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Visual Signals and the Communication Abilities of Children

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The communication abilities of children of differing ages (4-, 6-, and 11 years) were compared. The children performed two communication tasks and were interviewed in both face-to-face and audio-only contexts. While older children adapted to the loss of visual signals the younger age groups did not and their communication suffered. It appears that a significant amount of information which young children transmit occurs in a non-verbal format, and that visual signals are less demanding for young listeners. Such findings have implications for professionals working with young children since they show the importance of addressing both the child's visual signals and one's own.

Keywords: Communication, Visual, Gesture, Audio-only

Understanding the development of communication skills is central to being able to communicate effectively with children. We must be aware of both their abilities and limitations in order to do this. When investigating communication skills one must study both verbal and non-verbal phenomena, and how these interact to produce a set of efficient communication strategies.

Adults are on the whole, practised communicators who can adjust their communicative strategies to cope with different communicative media and can, therefore, maintain their task performance regardless of the availability of visual signals (for example, Chapanis, Ochsman, Parrish & Weeks, 1972; Williams, 1977). However, the presence or absence of visual signals does affect the process of communication. Boyle, Anderson and Newlands (1994) found that while the same level of task performance was maintained regardless of the availability of visual signals, significantly more words and turns were required for pairs of adult subjects to accomplish a problem-solving communication task in an audio-only context compared with face-to-face interaction. There is therefore, considerable evidence for the importance of the information transmitted by visual signals in the communication process.

Children may be particularily dependent upon non-verbal signals in their communication attempts. One important aspect of the non-verbal channel is gestures. Goldin-Meadow, Wein and Chang (1992) found that, when explaining their reasoning on conservation tasks, children transmit information via hand gestures which they do not verbalize. Goldin-Meadow et al. suggest that when children attempt to convey difficult material they often transmit some of it in gesture form only, showing that at some level they understand the material but cannot yet verbalize it.

Further evidence that gesture is an important source of information, for adults as well as children, comes from the work done by Cassell, McNeill and McCullough (1994). McNeill (1992) showed that there is a close semantic and pragmatic relationship between gesture and speech. Cassell et al. showed that this is taken into account by listeners with information transmitted via gesture being incorporated into listeners' mental representations.

It is suggested that gestural and speech material have different complexities, and that young children process the less demanding information (Feyereisen & de Lannoy, 1991; Church & Goldin-Meadow, 1986). Gestures may therefore help the communication process in the following ways; by aiding speech production and decreasing processing demands for speakers, and by easing interpretative demands for listeners.

It is important for professionals assessing what a child understands or knows to assess the information which children send in their non-verbal behaviour. In this vein, Rich (1968) points out the importance of both the non-verbal signals which the child sends and those sent by the professional when interviewing children. He emphasizes the wealth of information which may be available in behavioural cues which may never be expressed verbally by a child who either does not have the verbal ability, or who is embarassed or shy.

The referential communication paradigm developed by Glucksberg, Krauss and Weisberg (1966) has been used in many studies of children's referential communication skills. The basic paradigm involves one person describing a referent object to another person, in such a way that the second person can pick out the target object from an array of possible referents. The number of correct choices is then taken as a measure of communicative outcome. The communicative process, for example how effectively children deal with referential

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ambiguities, has also been extensively studied in this field.

Pechman and Deutsch (1982) found that the use of pointing gestures in the accomplishment of a referential communication task changed with age. Four-year-olds still use such pointing when referring to distant objects surrounded by other potential targets, making pointing ambiguous. In contrast, 9-year-olds and adults prefer to name referents in such contexts, although they were just as likely to use pointing when referring to near referents and if the context was less potentially ambiguous. This suggests that it is not just isolated linguistic or non-verbal skills which are lacking in young children, but a lack of pragmatic knowledge about how to use such communicative tools effectively.

A general conclusion from work in this area is that referential communication improves with age. Explanations for the poorer referential abilities of younger children range from language limitations (Asher & Wigfield, 1981), to cognitive restrictions (for example Glucksberg, Krauss & Weisberg, 1966; Asher & Parke, 1975). It is therefore predicted that if visual signals are less cognitively demanding, and children are able to represent knowledge gesturally before verbalizing it (as discussed above), then visual signals will play a particularly important role in the communication attempts of young children.

