald & Simon, 1984; Bernstein Ratner, 1987), and there is evidence (for example, Fernald, 1984) that children prefer listening to A–C rather than A–A speech. Nonetheless, in a direct test of comparative intelligibility, words randomly selected from parents' speech to children aged 1;10 to 3;0 proved significantly more difficult for adult listeners to recognize out of context than words from the same parents' speech to an adult (hereafter 'A–A speech') (Bard & Anderson, 1983). Whatever help parents may give children in cracking the linguistic code, it does not seem to include continuous exposure to unusually clear word tokens throughout the course of first language acquisition.

It is, of course, possible that children are simply unaffected by adults' careless articulation. Children's perceptual abilities may simply not be finely enough tuned or their mental lexicons densely enough populated (see for example Treiman & Breaux, 1982; Charles-Luce & Luce, 1990) to make them sensitive to many of the differences in articulatory clarity which confuse adult listeners. Alternatively, children may be unlike adult listeners in their appreciation of A–C speech: their preference for A–C speech may be a response to its greater intelligibility for them. In either case there will be no problem of unintelligible A–C speech as far as child listeners are concerned.

Even if children are sensitive to intelligibility deficits, they might make use of the fact that A–C speech is consistently characterized by various kinds of redundancy, that is, by clues to the identity of spoken words other than the speech sounds which represent them. These clues appear both in the linguistic and the extra-linguistic context.

The most immediate linguistic clues come from the utterance in which the word token occurs. Bard & Anderson (1983) presented to adult subjects written versions of the context sentences from which their excerpted words had come, but without the test words, and asked the subjects to supply the

omitted word. Blanks in A–C sentence contexts were filled correctly more often than blanks in A–A sentences. It seems unlikely, however, that the young children who originally heard these sentences had the command of their language which would have allowed them to make equally accurate predictions.

The remainder of the discourse provides further clues to word identity. The same lexical items are used more often in speech to children than in speech to adults, so that A–C speech has the lower type–token ratio (Broen, 1972; Phillips, 1973; Ringler, 1973; Remick, 1976). Lexical redundancy may arise because utterances to children are more often partly or completely repeated (Snow, 1972; Ringler, 1973; Newport, Gleitman & Gleitman, 1977), or because adults feel a need to dwell on the same topic longer with a child listener. Since changes of topic are clearly marked in A–C speech (see, for example, Messer, 1980), a single clearer token of a word might be used to help the listener to determine the identity of other, less intelligible instances within the same conversational episode.

Redundancy in the form of extra-linguistic context derives from the fact that A–C speech refers almost exclusively to objects and situations which are available to the child's senses at the time (Phillips, 1973; Snow, 1977). Furthermore, A–C speech is often used to direct the child's attention to aspects of non-linguistic context. Snow (1986) points out that adult speech which is semantically contingent or predictable from its physical context may offer advantages to the child because it can be understood without a full linguistic analysis.

By unfortunate coincidence, however, the clarity of speech appears to decrease as some of these sources of redundancy increase. In A–A speech word tokens which are more predictable from sentence context (Lieberman, 1963; Bard & Anderson, 1983; Hunnicutt, 1985) and those referring repeatedly to the same entity (Fowler & Housum, 1987; Fowler, 1988; Bard, Lowe & Altmann, 1989) are shorter and less intelligible when played in isolation than their less redundant counterparts.

Even though parents might be expected to resist these effects in order to protect the intelligibility of the child's linguistic input, increased predictability from sentence context has already been found to correlate with lowered word intelligibility to the same degree in A–C and A–A speech from the same individuals (Bard & Anderson, 1983). There is good reason to suspect that the other sorts of redundancy which characterize speech to young children will also make words susceptible to abbreviation and degradation.

The discourse-based and extra-linguistic redundancy of A–C speech could be predicted to have similar results, because both affect the status of referring expressions. Both when an expression indicates an entity already mentioned (like *the stuff* in example (1) below) and when it indicates an object which is

clearly visible at the time (like *this page* in (2)), the expression belongs to the GIVEN (Clark & Haviland, 1977) or the EVOKED category (Prince, 1981): it denotes an entity already brought to the listener's or reader's notice.

(1) We had to carry *all the experimental materials* with us every day. *The stuff* was heavy and we staggered over the slippery cobblestones like a pair of drunks.
(2) Take a good look at *this page*.

It is a general observation that Given expressions may be lexically or syntactically simpler than expressions which introduce NEW items. For example, in (1) the expression which introduces a New entity, *all the experimental materials*, is longer, syntactically more complex and more specific than the later mention, *the stuff*. There was no need to go through a similar sequence for *this page*, however. The reader of a journal article operates in a physical context which provides an obvious page for the deictic expression to refer to on its first mention. If degraded pronunciations are controlled by the same processes which abbreviate referring expressions (Fowler & Levy, 1991), then both the repetitious and the contingent nature of A–C speech, which load it with Given material, may not be an unmitigated blessing for child listeners. Should the intelligibility of A–C words fall in these cases, the poor quality of A–C speech might offset any clues to its interpretation which contexts can offer.

This paper presents a series of experiments designed to show, first, how far A–C speech suffers from the effects of its redundancy in context and, second, whether young listeners can overcome any resulting difficulties. The work makes use of a corpus in which randomly sampled A–C words had proved relatively unintelligible compared to A–A controls (Bard & Anderson, 1983). Those results find some explanation in the present findings. These show that words in A–C speech which refer to entities already Given via linguistic or extra-linguistic context are less intelligible than New items. Because such words are very common in A–C speech in general, these results predict that A–C words will often be unclear. A further experiment shows that the less clear word tokens should create perceptual problems for young listeners, because they are sensitive to intelligibility differences. Paradoxically, these problems may give rise to a compensatory strategy which constitutes one of the bootstraps for first language acquisition.

EXPERIMENT 1: SELF-REPETITION

INTRODUCTION

Perhaps because of its use in controlling the behaviour of listeners with limited language ability and labile attention, A–C speech is characterized by a rate of self-repetition which far exceeds rates for speech among adults.

Some of the reiterations of the message are recast or expanded, while others are partial or complete word-for-word repetitions of immediately preceding utterances. Examples of such sequences are found in (3) and (4) below.

(3) You *see what else is in the box. See what else is in the box.*
(4) *It's a blue dog. It's a blue dog* like yours, isn't it?

Adults do repeat themselves, but with slight modifications, under other circumstances – for example, when they dictate documents on to tape for later transcription by an audio-typist. In this case the partial repetition is a self-correction, the edited or amended version of an immediately preceding sentence or sentence fragment which it is intended to over-write on the final tape. In both cases of self-repetition, the clarity of the latter version is important: both the child and the audio-typist have to be able to recognize what is being said. Yet, it has been shown that for words appearing in both versions of a dictated sentence, the second token will be shorter and less intelligible than the first (Bard, Lowe & Altmann, 1989).

Arguably, any immediate self-repetition is redundant for the speaker – because her knowledge of the prior token makes the later mention Given –, even though it may be New for an eventual listener who has not heard the earlier attempt. If adults regulate their pronunciations in the same way when addressing children and dictating machines, we might expect a similar loss of intelligibility in immediate self-repetitions in A–C speech. Moreover, since self-repetition is so common in A–C speech and so rare in face-to-face A–A speech, any consequent intelligibility loss could go some way towards explaining the comparative unintelligibility of words in speech to children.