The present experiments show that young children's communication abilities are affected by their access to visual signals. We report three studies, the first compares 6- and 11-year-olds' performance with adult performance on a collaborative communication task in both face-to-face and audio-only contexts. The second study investigates the referential abilities of 3- to 4-year-olds, using an adaptation of the original Glucksberg and Krauss task (Glucksberg et al., 1966) in both communicative contexts. The motivation behind the second study was to investigate whether the impact of visual signals on communicative outcome would be greater for subjects with more limited linguistic abilities. The third study investigates how the visual channel influences the efficiency of interviewing these young children.

Experiment 1

Church and Goldin-Meadow (1986) propose that non-verbal signals require less processing capacity, and will be used in place of verbal messages when children are acting within their zone of proximal development (Vygotsky, 1934:1962). Shatz (1977) suggests that communicative development involves the learning of "information-handling techniques". As these become better learned, tasks become easier and require less processing capacity. Communication tasks will therefore present greater problems to the younger children than the older, and non-verbal signals will be more prevalent in their communication. It is therefore, for present purposes, advantageous to use the same task in the different age groups, in order to see the relative effects which visual signals have on communicative outcome.

The collaborative approach to communication (e.g. Clark & Wilkes-Gibbs, 1986) proposes that communicative outcome is the result of the unique collaboration between individuals in interaction. This is the approach taken here where the dialogue pair is the unit of analysis. Task performance reflects the efficiency of communication between the pair, which is the result of both speaker and listener behaviour. The primary aim of this paper is to investigate the differences which occur in collaborative interaction between face-to-face and audio-only communication, and how these differences are affected by the age of the participants. The measure of communicative success, in both communication tasks used, is a result of Instruction Follower action. That action will, however, be directly influenced by the Instruction Giver's quality of input, and the Instruction Follower's ability to response appropriately in order to establish mutual understanding.

The Map Task (Brown, Anderson, Shillcock & Yule, 1984) was the preferred task since a large corpora of adult Map Task dialogues were already available with which to make comparisons. Six-year-olds were taken as the youngest group since pilot work had shown that this is the youngest age group with which the Map Task is an appropriate communication task. The 11-year-old age group was chosen since it was expected that there would be significant developmental differences between this age group and the 6-year-olds. This Map Task is a demanding one for children as young as 6 years of age, particularily since the map features have written labels. This may affect comparisons between older and younger children. However, the emphasis in the present paper is on the differing ways in which children of different age groups deal with face-to-face and audio-only communication. It is therefore comparison between these different contexts which is of primary importance here.

Method

Subjects. Twenty 6-year-olds (age range 5;8–6;7, mean = 6 years), and twenty-four 11-year-olds (range 10;3–11;2, mean = 11 years), from Glasgow Primary schools, served as subjects. Parental consent was obtained and the children were brought to a recording studio in Glasgow University for testing. The data from one pair of 11-year-olds is not included in the gesture and verbal contributions results since part of this data was lost during recording due to a technical fault.

Design. A mixed design was used, with Visibility Context a within-subjects factor (each pair of subjects completed the task in both the face-to-face and the audio-only condition), and Age a between-subjects factor. Half the pairs did the face-to-face condition first, half the audio-only.

Task. The task used was the Map Task which elicits natural, spontaneous and yet content-controlled dialogues. Two pairs of maps were used each consisting of an Instruction Giver and an Instruction Follower map (see Fig. 1). The map landmarks were portrayed as line drawings and the maps themselves were reproduced on A3 sized paper (297×420 mm). The maps were identical to maps used by Boyle et al. (1994) in terms of complexity. The only difference was that the present maps had features which were labelled with words which young children would find easier to read. For example a