METHOD

Corpus

The materials were drawn from 12 45-minute studio-recorded sessions, in which a parent spoke to his or her child and to an experimenter. Both parents of one boy and one girl in each of three age groups (1;10–2;0; 2;4–2;6; 2;10–3;0) participated. After discussing with the parent the family's history and details of the child's contacts and play habits, the experimenter encouraged the parent to help the child play with a standard set of toys so that the child's speech in play might be recorded. The parent later engaged the child in conversation about one of his or her own toys which resembled one in the studio. The experimenter remained in the studio, speaking to parent or child where appropriate and directing a microphone towards the child. The parent's speech was recorded on a separate channel of a Revox A77 stereo tape recorder via a laveliere microphone.[1] Tapes were fully transcribed

[1] Other details will be found in Bard & Anderson, 1983.

in the standard orthography and all utterances were classified by speaker and addressee. The experimental materials were all selected from the nouns spoken by the parents. Excluding proper names, there were 2568 nouns in A–C speech and 1445 in A–A speech.

Materials and design

Since immediate self-repetitions of the kind identified in the literature for A–C speech are rare in speech to adults, only the speech of parents to children was used here. From the set of nouns used by each parent to his or her child, four pairs of word tokens were chosen. Each pair included two successive co-referential tokens of a single noun which occurred in a self-repetition, that is, in a pair of utterances in the same conversational turn, the second of which either fully repeated, partly repeated or paraphrased the first without altering the noun phrase containing the selected word. The materials were also balanced with respect to the referent location variable used in Experiment 2, giving two referent-present and two referent-absent types, each with a first and a repeated token for each of 12 parents. The materials were thus 96 spoken words, two tokens of each of 48 word types.

The selected items were excerpted from their taped contexts electronically. To give balanced representation of speaker, token, and referent location without allowing any subject to hear both tokens of any word, two groups were necessary. To allow this experiment to be run with Experiment 2, each of these had to be divided once more, giving four balanced groups, with pairs of groups forming full replicates of the design. Each group was presented in random order interspersed with materials from Experiment 2. Intensity levels were held constant as far as possible. Each word was preceded by a spoken number and repeated three times at approximately 5 sec intervals.

Subjects and procedure

Twenty-four adult native-speakers of English (six per group) from the Edinburgh University community heard stimuli presented monaurally on a Revox A77. They were told that each stimulus was a word taken from conversational speech and that they were to write each word they thought they heard, guessing if necessary.

RESULTS

Letter perfect or fully homophonous identifications of the stimulus counted as correct answers. These were analysed via a pair of ANOVAs taking either subjects or words as individual cases, both having the design (2) token × (2) referent location × (2) replication, where two subject groups formed a full

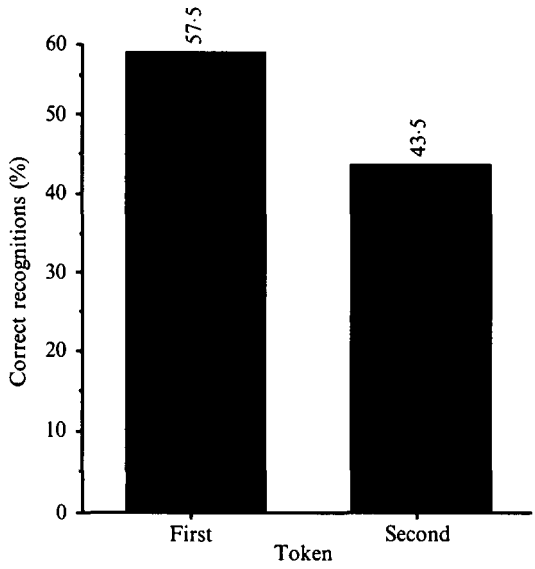

Fig. 1. Experiment 1. Correct recognitions by adult listeners for words repeated in speech to children (144 attempts per cell).

replication. In all cases, F-ratios will be reported by subjects (F_1) and by materials (F_2) only if the composite and more conservative measure (*Min* F') failed to reach significance.[2]

Fig. 1 shows the predicted effect of repetition. With 57·5 % or 6·92 out of 12 words correct on average, first tokens were more intelligible than second tokens, which attracted only 43·5 % or 5·28 correct responses on average ($F_1(1,22) = 11{\cdot}84$, $p < 0{\cdot}005$; $F_2(1,44) = 3{\cdot}92$, $p < 0{\cdot}05$; *Min* $F'(1,64) = 2{\cdot}94$, $p < 0{\cdot}10$). There were no other significant effects.

DISCUSSION

A–C speech appears to share with A–A speech a tendency to lose in clarity what it gains in repetitiveness. Although the textual redundancy of A–C discourse might be an aid to word recognition for a child who attended carefully to every parental utterance, impressionistic evidence suggests that parents often repeat themselves because the child's attention wanders. Experiment 1 indicates, however, that parents may increase the child's difficulties by producing less clear speech as they try to elicit a response.

[2] Whereas a significant F_1 indicates a result which should be replicable using the same materials and another sample of subjects, and a significant F_2 a result which should be robust with the same subjects and another sample of materials of the same sort, a significant *Min* F' implies that the observed result should recur with new samples of subjects AND materials.

The loss of clarity may help to explain the variation in findings on the effects of maternal self-repetitions. For instance, an early result by Newport (1976) is now more understandable: in her study, the probability of a child's responding appropriately to any of a series of repeated utterances did not increase with the position of the utterance in the series. While repetition might provide context, it might also provide difficulties of perception. Newport, Gleitman & Gleitman (1977) failed to find any significant correlation between rate of maternal repetitions and subsequent linguistic development when the child's age and linguistic stage at first sample were controlled for. Hoff-Ginsburg (1986) did find a correlation between maternal self-repetition and child progress for children who were 2;6 at initial testing, but a subsequent analysis brought this into question. Unlike other positive predictors of children's progress from the earlier study, repetitions elicited responses from children which were no more frequent or relevant than those following a non-predictive control category (Hoff-Ginsburg, 1990). This outcome might also be expected if parents' self-repetitions gave children more but not better opportunities to process an utterance.

EXPERIMENT 2: LOCATION OF REFERENT

INTRODUCTION

Even if the redundancy of A–C utterances in their linguistic context is not as helpful as we might hope, there is every reason to believe that children find extra-linguistic information salient and that the A–C register includes numerous successful strategies for directing children's attention to relevant aspects of the non-linguistic environment in the form of nearby objects and ongoing events. Yet, as we have seen, by becoming an object of visual attention, a denoted item becomes Given rather than New even if it has never been mentioned before. An utterance like (5),

(5) Put *the red one* in *the round hole.*

is permissible when the listener can be assumed to be able to identify both *the red one* and *the round hole* uniquely. Although the items might have been introduced earlier in the conversation, this utterance could itself provide the first overt mention of both, particularly when the listener can see which hole is round and which object is red. The referents of these expressions are present in the listener's current representation of the universe of discourse whether or not they are in his/her current representation of the discourse itself. Experiment 2 asks whether the availability of a referent in the extra-linguistic environment yields the same effects on intelligibility as availability within linguistic context. If the two effects are parallel, expressions referring to objects visibly present at the time of speaking should be less clearly articulated than expressions whose referents are elsewhere.