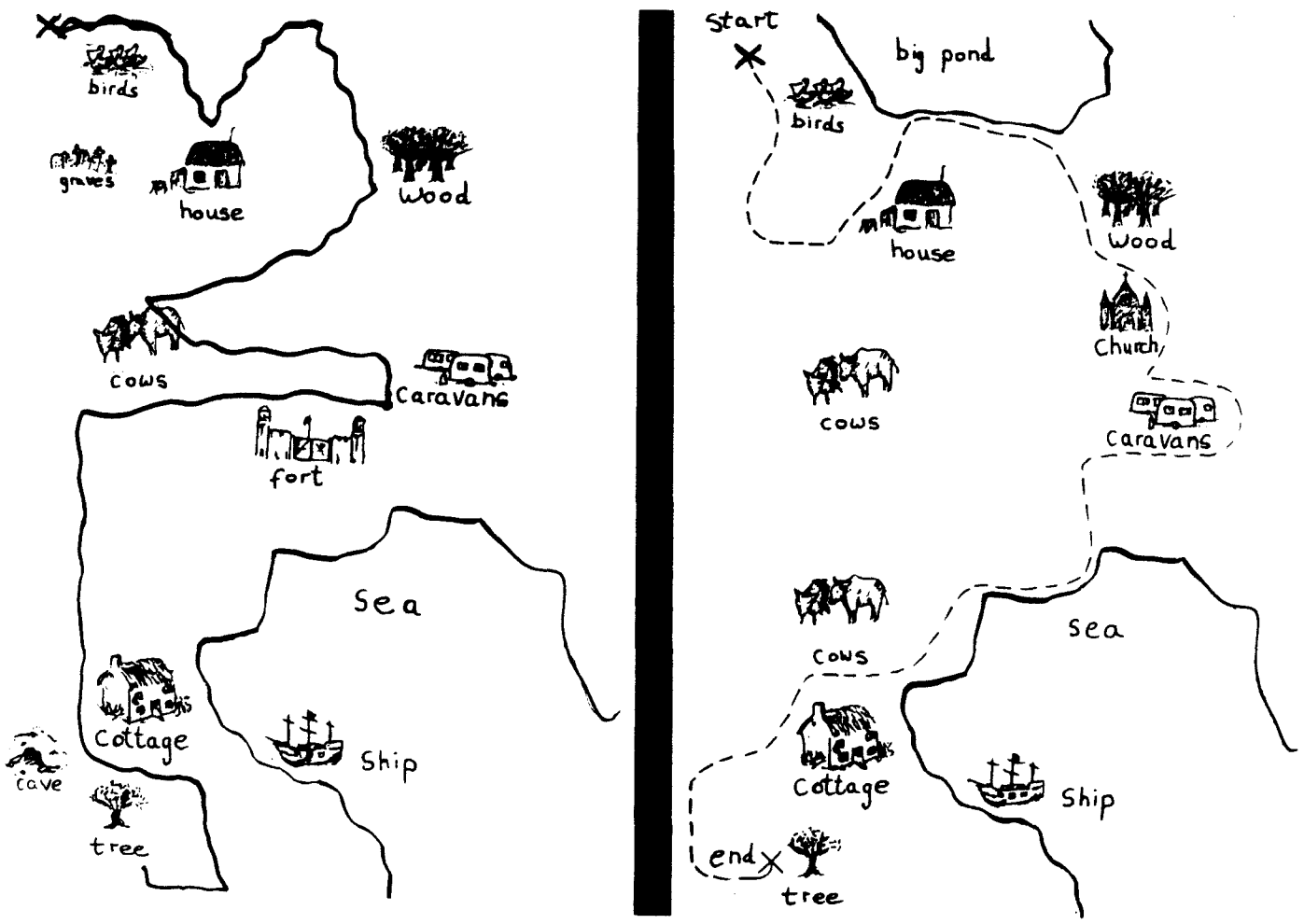

Figure 1. Instruction Giver and Instruction Follower Maps. The right hand side of the figure shows an Instruction Giver Map and the left hand side shows a completed corresponding Instruction Follower Map.

feature labelled on the children's maps as "hut" was called "thatched mud hut" on the adult maps.

Each map in a pair shows a start point, but only the Instruction Giver's map has the route and the finish point marked. There are a number of features common to both maps but also a number of features which differ, for example, because they are present on only one participant's map, or because they are in differing locations. Such discrepancies between the maps were incorporated into their design in order to produce points of communicative difficulty. Subjects are told that the aim of the task is for the Instruction Giver to tell the Instruction Follower about the route so that he or she can reproduce it on his or her map as accurately as possible. They are informed that there may be differences between the maps.

A useful feature of the Map Task is that it provides an objective, quantifiable measure of communicative success. By calculating the area (in cm^2) between the original "correct" Instruction Giver route and the route which is drawn by the Instruction Follower, a map deviation score is produced for each dialogue. The larger the deviation score for a map the poorer the performance of that dialogue pair.

Procedure. While doing the task subjects sat facing one another about 3 feet apart with their maps resting on a 2-way easel between them. One subject was assigned the role of Instruction Giver, the other the role of Instruction Follower. In the face-to-face condition the subjects could see one another's faces and upper bodies. In the audio-only condition a cardboard screen was erected between them and adjusted to block their views of one another's face.

All of the dialogues were recorded on a DAT (Sony DTC1000ES) using Shure SNIOA microphones. The interactions were also video-recorded using two cameras (one for each subject, JVC 880E). Inputs from these cameras were mixed using a vision mixer (JVC KM2500) and recorded on a VHS video recorder (JVC BR-S810E).