METHOD

Materials

The common nouns in the corpus used for Experiment 1, and already classed by addressee, were cross-classified according to the location of the entity referred to. PRESENT nouns named objects or persons in the studio as they were being discussed or acted on by speaker or listener. The token of *door* in (6) is classed as present because it was uttered when the parent was helping the child explore the possibilities of a toy which had several lockable doors.

(6) Are you going to lock the *door* now?

ABSENT nouns referred to entities or events not present in the studio. In (7) below, which was addressed to the experimenter, *blocks* referred to toys which the child had at home.

(7) Occasionally with *blocks* and things of that nature.

NEUTRAL nouns referred to abstractions and to physical or geographical entities in which the studio was contained, as well as those where the reference was uncertain or the expression non-referential. In (8) and (9) below, *minute* and *hour* belong to this category because they are abstractions.

(8) A–C: Just come and sit on Daddy's knee for a *minute*.
(9) A–A: We have about, uh, the best part of an *hour* before I go to the office.

In (10) the adult token of *juice* is neutral because negative expressions of this kind cannot refer: the parent is observing that there is no juice present.

(10) A–C: What's in that?
C: Juice
A–C: No *juice*.

Fig. 2 displays the different distributions of A–C and A–A nouns among these categories. It illustrates a familiar asymmetry between A–A speech, which refers largely to entities which are absent (54% of the 1445 common nouns) or neutral (another 40%), and A–C speech, which deals with visible things (65% of the 2568 common nouns) and less often with neutral (19%) or absent (16%) entities.

Because of the small set of A–A nouns with present referents (5.5%), materials for this cell were not available from all speakers. Even for the five remaining cells, it was not possible to match words across all cells, because the categorization selected different words: present items included only the names given to objects contained within the studio; absent items also included

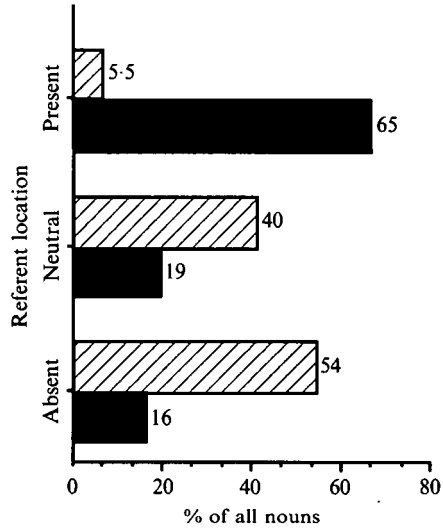

Fig. 2. Distribution by addressee and referent location of common nouns from speech of twelve parents. ▨, Speech to adult; ■, speech to child.

many objects which were not present, and neutral nouns often named non-objects. Instead, each of the five populous cells was sampled by selecting four word tokens randomly from each parent's speech in each cell: pairs of numbers were drawn from a random number table, with the first giving the page of transcription and the second the tabulated word on that page in the appropriate cell. Only first mentions of an item were used: repeated items were replaced by further random selection. The design yielded 20 word tokens per parent, 48 per referent location × addressee cell, and 240 items in all.

Despite our inability to match words across cells, random selection of words produced items of similar syllable lengths throughout: the mono-syllable-to-polysyllable ratio was statistically indistinguishable by χ^2 across referent location within addressee (for A–C words: present 27/21, neutral 22/26, absent 26/22; for A–A words: neutral 21/27, absent 20/28) and across addressee within referent location. The neutral items selected were not all abstract nouns. Only 30 of the 48 A–A items and 16 of the 48 A–C words could be so classified. The rest were concrete nouns of uncertain reference or no real referent (see example (10)).

Design, subjects and procedure

Word tokens were captured as in Experiment 1. Materials were divided into four groups, with one word from each parent's speech in each addressee × location cell in each group. Within each materials group, words from the

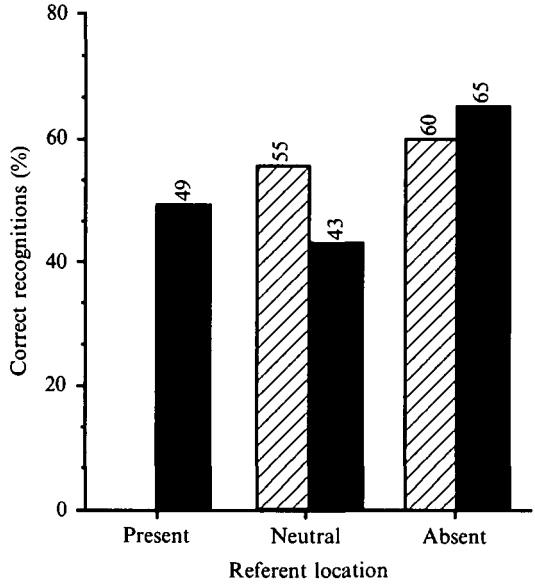

Fig. 3. Experiment 2. Correct recognitions by adult listeners for nouns by addressee and referent location (288 attempts per cell). ▨, Speech to adult; ■, speech to child.

present experiment were randomized with the words used for Experiment 1 and presented to the same subjects.

RESULTS

Responses were scored as in Experiment 1. Fig. 3 shows the rate of correct recognitions for each of the five cells. Because the A–C and the A–A words do not cover the same categories, two pairs of ANOVAs were run, one to examine the effects of location (present, neutral, absent) on A–C words alone and the other to investigate the two levels of location (neutral, absent) which were crossed with two levels of addressee (adult, child).

Within A–C words the predicted effect of location was found: nouns with absent referents were significantly more intelligible (65 % correct recognitions) than those with neutral (43 %) or present referents (49 %) (Scheffé tests at $p < 0{\cdot}05$ within the location effect: $F_1(2, 40) = 29{\cdot}14$, $p < 0{\cdot}05$; $F_2(2, 132) = 3{\cdot}29$, $p < 0{\cdot}05$), while neutral and present items did not differ significantly.

Over words to both addressees, nouns with absent referents were again easier to recognize (62·5 % correct) than those in the neutral category (49 %) overall (*Min* $F'(1, 193) = 4{\cdot}08$, $p < 0{\cdot}05$). Since neither the addressee effect nor the addressee × location interaction was significant, there were no intelligibility differences due to addressee alone.

DISCUSSION

The location of the entity referred to affects the intelligibility of the noun in the referring expression. This result has implications for the control of speech intelligibility and for the nature of speech to young children.

First, the results of Experiment 2 confirm the analogy between two kinds of Given-ness: entities which are, in Prince's (1981) terms, textually evoked by previous mention and items which are situationally evoked by physical presence both show loss of intelligibility. If we believe Lieberman's (1963) original suggestion that words are less carefully articulated where listeners have other clues to their identity, we must describe this result as implicating all kinds of textual and situational information in the process of recognizing words in running speech. Moreover, Fowler (1988) has demonstrated that repetition lowers intelligibility only in meaningful sentences and not in word lists. Taken together, Fowler's findings and the present results show that speakers, like listeners, respond to redundancy at higher linguistic levels: low-level redundancy in the form of repeated articulation of a word without reference to Given information (as in Fowler's lists) has no effect; the use of a word to refer to Given information either with repetition (as in Fowler's sentences or Experiment 1) or without repetition (as in the present experiment) degrades pronunciation.