Video analysis. Communicative gestures were coded from the video recordings of the interactions. The angle of the easel meant that it was impossible for the children to see each other's hands unless they raised them in a deliberate attempt. When hands were raised in order to "show" a gesture to a partner this was coded as a communicative gesture. Two coders independently coded a dialogue for gesture and agreed on 95% of incidences that a gesture had occurred and whether it was deliberately communicative. This definition of gesture includes only part of the overall gesturing behaviour observed, but it is appropriate here because the focus of the present study is to attempt to quantify how much information is transmitted from sender to receiver in gesture, and this can only happen if the receiver witnesses the gesture.

Results

*Task performance.** A square root transformation was carried out on the deviation scores. (The means are presented in Table 1). A 2-way ANOVA was used with

*The performance and gesture data reported in Experiment 1 was presented at the Child Language Seminar, 1993, and is reported in Doherty-Sneddon (1993).

Table 1
Communicative Performance and Gesture Data in Face-to-Face and Audio-Only Interaction for 6- and 11-Year Olds.

	Face-to-Face 6-year-olds	Audio-Only 6-year-olds	Face-to-Face 11-year- olds	Audio-Only 11-year-olds
Performance (Deviation Score)	252 cm^2 (*SD* = 54)	360 cm^2 (*SD* = 113)	243 cm^2 (*SD* = 81)	203cm^2 (*SD* = 72)
Gesture (per 100 words)	2.29 (*SD* = 3.5)	2.46 (*SD* = 3.49)	2.31 (*SD* = 1.73)	0.4 (*SD* = .6)

one between-subjects factor, Age (2 levels: 6-year-olds and 11- year-olds), and one within-subjects factor, Visual Context (two levels: face-to-face and audio-only).

The deviation scores ranged between 35 cm^2 and 558 cm^2 with a mean of 255 cm^2. A significant effect of Age was found, $F(1,20) = 7.46$, $p < .05$. The 6-year-old Instruction Follower routes deviated from the Instruction Giver routes around 39% more than the 11-year-olds.

A significant interaction between Age and Visual Context was found, $F(1,20) = 6.57$, $p < .05$. Simple effects analyses showed that there was no difference in performance between the age groups when interacting face-to-face, but the 6-year-olds did much worse when they were communicating in the audio-only context, $F(1,40) = 14.02$, $p < .01$. The 6-year-olds' performance was significantly worse in the audio-only context compared to their own face-to-face performance, $F(1,20) = 5.37$, $p < .05$.

In summary, 6-year-olds can communicate as effectively about the Map Task as 11-year-olds when interacting face-to-face, however, they cannot adjust to the audio-only context in the way that 11-year-olds do, and their task performance suffers. Boyle et al. (1994) report that the mean score for adult subjects on this task was 61 cm^2 and that there was no change in task performance between face-to-face and audio-only communication. Adults therefore perform this task better than either group of children and like the 11-year-olds can adapt to audio-only interaction.

The fact that 11-year-olds do no better than 6-year-olds in face-to-face interaction is rather surprising given the expectation that their communication skills would be more developed. (Other referential studies would predict differences in communicative ability between these age groups, for example Glucksberg & Krauss, 1967; Lloyd, 1992.) This is however, an age at which many aspects of cognition undergo change, as children move into formal operations (Piaget, 1926).

Communicative gesture. A 2-way ANOVA was carried out with Age, a between-subjects factor (two levels: 6 years and 11 years), and Visibility Context, a within-subjects factor (two levels: face-to-face or audio-only). The dependent variable was the frequency per 100 words with which speakers used communicative gestures. The count of communicative gestures is based upon both participants. Means are shown in Table 1.

Visibility Context had a significant effect on the frequency with which communicative gestures were used, $F(1,19) = 5.61$, $p < .05$. Simple effects analyses showed that this was significant only for the 11-year-old subjects, $F(1,19) = 11.34$, $p < .05$. The frequency of gestures did not change between contexts for the 6-year-olds.

As a comparison, 16 dialogues from the corpus which Boyle et al. (1994) analysed (Anderson et al., 1991) were coded for communicative gesture. Eight of these were face-to-face conversations and eight were audio-only. In face-to-face interaction adults used only 0.25 communicative gestures per 100 words, and they never used such gestures in audio-only conversations. The number of communicative gestures used by the adults was therefore negligible.

Verbal contributions. The dependent measures of verbal contributions made by the participants were chosen to correspond with those used to investigate adult Map Task dialogues (Boyle et al., 1994). Boyle et al. found that adults took significantly more words and turns, and produced significantly longer turns when they could not see one another. These effects are now investigated in children's Map Task dialogues.