Second, the results make it clear that the overall intelligibility difference between A–C and A–A speech previously established in this corpus must be partly attributable to referent location: if we match A–C and A–A samples for referent location, the addressee effect disappears. Typically, as Fig. 2 illustrates and as other researchers have suggested (Phillips, 1973; Snow, 1977), A–C and A–A speech are not matched in this respect. Because speech to children usually refers to visible objects it should be harder to decipher than speech less grounded in the 'here and now'. Like its characteristically repetitive quality, the typical relationship between A–C speech and its extra-linguistic context helps make A–C speech more redundant and, concomitantly, less intelligible. It remains to be seen whether the advantages of redundancy in the form of contingency on extra-linguistic context ultimately outweigh the disadvantages.

Before turning to a study of children's perceptual capacities, it is worth noting one unexpected characteristic of the results: the group of nouns which were labelled 'neutral' behaved like present items, whereas one might have expected them to pattern like absent ones. The outcome is unlikely to have to be due to the use of abstract nouns *per se*: there was no addressee effect among neutral items, even though there were twice as many abstract words among neutral A–A items as among neutral A–C items. It may be that various subsets of items in this category behave in ways appropriate to particular contexts in which they occur (see, for example, the play scenario of example

(10) above). A study that would test the relevant hypotheses lies beyond the scope of the present paper.

EXPERIMENT 3: CHILD SUBJECTS

INTRODUCTION

So far we have shown that certain characteristics of speech addressed to young children are associated with reduced intelligibility of individual word tokens, but our studies have used only adult subjects to test intelligibility. It is entirely possible that the results do not generalize to the abilities of child listeners. Experiment 3 compares adult and child listeners directly.

There are a number of questions which we might ask about child listeners which bear on the importance of the results of Experiments 1 and 2. First, are children ever sensitive to what adults perceive as loss of clarity? Children who cannot yet deploy a full account of the syntax of their language in aid of recognizing running speech may be both more dependent on and more skilled at sound-driven, bottom-up processing of speech than adults are. Or, as we suggested earlier, their small vocabularies may offer less opportunity to confuse the word actually uttered with similar words. Under either scenario, major differences in intelligibility for adults should make little difference to young children.

Second, are children insensitive to the particular loss of clarity that comes with parental speech? Sachs (1977) has claimed that there is a match between infants' perceptual capacities and the peculiarities of adult–child speech, and that the match is part of the innate behavioural repertoire of our species. Children's preference for listening to A–C speech (Fernald, 1984) and their sensitivity to prosodic cues within it (Kemler-Nelson, Hirsh-Pasek, Jusczyk & Cassidy, 1989) point in this direction. It may be that the match of parental production with child perception or expectation is great enough to overcome or even reverse the sorts of effects which we find with adult listeners.

Third, given that A–C speech very regularly describes physically present objects and events, does the child profit from such supporting context? Even if their perceptual abilities do not protect them against reduced or degraded pronunciations, so long as children's attention is successfully directed by parental speech, the resulting observations may help to limit the set of known words which serve as candidate identities for stretches of speech sound. The objects attended to should also be candidate referents for spoken words whose meaning is as yet unknown to the child. If young children actually do deploy non-linguistic context in speech recognition but have some sensitivity to degraded pronunciation, then they will not perform uniformly on A–C speech. Instead, they may be competent at recognizing words whose denotanda are present, and relatively incompetent, that is, sensitive to unintelligibility, otherwise. In the normal case, where a poorly articulated

word token is uttered in the presence of an obvious referent, the clarity with which the word is pronounced may be of little importance.

Experiment 3 was designed to distinguish young children's behaviour from adults' in all these areas. All the stimuli are object names. Tokens of the same words produced in running speech and read one at a time from a list should contrast sharply in intelligibility and so allow a general comparison of adult and child sensitivity to the unintelligibility of spontaneous speech. Tokens of words from parents' speech to their children and to an adult allow us to determine whether children are subject to the same difficulty as adults in recognizing A–C as opposed to A–A speech. Also, each word is presented with an exemplar of the object which it names clearly visible and with an exemplar hidden from view in order to see whether children are able to profit from visual context during word recognition. Finally, word tokens which were originally uttered in the presence of their referent can be compared with those originally uttered with referent absent to determine whether children are sensitive to the sorts of differences found in Experiment 2.

METHOD

Subjects

Sixty-four children (34 girls, 30 boys) attending nursery schools in Edinburgh or Glasgow served as subjects. Their mean age was 3;5, S.D. = 6·1 months, and they were divided pseudo-randomly into eight groups. Forty members of the Edinburgh University community served as adult controls, and were also subdivided into groups.

Materials

All stimulus words were concrete nouns which might readily be represented by a small toy and all occurred free from extraneous noise in the corpus used for Experiments 1 and 2. The materials were of two sorts.

The SPONTANEOUS stimuli were eight tokens of concrete nouns taken from the speech of each of the 12 parents whose nouns were classified previously. Four of the eight words from each parent were addressed to the child listener, the other four to the adult. Two of the child-addressed words were matched to tokens of the same words addressed to the adult listener. The others were unmatched across addressee: they represented different lexical items. These were chosen from all the noun lists so as to achieve maximal lexical diversity. Of the resulting 96 word tokens, 94 were classifiable by the location of their referents when they were uttered: 50 had been uttered with their referent present and visible in the studio, 44 with their referent absent. While the stimuli did not represent 72 unique lexical items (48 unmatched + 24 matched), there was no duplication in the materials heard by any subject.

Paired with the spontaneous stimuli were CITATION forms. For each

spontaneous lexical item, a citation form was read from a list by a speaker of the same sex and age range as the parent who produced the original token. Both spontaneous and citation forms were excerpted from recordings as described for Experiment 1, so that both had equally abrupt onsets and offsets.

Design and procedure

To create short sessions, stimuli were divided into eight presentation groups, each containing 12 conversational and 12 citation forms. The conversational forms in each group represented half the informants, but both levels of addressee (child, adult) and word type (matched, nonmatched). Words occurring as citation forms in one group occurred as spontaneous forms in other groups in a balanced way. For each group two tapes were made, each containing all the conversational forms and one or other half of the citation forms for the group. Each tape consisted of two half-sessions, within each of which two citation forms were followed by six conversational forms and a third citation form. Every word was presented three times in succession at roughly 5 sec intervals. Tapes were presented on a Revox A77 with two external speakers.

Each subject was tested in two sessions, hearing one tape per session. Within each session two LISTENING CONTEXTS prevailed, one for each half of the session. In the VISIBLE condition, a set of 25 toys among which the named objects were included, was set out on top of a large wooden box as the tape was played. In the HIDDEN condition, the same toys were in the closed box while each stimulus was presented. For child subjects, context (visible, hidden) and session (1, 2) were counterbalanced within each group, with all combinations of session and listening context order represented among the children hearing each tape. Each child comprised a full replicate if both matched and unmatched pairs were considered. For adult subjects, counterbalancing for order of listening conditions was over the whole design: half the groups began with the visible condition in both sessions, and the other half with the hidden condition.

Procedure for child subjects. The experimenters visited each child's nursery for several days before testing began, playing with the children and familiarizing them, in groups of three to six, with all the toys used in the experiment. If any child in a group could not name a toy as it was drawn from a bag, the whole group was given practice with the word.

The two test sessions were separated by at least 24 hours. Before the first, the child was told that a monkey hand puppet was not allowed out to play because he had a cold, but that the puppet would ask the child to bring the toys he wanted to play with. The child was instructed to listen carefully because the cold might make the monkey's voice sound strange or difficult to understand, and to guess if s/he were uncertain as to what the monkey

wanted. The child was instructed to repeat what the monkey asked for each time and then to retrieve it either from the top (visible condition) or the inside (hidden condition) of the box which was placed directly before her/him. During testing, an experimenter sat concealed behind the upright tape recorder, which was set with its blank side to the child, and held the puppet up so that it was visible to the child over the top of the recorder. All deliveries, correct and incorrect, were greeted enthusiastically by the monkey, who handled the toy before returning it to the child to replace with the others. The tape was paused during these episodes so that no words were missed. A second experimenter recorded both the child's verbal response and the toy selected. All children tested were able to perform the task.

Procedure for adult subjects. Adult subjects were run in groups of five in a recording studio and received both sessions in a single day. Adults were told that they were controls in an experiment on children and were instructed to write down the words they heard. They were shown the appropriate set of toys before the first session.

RESULTS

Scoring and pre-analysis

Adults' responses were scored correct if they were exact transcriptions of the stimuli. Children's responses depended on the toy chosen rather than the toy named, because choices were correct slightly (about 3%) more often than naming. Correct choices attracted both more naming overall (with 94% of correct choices accompanied by verbal response) and more naming corresponding to choice (93% of correct choices) than incorrect choices did (65% named in some way, 62% named as choice).

Results were initially analysed in four pairs of ANOVAs, one pair for each combination of spontaneous word type (matched, unmatched) and subject age (child, adult). Within each pair, the by-materials ANOVA used word tokens as cases and the by-subjects ANOVA used subject replications (as each subject comprised only half a replication for matched or unmatched words). All had the same design: addressee (child, adult) × listening context (referent hidden, referent visible) × order (first presentation, second presentation). The only effect to reach significance both by subjects and by materials was order of presentation: first presentations gave a lower rate of correct identification than second when child subjects tried to recognize both matched words (35 vs. 43%: $Min\ F'(1, 80) = 4.98$, $p < 0.05$) and unmatched words (44 vs. 51%: $Min\ F'(1, 78) = 5.66$, $p < 0.025$), and when adult subjects tried to recognize unmatched words (83 vs. 89%: $F_1(1, 16) = 11.63$, $p < 0.005$; $F_2(1, 16) = 4.17$, $p < 0.057$). Subjects, in effect, learned to recognize stimuli better over sessions, with adults in particular reaching ceiling accuracy.

The circumstances in which learning occurred here were not directly analogous to the natural situation. In the second session of the present experiment the child was given a token identical to one s/he had heard before, but in a different linguistic context. Experiments 1 and 2 have shown that both repetition and differences in referential support should affect the way words are pronounced: out of the laboratory, the two tokens should not be identical. Because learning effects under unnatural conditions are not directly relevant to our present concerns, and because they might obscure the efforts of interest, the remainder of the analyses deal only with the results from the initial sessions.[3]

In this half of the design each subject was only a half-replicate, hearing each word only in one listening context. Accordingly, subject groups filling complementary halves of the design were paired to form composite groups. Those composite groups of child subjects were retained which matched adult groups in having the same order of listening conditions for the same materials. This is a very conservative treatment which allows adult and child performance to be compared under identical conditions. It halves the sample of child subjects. While it retains all of the data in first sessions of the remaining subjects, the by-replicates analysis maintains the fiction that only half this number of subjects participated, and therefore reduces the available degrees of freedom. As a result, larger F-values will be needed to achieve the same levels of significance, and the results we report should be very robust.[4]

Are children sensitive to loss of intelligibility?

Citation vs. spontaneous forms. The largest differences in intelligibility should distinguish citation forms from those extracted from running spontaneous speech. Children did recognize citation forms more often than spontaneous forms. Over 40 unmatched words children recognized 81% of the citation forms but only 44% of the corresponding spontaneous forms (the form effect in a form (citation, spontaneous) × addressee (adult, child) ANOVA was $F_2(1, 38) = 35{\cdot}56$, $p < 0{\cdot}0001$).[5] Over 18 matched words, children recognized 72% of the citation forms but only 40% of the corresponding spontaneous forms addressed to adults and 30% of those addressed to children ($F_2(2, 34) = 13{\cdot}22$, $p < 0{\cdot}0001$).

Effects within spontaneous forms. To examine the results for first presentations of spontaneous forms, by-materials and by-subjects ANOVAs

[3] In fact, the two sessions had been used only in an attempt to study listening context as a repeated measure within both subjects and materials.

[4] Wherever it was possible to compare replicate-based with subject-based results or adults-only with children-only results, the same effects were found as in the conservative analysis reported here.

[5] Errors in the assignment of citation forms to conditions gave too many missing cells in the by-subjects analysis to fill by standard procedures. Rather than omit subjects or groups, we report only by-materials analyses, where empty cells were within acceptable limits.

were run including subject age (child, adult) × word type (matched, unmatched) × addressee (child, adult) × listening context (hidden, visible) × composite group (I–IV). Again children were sensitive to the unintelligibility of excerpted words: they were significantly less able to recognize such forms than adults were. Over all first presentations of spontaneous forms, adult listeners recognized 80%, while child listeners recognized only 39% (*Min* $F'(1, 92) = 53.68$, $p < 0.0001$).

Are children particularly expert at recognizing child-addressed words?

Children were no better at recognizing words taken from A–C speech than adults were. Over all subjects, the tokens addressed to children, at 65% correct, were actually more intelligible than those addressed to adults, at 59% correct ($F_1(1, 28) = 10.66$, $p < 0.003$; $F_2(1, 64) = 1.79$, $p > 0.10$). Any special skill the children had at recognizing A–C words should show up in the interaction between subject age and the word's original addressee, but the relevant effects did not approach significance ($F_1 < 1$; $F_2 < 1$). In fact, as Table 1 shows, child listeners showed a less general trend than the adult

TABLE 1. *Experiment 3. Correct recognitions by child and adult subjects of first presentations of nouns*[a]

	Subjects							
	Children ($N = 32$)				Adults ($N = 40$)			
Addressee:	Child		Adult		Child		Adult	
	Mean	%	Mean	%	Mean	%	Mean	%
Word type								
Matched	0·97	32	1·16	52	2·50	83	2·23	74
Unmatched	1·53	51	1·00	33	2·55	85	2·38	79
Listening context								
Toys-visible	1·59	53	0·91	30	2·58	86	2·18	73
Toys-hidden	0·91	30	1·25	42	2·48	83	2·43	81

[a] Effects of original addressee (child, adult), matching condition (matched, unmatched) and listening contexts (toys-visible, toys-hidden), max. score per cell = 3.

listeners towards better recognition for A–C speech (for the interaction of subject age × addressee × word type: $F_1(1, 28) = 10.93$, $p < 0.003$; $F_2(1, 64) = 2.53$, $p > 0.10$). Adults recognized more A–C than A–A words both among pairs matched (83% vs. 74%: Scheffé test at $p < 0.05$) and unmatched (85% vs. 79%: Scheffé test at $p < 0.05$) across addressee. Children did better at A–C unmatched words only (51% vs. 33%: Scheffé test at $p < 0.01$). For

matched pairs, children were significantly WORSE at recognizing the tokens originally addressed to children (32% vs. 52%: Scheffé test at $p < 0{\cdot}01$). Apparently there is nothing intrinsic about the way words are pronounced when addressed to children which makes them easy for children to recognize.