Number of words. The measure of the number of words used includes repeated words and fillers, (fillers represent only 0.5% of the total number of words and do not differ in frequency between face-to-face and audio-only conversations). A three way ANOVA was carried out with Age (6 years and 11 years) and Task Role (Instruction Giver and Instruction Follower) between-subjects variables. Visibility Context was a within-subjects variable. There were no significant main effects or interactions. The means are presented in Table 2. This shows that Visibility Context has no effect on dialogue length.

Boyle et al. (1994) found that Instruction Givers play a significantly more dominant verbal role in the task than

Table 2
Mean Number of Words and Turns Produced by 6- and 11-Year-Olds in Map Task Dialogues: Face-to-Face and Audio-Only Interaction

	N Words Face-to-Face	*N* Words Audio-Only	*N* Turns Face-to-Face	*N* Turns Audio-only
6-year-old (IGs)	253 (*SD* = 185)	289 (*SD* = 215)	39.3 (*SD* = 35)	48.2 (*SD* = 59)
6-year-old (IFs)	199 (*SD* = 180)	244.8 (*SD* = 292)	39.2 (*SD* = 35)	47.7 (*SD* = 59)
11-year-old (IGs)	393 (*SD* = 410)	379 (*SD* = 313)	40.9 (*SD* = 54)	45.9 (*SD* = 48)
11-year-old (IFs)	184 (*SD* = 294)	176 (*SD* = 214)	40.8 (*SD* = 54)	45.2 (*SD* = 48)

Instruction Followers (Boyle et al., 1994). This was investigated in the two groups of children. If the 6-year-old Instruction Givers are transmitting information gesturally, which is not verbalized, then it would be expected that they would produce relatively smaller verbal contributions.

Planned comparison *t*-tests were therefore carried out on the child data. As expected six 6-year-old Instruction Givers and Followers produced equivalent numbers of words, (271 and 220 per dialogue, respectively). In contrast 11-year-old Instruction Givers produced significantly more words than their Instruction Followers in both face-to-face and audio-only interaction ($t(38) = 3.78$, $p < .05$; $t(38) = 3.84$, $p < .05$, respectively). The results suggest that the way in which the communication task is tackled is more similar between adults and 11-year-olds than between adults and 6-year-olds.

Number of turns. A 2-way ANOVA was carried out on the number of turns produced in each dialogue. Age was a between-subjects factor (two levels; 6 years or 11 years), and Visibility Context was a within-subjects factor (two levels; face-to-face and audio-only). Means are presented in Table 2. No significant effects were found although there was a trend in both age groups for an increase in the number of turns spoken in the audio-only context (a 22% increase for the 6-year-old pairs, and a 13% increase for the 11-year-old pairs). This is in agreement with the pattern of adult results reported by Boyle et al. (1994). Adults were found to take significantly more conversational turns to accomplish the Map Task in audio-only interaction.

Words per turn. A 3-way ANOVA was carried out on the mean number of words per turn for each participant in each dialogue. Age and Task Role were between subjects factors (Age two levels: 6 years or 11 years; Task Role two levels: Instruction Giver or Instruction Follower). Visibility Context was a within-subjects factor (two levels: face-to-face and audio only).

Visibility Context did not affect the mean length of turns for either age group. The was a significant effect of Task Role, $F(1,34) = 18.85$, $p < .001$, with Instruction Givers using longer turns (9.1 words per turn) than Instruction Followers (4.6 words per turn). Finally there was a significant interaction between Age and Task Role, $F(1,34) = 4.2$, $p < .05$. Simple effects analyses revealed that the above Task Role effect only held for the 11-year-old pairs. The more dominant role of Instruction Givers which is reported for adult pairs (Boyle et al., 1994) in terms of words per turn, is therefore found for 11-year-olds but not for 6-year-olds. Planned comparisons *t*-tests also showed that the 11-year-old Instruction Giver turns were significantly longer than the 6-year-old Instruction Givers' (face-to-face: $t(34) = 3.74$, $p < .05$; audio-only $t(34) = 2.42$, $p < .05$). The following extracts are examples of the beginnings of face-to-face dialogues between 6-year-olds (extract 1) and 11-year-olds (extract 2).

Extract 1: A = Instruction Giver 1; B = Instruction Follower 1

(A): Nicholas?
(B): Yes.
(A): Up from the top.
(B): At the tree? Come on that's dead up at the top.
(A): Right so at the top left corner.
(B): That way?
(A): Yeah. Right a wee curved line down.