Can children use extra-linguistic context as an aid to word recognition?

Not only can children use extra-linguistic cues in recognizing spoken words, but they appear to apply such cues where the unintelligibility of words in parental speech is likely to demand them. We reach this conclusion by examining the interactions of listening condition with other variables.

Only children recognized significantly more object names in general when their referents were visible (42%) than when they were hidden (36%) (by-subjects Scheffé at $p < 0{\cdot}05$ within the interaction of context × subject age: $F_1(1, 28) = 8{\cdot}53, p < 0{\cdot}007$; $F_2(1, 64) = 1{\cdot}10, p > 0{\cdot}10$). Moreover, the helpful effect of being able to see the referent while listening to the word is restricted to A–C materials (see Table 1). That is, child subjects recognized significantly more A–C words when they could see the toys (53% for toys visible vs. 30% for toys hidden: Scheffé at $p < 0{\cdot}05$ within the interaction of context × subject age × addressee: $F_1(1, 28) = 6.77$, $p < 0{\cdot}025$; $F_2(1, 64) = 2{\cdot}07$, n.s.), but showed no parallel effect for A–A words (30% visible vs. 42% hidden). In fact, the intelligibility advantage for child-addressed speech itself was significant only for responses in the toys-visible condition (Scheffé at $p < 0{\cdot}05$).

To understand why the presentation context selectively affected A–C words, we have to reconsider the contexts in which the words were originally spoken. Recall (Fig. 2) that most nouns spoken to children in our corpus were uttered in the presence of their referents. Could it be that A–C words were easier to recognize when listening context (toys visible) matched the typical production context (referent present)? Materials for Experiment 3 contained both referent-present and referent-absent object names, but the proportions had not been balanced across addressee or group because of the intricacy of the design and the rarity of A–A referent-present items. To see if original production context might be implicated in the apparent effects of addressee and listening context it was necessary to conduct additional analyses.

First, stimuli were classified by addressee (child, adult), original production context (referent present, referent absent) and listening context (toys visible, toys hidden). The A–C words included 35 items which had originally been said in the presence of their referents but only 12 said with referents absent. The A–A words had 15 present and 32 absent items. The association between original object location and addressee was significant ($\chi^2 = 15{\cdot}42$, D.F. $= 1, p < 0{\cdot}001$): intelligibility results for A–C words were largely results for referent-present words, while A–A results were largely for referent-absent items. If performance is better when original and listening contexts

match, then the largely referent-present A–C words should indeed do better than A–A words in the toys-visible condition.

Next, the effects of addressee and context on children's first session responses were examined via multiple regression analysis, which dealt more gracefully than ANOVA with the imbalances created by adding the original production context variable *post hoc*. These analyses showed that performance was indeed best in the conditions where speaking and listening context matched, as they do in face-to-face communication. Separate multiple regression equations were constructed for words originally spoken with and without referents present. These differed significantly ($F(3, 88) = 4{\cdot}24$, $p < 0{\cdot}008$). Of the two predictor variables, original addressee made no independent contribution to explaining the variation in children's accuracy in either group ($\beta = -0{\cdot}031$ for originally present; $\beta = 0{\cdot}17$ for originally absent). As Fig. 4 shows, listening context did affect accuracy of recognition,

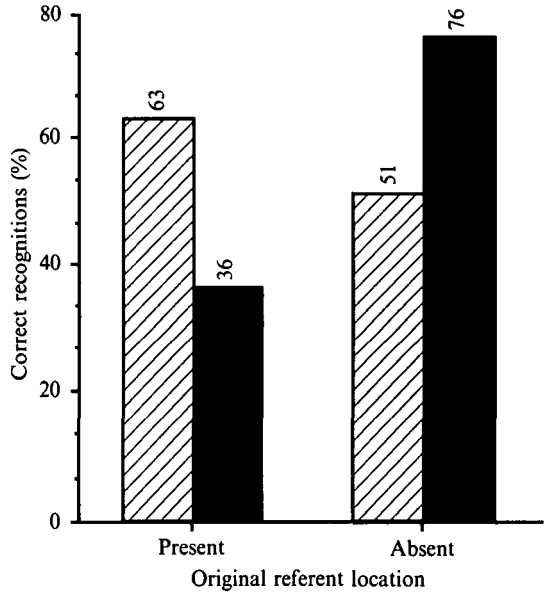

Fig. 4. Experiment 3. Correct recognitions by child listeners for nouns by speaking (referent-absent, referent-present) and listening (■, toys-hidden; ▨, toys-visible) condition.

but the effects depended on the circumstances in which the word was originally spoken. As predicted, for words which had originally been spoken in the presence of their referents, the toys-visible condition made for more accurate recognition ($\beta = 0{\cdot}279$, $t(48) = 1{\cdot}99$, $p < 0{\cdot}05$). For words originally spoken with referents absent, the toys-hidden condition tended to give the better scores ($\beta = -0{\cdot}362$, $t(44) = 2{\cdot}45$, $p < 0{\cdot}025$). One consequence is that children's results in this experiment resemble adults' behaviour in Ex-

periment 2 only when the listening conditions are the same and no potential referents are visible: only in the toys-hidden condition do originally referent-absent items prove easier to recognize.

Taken together, the regression results tell us that if children did better at A–C words, it was because those words had been said with their referents present AND because the child subjects could see the set of toys while listening to the words. The addressee effect is an artefact of the other effects.

DISCUSSION

The results of Experiment 3 suggest that the results of Experiments 1 and 2 are relevant to children. In Experiment 3, child subjects were susceptible to differences in intelligibility. Like adults, they found it harder to recognize nouns excerpted from running speech than words uttered in a list. In fact, child subjects were only half as accurate as adults were in recognizing excerpted words. Moreover, children did not have any particular expertise in interpreting the speech of parents to their children. Children favoured A–C words less often than adults did and produced robust differences only when they could see the toys as they listened. Whatever these results point to, it is not a perceptual skill which makes the unintelligibility of parental speech irrelevant to child listeners.

Instead it looks as if children make use of extra-linguistic context to supply information which is lacking in the speech signal. Interestingly, extra-linguistic support is only sometimes useful. Ability to see the set of potential referents produced higher recognition scores only on words originally uttered with referents present. For words originally uttered with referents absent, inability to see the potential referents was an advantage. Fortunately the present/visible match is the one which appears to prevail in the child's linguistic environment, so that the results offer at least one way in which children can mitigate the effects of the conditions in which parents speak to them.

But why is supporting physical context not always helpful to child listeners? We can see two possible explanations, which differ in plausibility.

Perhaps, there is a categorial distinction between the way a parent pronounces an object name when its referent is available to the senses and when it is only available to the mind's eye, a distinction which the child both recognizes and understands. It has been suggested that A–A speech uses accented tokens for New and de-accented for Given items (Terken & Nooteboom, 1987). If child subjects were able to categorize stimuli in the present experiment, we could attribute their poor performance on toys-visible referent-absent words as the result of conflicting signals: the categorization of the word token would presumably direct them to ignore their surroundings, while the experimental task would require them to scan an array of toys for the appropriate item.

The difficulty with this explanation is that it demands a finely tuned analysis on the child's part. Binary distinctions like, for example, the contrast between accented and unaccented words could be difficult to make on-line, particularly for words excerpted from their natural contexts. Moreover, if our child subjects understood the discourse function of the accented/de-accented contrast, they ought to have interpreted de-accented items as Given both in terms of physical surroundings and in terms of linguistic context. De-accented items should have signalled either things children could see OR things which had been mentioned before. The latter would lead to a particular kind of error: referent-present stimuli should have been mistaken for repetitions of earlier items. But such errors were not common. To produce the actual pattern of results, the children would have had to interpret a categorial distinction in pronunciation only with respect to physical surroundings.

A less demanding explanation depends on the relative utility of auditory and visual information. Current models of word recognition suggest that the acoustic energy corresponding to a word is initially interpreted as a set of lexical hypotheses, composed of similar sounding words and with 'strength' or 'activation level' depending on, among other things, the perceived resemblance between the spoken word and the idealized hypothesis (Marslen-Wilson, 1987). If a word token cannot be recognized because speech sound is an adequate clue to its identity, the listener can be thought of as entertaining a large number of weak lexical hypotheses without being able to decide among them. A visible set of candidate referents may be smaller than the set activated by the speech sounds and may help to reinforce the correct candidate, increasing the chances of a correct identification. For the unclear pronunciations of referent-present items we expect this scenario to hold. On the other hand, when word tokens are intelligible in isolation, competing sound-based hypotheses, by definition, throw up a good front-running candidate identity. The set of visible referents is not only unnecessary now, but also potentially counterproductive: the set of attractive 'toy-based' lexical hypotheses will be larger than the sound-based set, so that the set of visible items will provide robust and distracting alternatives to the correct choice.

GENERAL DISCUSSION

Redundancy in speech to small children has a price. Repetition (Experiment 1) and contingency on situations accessible to the senses (Experiments 2 and 3) correlate with loss of articulatory detail. These effects seem to operate regardless of addressee, for wherever we have examined both addressee and redundancy (in the case of original extra-linguistic context in Experiment 2 and listening context in Experiment 3), addressee has had no significant

independent effect. The results give us no grounds for supposing that the relative unintelligibility of A–C speech is due to anything other than the various kinds of redundancy.

By reducing clarity when contextual support is high, parents seem to be placing their young children at a disadvantage. Our child subjects, who were not very much older than the original child addressees, were sensitive to the relative unintelligibility of words as pronounced in running speech and of words uttered with referents present (Experiment 3). Our results suggest that children are not without a remedy for the difficulties presented by the object names in A–C speech. When child subjects attempted to recognize tokens of nouns originally uttered in the presence of their referents, they were able to take advantage of an extra-linguistic context which included a referent for each word.

Still, the original finding that A–C speech is less intelligible than A–A speech (Bard & Anderson, 1983) was based on a random sample of words in both categories, only about a third of which were object names. The presence of a visible referent might be expected to bear less directly on the interpretation of other words. Even in the case of readily interpretable nouns, we have to ask why adults should succumb to processes which degrade intelligibility at all. These processes may be widespread in speech to adults who have mastered their language and have mature strategies for interpreting discourse but speakers are not limited to a single register. Indeed, there is evidence that when syllables in A–C speech are accented they will have more discriminable vowels and more pronounced pitch change than analogous examples of A–A speech (Garnica, 1977; Bernstein Ratner, 1984; Fernald & Simon, 1984). Since so many features of A–C speech differ from A–A speech, why should the control of intelligibility, potentially so crucial for the child's linguistic bootstrapping, operate just as it does for A–A conversation?

The answer may lie in the relationship between the recognition of words and the understanding of the discourse in which they occur. When dealing with word tokens which would be difficult to identify in isolation, adults certainly make use of linguistic context. It has recently been suggested that it is not just the recognition of words which profits from this process, but that the comprehension of the discourse as a whole is furthered when context is consulted to aid recognition.

The first demonstration of this relationship comes from an experiment in which Fowler & Housum (1987) interrupted a recorded monologue from time to time to present a pair of excerpted word tokens. Adult subjects were to judge whether they had heard either word in the foregoing passage. In the critical trials, the first test word was either the token of a word recently heard or a later, not yet heard, token of the same word. The second test word was closely related to the earlier token in the immediately preceding part of the passage. Fowler & Housum found that the second token of the repeated

word, which subjects had never heard before, was a better prompt than the first, clearer, recently heard token: the related word was recognized faster after the second token. Fowler & Housum proposed that the degraded pronunciation of repeated words signals the fact that they refer to items already given in discourse. Their phonological character helps them to be properly understood.

Bard, Cooper, Kowtko & Brew (1991) showed that it was not the status of a word as first or second token which changed its efficacy as a prompt but rather its intelligibility. In the same sort of paradigm as Fowler & Housum had used, second tokens did not uniformly prime related words better than first. Instead, the harder the prime was to recognize, either because of its form or because of added noise, the better it worked in 'activating' the listeners' memory for a word related in recently heard context. Bard *et al.* argued that it is the use of context to aid recognition of the less intelligible words in running speech, rather than some later decision about the status of these items, which associates degraded word tokens with stored information.

Let us suppose that children's speech perception and understanding work analogously to adults'. Less intelligible word tokens will not be recognized without contextual support. Incomplete mastery of the language's syntactic structure means that this formal level offers less relevant information than it would to adults. A proportionately greater role must be played by other pertinent material. Part of this will be found in the foregoing discourse. Yet children's failure to attend consistently to parental speech suggests that referential processes like the ones underlying the adult probed recall results will not be as efficient for younger children. Fortunately, the contingent nature of A–C speech means that much crucial information for interpreting it lies in its non-linguistic surroundings. Were a child always able to recognize the words on the basis of their sound alone, there would be no pressing need to attend to what is happening outside the linguistic signal, and as Experiment 3 showed, little profit. A child might be best attending to the speech or to the surroundings but not simultaneously to both. We suggest that the relative unintelligibility of A–C speech serves to force the child to attend to his/her surroundings, as it forces adult listeners to attend to their understanding of prior discourse, and at the same time allows the distribution of attention to yield success. Just as adults might need to 'follow' a monologue to interpret certain words in it, children might need to 'follow' the extra-linguistic situation as the adult makes reference to it.