Extract 2: C = Instruction Giver 2; D = Instruction Follower 2

(C): Right, start off, right start right you go east–south, a little east–south, that way to near the birds then curve round to your, to the south, down south and a little to the west in a curve. Then round past the house. Have you got a house on that?
(D): Uh huh.
(C): Down past the house and go up near the big pond.
(D): I don't have a big pond.
(C): Up here!

The longer length of the 11-year-old Instruction Giver turns therefore, appears to reflect an increased complexity of their speech compared with that of the 6-year-old.

Discussion of Experiment 1

Six-year-old speakers perform more poorly on the Map Task when communicating in an audio-only context compared to face-to-face. Like adults (Boyle et al., 1994), 11-year-olds' performances are not affected by the absence of the visual channel. The 11-year-olds' level of performance does however fall short of the adults'. This contrasts with the findings of Lloyd (1991, 1992) who studied task-oriented interaction of different age groups communicating by telephone. He found that communicative outcome did not differ between 10-year-olds and adults, but that 7-year-olds performed more poorly than both of the older groups. One explanation for the discrepancy between the present study and Lloyds' in terms of task performance development is in terms of task demands. Lloyd's 10-year-olds and adults were near ceiling. The present Map Task may present higher task demands which results in the differential between 11-year-olds and adults.

The younger children use more communicative gesturing than the older children and adults in general and do not abandon this non-verbal strategy in the audio-only context. In contrast, although the 11-year-olds use communicative gestures in face-to-face conversation, they do not use this form of communication in the audio-only context. This shows that the older children are sensitive to the change in communicative medium and act upon this, the younger children do not have the communication skills available to do this.

McNeill (1992) suggests that when information is not presented verbally it is often presented non-verbally, and vice versa. The longer turn lengths of the 11-year-old Instruction Givers compared with that of the 6-year-olds suggests that 11-year-olds produce more complex speech. This adds further evidence that 6-year-olds are more dependent upon visual signals.

Experiment 2

The purpose of Experiment 2 was to investigate whether the face-to-face benefit found in Experiment 1 for the 6-year-olds would be found with younger