Once the child is attending to both speech and its non-linguistic circumstances, s/he may well find clues to the interpretation of the speech – in terms both of the words which are said and of the meanings which utterances represent. At the very least, the contextually provided interpretation of an utterance will help the child understand the current utterance. At best, it will aid in the acquisition of new words and of the grammar itself, for it is claimed

that the ability to form associations between linguistic forms and their interpretations may be vital to the acquisition of a first language (Pinker, 1979; Wexler & Culicover, 1980; Pinker, 1989). Something more than the positive examples provided by adult utterances is needed to correct any overly general grammar which the child might induce from them. Like negative feedback on unacceptable utterances (see Bohannon & Stanowicz, 1988; Bohannon, MacWhinney & Snow, 1990), interpretations of linguistic input can serve this constraining role. The extra-linguistic context of an A–C utterance is so often the situation which it represents that attending to both utterance and context gives access to the basis for the needed interpretation. However the interpretation is developed and however matches are made between sentence parts and interpretations, the unintelligibility of speech to children may encourage children to form the necessary associations between interpretation and utterance which will support and streamline acquisition.

REFERENCES

Bard, E. & Anderson, A. (1983). The unintelligibility of speech to children. *Journal of Child Language* **10**, 265–92.

Bard, E., Cooper, L., Kowtko, J. & Brew, C. (1991). Psycholinguistic studies on the incremental recognition of speech: an introduction to the messy and the sticky. Deliverable R1.3B, DYANA, ESPRIT Basic Research Action BR3175.

Bard, E., Lowe, A. & Altmann, G. (1989). The effects of repetition on words in recorded dictations. *Proceedings of EUROSPEECH '89* **2**, 573–6.

Bernstein Ratner, N. (1984). Pattern of vowel modification in mother–child speech. *Journal of Child Language* **11**, 557–78.

—— (1987). The phonology of parent–child speech. In K. Nelson & A. van Kleeck (eds), *Children's language*, Vol. 6. Hillsdale, NJ: Erlbaum.

Bohannon, J. & Stanowicz, L. (1988). The issue of negative evidence: adult responses to children's language errors. *Developmental Psychology* **24**, 684–9.

Bohannon, J., MacWhinney, B. & Snow, C. (1990). No negative evidence revisited: beyond learnability or who has to prove what to whom. *Developmental Psychology* **26**, 221–6.

Broen, P. (1972). *The verbal environment of the language-learning child.* The American Speech–Language–Hearing Association Monograph 17.

Charles-Luce, J. & Luce, P. (1990). Similarity neighbourhoods of words in young children's lexicons. *Journal of Child Language* **17**, 205–15.

Clark, H. & Haviland, S. (1977). Comprehension and the given–new contract. In R. Freedle (ed.), *Discourse processes: advances in research and theory*, Vol. 1. Norwood, NJ: Ablex.

Cole, R. & Jakimik, J. (1980). A model of speech perception. In R. Cole (ed.), *Perception and production of fluent speech.* Hillsdale, NJ: Erlbaum.

Fernald, A. (1984). The perceptual and affective salience of mothers' speech to children. In L. Feagans, C. Garvey & R. Golinkoff (eds), *The origins and growth of communication.* Norwood, NJ: Ablex.

Fernald, A. & Simon, T. (1984). Expanded intonation contours in mothers' speech to newborns. *Developmental Psychology* **20**, 104–13.

Fowler, C. (1988). Differential shortening of repeated content words produced in various communicative contexts. *Language and Speech* **28**, 47–56.

Fowler, C. & Housum, J. (1987). Talkers' signaling of 'new' and 'old' words in speech and listeners' perception and use of the distinction. *Journal of Memory and Language* **26**, 489–504.

Fowler, C. & Levy, E. (1991). Some ways in which forms arise from functions in linguistic communications. *Proceedings of the XIIth International Congress of Phonetic Sciences* **1**, 279–82.

Garnica, O. (1977). Some prosodic and paralinguistic features of speech to young children. In C. Snow & C. Ferguson (eds), *Talking to children*. Cambridge: C.U.P.

Hoff-Ginsburg, E. (1986). Function and structure in maternal speech: their relation to the child's development of syntax. *Developmental Psychology* **22**, 155–63.

—— (1990). Maternal speech and the child's development of syntax: a further look. *Journal of Child Language* **17**, 85–99.

Hunnicutt, S. (1985). Intelligibility vs. redundancy – conditions of dependency. *Language and Speech* **28**, 47–56.

Kemler-Nelson, D., Hirsh-Pasek, K., Jusczyk, P. & Cassidy, K. (1989). How the prosodic cues in motherese might assist language learning. *Journal of Child Language* **16**, 55–68.

Lieberman, P. (1963). Some effects of the semantic and grammatical context on the production and perception of speech. *Language and Speech* **6**, 172–5.

Marslen-Wilson, W. (1987). Functional parallelism in spoken word recognition. *Cognition* **25**, 71–102.

Marslen-Wilson, W. & Welsh, A. (1978). Processing interactions and lexical access during word recognition in continuous speech. *Cognitive Psychology* **10**, 29–63.

Messer, D. (1980). The episodic structure of maternal speech to young children. *Journal of Child Language* **7**, 29–40.

Newport, E. (1976). Motherese: the speech of mothers to young children. In N. Castellan, D. Pisoni & D. Potts (eds), *Cognitive theory*, Vol. 2. Hillsdale, NJ: Erlbaum.

Newport, E., Gleitman, H. & Gleitman, L. (1977). Mother, I'd rather do it myself: some effects and non-effects of maternal speech style. In C. Snow & C. Ferguson (eds), *Talking to children*. Cambridge: C.U.P.

Pinker, S. (1979). Formal models of language learning. *Cognition* **7**, 217–83.

—— (1989). *Learnability and cognition : the acquisition of argument structure*. Cambridge, MA: MIT.

Phillips, J. (1973). Syntax and vocabulary of mothers' speech to young children: age and sex comparisons. *Child Development* **44**, 182–5.

Pollack, I. & Pickett, J. (1963). The intelligibility of excerpts from conversation. *Language and Speech* **6**, 165–71.

Prince, E. (1981). A taxonomy of given–new information. In P. Cole (ed.), *Radical pragmatics*. New York: Academic Press.

Remick, H. (1976). The maternal environment of linguistic development. Unpublished doctoral dissertation, University of California at Davis.

Ringler, N. (1973). Mothers' language to their children and to adults over time. Unpublished doctoral dissertation, Case Western University.

Sachs, J. (1977). The adaptive significance of linguistic input to prelinguistic infants. In C. Snow & C. Ferguson (eds), *Talking to children*. Cambridge: C.U.P.

Snow, C. (1972). Mothers' speech to children learning language. *Child Development* **43**, 549–65.

—— (1977). Mothers' speech research: from input to interaction. In C. Snow & C. Ferguson (eds), *Talking to children*. Cambridge: C.U.P.

—— (1986). Conversations with children. In P. Fetcher & M. Garman (eds), *Language acquisition* (2nd edn.). Cambridge: C.U.P.

Terken, J. & Nooteboom, S. (1987). Opposite effects of accentuation and deaccentuation on verification latencies for given and new information. *Language and Cognitive Processes* **2**, 145–63.

Treiman, R. & Breaux, A. (1982). Common phoneme and overall similarity relations among spoken syllables: their use by children and adults. *Journal of Psycholinguistic Research* **11**, 569–98.

Wexler, K. & Culicover, P. (1980). *Formal principles of language acquisition*. Cambridge, MA: MIT.