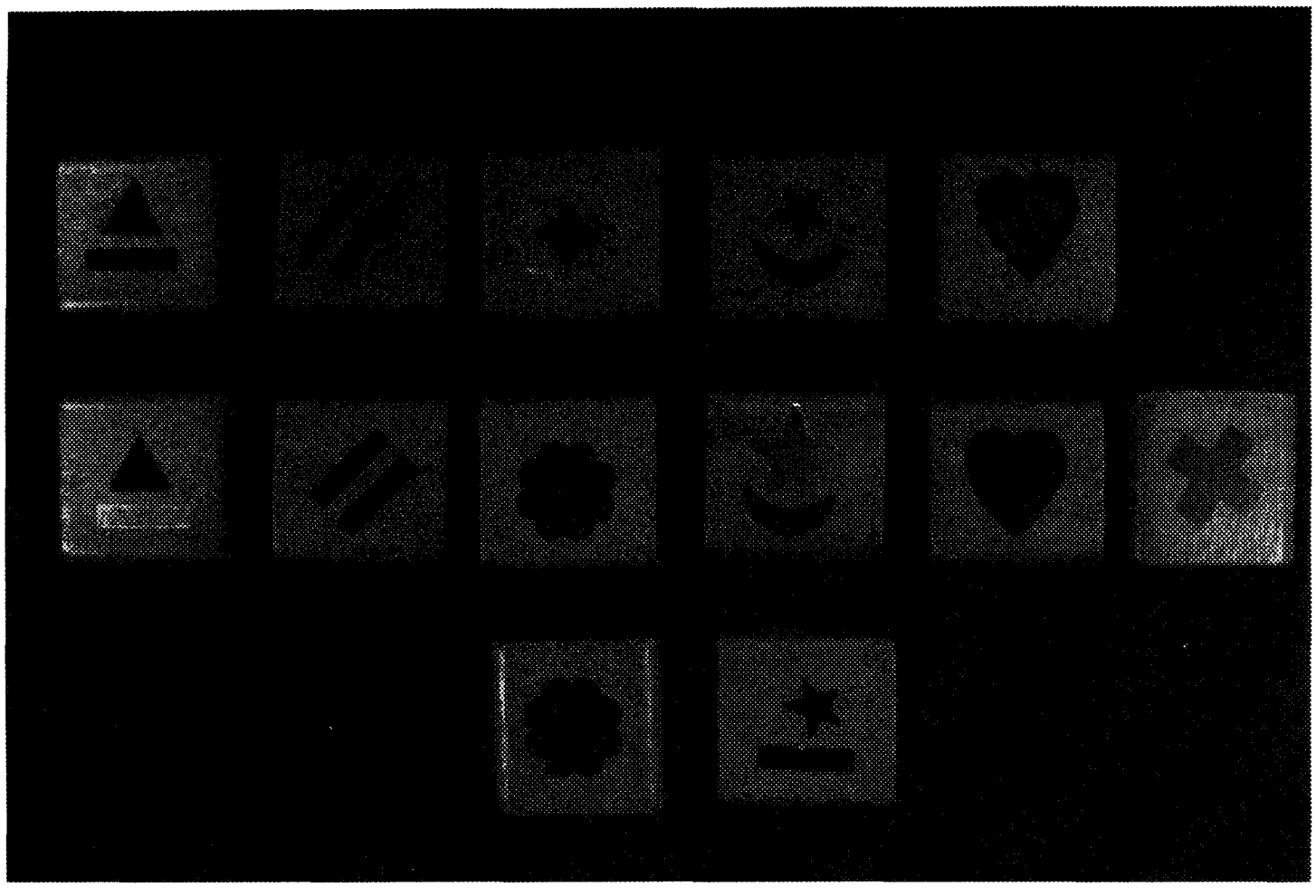

Figure 2. A set of Instruction Follower blocks used in Experiment 2. The top row are the target referents (the Instruction Giver's blocks match these 5). Below these are the filler blocks which are similar to the targets but differ in, for example the colour of an element of the pattern. There is one filler which is not related to the target blocks, in this case the cross to the right of the figure.

children using a different task. Earlier pilot work at Glasgow University had found that preschool children could not cope with the Map Task. A simpler referential task, the Glucksberg and Krauss task, was used.

Method

Subjects. Twenty-six 3- to 4-year-olds (mean age = 44.2 months, range: 36.5 – 54 months) from a resident playgroup in the Psychology department, University of Stirling, served as subjects.

Design. A within-subjects design was used with the pair as the unit of analysis. The subjects were paired, and each pair was tested in both the face-to-face and audio-only contexts (the order of the contexts was counter-balanced across the pairs).

Task. The task used was a variation of the referential task designed by Glucksberg, Krauss and Weisberg (1966). The stimuli used were carefully designed in order to present the children with a task which would be communicatively challenging, but which they could achieve with some effort.

The children were randomly assigned the role of Instruction Giver or Instruction Follower. The Instruction Giver was given a set of five blocks stacked in an opaque dispenser. The Instruction Follower had an array of 13 blocks in front of them, but to the side where they are occluded from the view of the Instruction Giver by a screen.

Each block had an individual design on one of its faces. See Fig. 2 for examples of these designs. The designs were chosen on the basis that the correct referent would not always be readily identifiable as some ambiguity would exist between two or more blocks in the Instruction Follower's array. The different shapes and colours meant that children of this age would find describing them a fairly demanding but not impossible task. Five of the Instruction Follower's blocks matched exactly the designs on the five blocks which the Instruction Giver possessed. The task involved the Instruction Giver removing his/her blocks one at a time from the dispenser and describing them to the Instruction Follower so that he/she could choose the correct matching block from their referent array. The Instruction Follower then placed the chosen referent into their own stacking container so that the order of choices could be later checked by the experimenter. There were three different sets of stimuli which were randomly used across the two conditions with no pair receiving the same stimulus set twice.

A low table was used and the children sat opposite one another. The table was sectioned in front of the children by a screen. In the face-to-face condition a section of this was removed so that they could see one another. Each child's materials were placed on the far side of a further screen to the left of the child and perpendicular to the central screen, so that the children could not see one another's test materials. The lower half of the central screen consisted of flaps which enabled the Instruction Follower to push his/her blocks through to the Instruction Giver, if they wished, in order to check if the correct one had been chosen.

Procedure. The children were brought to the testing room in pairs. They were introduced to the task by the

experimenter using practice blocks on which there were pictures of farm-yard animals. This was done to familiarise the children with the task itself without giving them practice describing the kinds of shapes they were about to use in the test proper. The children were informed that the Instruction Follower could pass blocks which they thought were correct through the "flap screen" so that the Instruction Giver could check whether the intended block had been selected. When the experimenter judged that the children had grasped the principle behind the task, the test proper began. If a pair obtained a very low score they were allowed to try again if they wished, up to a maximum of three trials in each context. Some pairs therefore completed only one trial per context while others did three.

All of the dialogues were recorded using two microphones (Sony F-V610) and a Sony TC-FX320 analogue tape deck.

Results

Task performance. The task score was the number of target referents (out of a possible five per trial) which were correctly chosen by the Instruction Follower. Although some pairs completed more than one trial per condition this did not improve performance. This was statistically tested using a by-trial analysis on the scores. A one-way ANOVA was used with one between-subjects factor, Trial Number [five levels; trials 1–5 (only one pair completed more than five trials between the two conditions)]. Performance did not change across trials. Furthermore, trial ordering did not differ between the face-to-face and audio-only conditions, the mean number of trials in the face-to-face conditions was 2.4, and for audio-only it was 2.2. There was therefore, no systematic advantage or disadvantage for either condition. The mean score for each pair in each context was therefore taken as the dependent variable in subsequent analyses.

A one-way ANOVA was carried out with Visibility Context a within-subjects factor (two levels: face-to-face and audio-only interaction). A significant effect of Context was found, $F(1,12) = 9.59$, $p < .01$. The children performed significantly better when they interacted face-to-face (mean score = 4.01) compared with audio-only conversation (mean score = 2.55). Four-year-olds therefore perform 54% better when they can see one another compared with when they cannot.

Verbal Contributions

Number of words. A two-way ANOVA was carried out with one between-subjects factor, Task Role (two levels; Instruction Giver and Instruction Follower), and one within-subjects factor, Visibility Context (two levels face-to-face or audio-only). The dependent variable was the mean number of words spoken by each subject in each condition.

A significant effect of Visibility Context was found, $F(1,22) = 4.22$, $p < .05$. The audio-only dialogues were significantly longer (mean = 147.3 words) than the face-to-face conversations (mean = 109.2 words).

Number of turns. A one-way ANOVA was carried out with the number of turns as the dependent variable, and Visibility Context a within-subjects factors. There was no significant difference between the two contexts, although there was a trend for an increased number of turns in the audio-only context, (mean face-to-face = 31 turns per dialogue, mean audio-only = 46 turns per dialogue).

Words per turn. A two-way ANOVA was carried out on the mean length of conversational turns produced by each participant. Task Role was a between-subjects factor (two levels: Instruction Giver or Instruction Follower), and Visibility Context was a within-subjects factor (two levels: Face-to-face and audio only). Visibility Context did not affect the mean length of turns. Task Role had a significant effect, $F(1,22) = 6.69$, $p < .05$, with Instruction Givers producing longer turns (7.18 words per turn) compared with Instruction Followers (4.43 words per turn). This illustrates the more dominant role, in terms of verbal effort, of the Instruction Givers in this task.

Discussion of Experiment 2

It has been found that the 4-year-olds' communicative performance is significantly affected by the presence or absence of visual signals. It appears that, as for the 6-year-olds in Experiment 1, visual signals play a central role in the communication of 4 year olds. Both of the younger age groups show increases in verbal material in the audio-only context (18% more words for 6-year-olds and 35% for 4-year-olds; 22% more turns for 6-year-olds, and 33% for 4-year-olds), this corresponds to the increased length of audio-only Map Task dialogues between adults reported by Boyle et al. (1994). The reason that this does not benefit the two younger groups of subjects may be that young listeners handle the processing of messages better when visual signals such as gesture, gaze, facial expression, and lip configuration, are available. This may be because of limited comprehension or because the verbal expressions of younger speakers are of insufficient quality without accompanying non-verbal signals. The 11-year-olds increase the number of conversational turns which they use in the audio-only context, but not the number of words. This reflects their use of rather long conversational turns in the face-to-face dialogues compared with those of the 6-year-olds. The older children therefore spread their more extensive verbal effort over more turns in the audio-only context.

Experiment 3

Experiments 1 and 2 both investigated the role which visual signals play in child–child task-oriented interaction. We wished to see whether visual signals would have similar effects in adult–child interactions. Furthermore we wished to move away from referential and problem-solving dyadic communication to the more applied communicative situation of an adult interviewing a child. It is likely that visual signals will play a rather different role during an "interview" situation than in a task-oriented interaction. When doing a communication task (as in Experiments 1 and 2), the task itself gives some structure to the interaction. Furthermore, there are

task materials which have to be attended to. Such considerations may over-ride aspects of visual signal functioning, for example in regulating interaction. In an interview the more social functions of visual signals may have greater importance. For example, Kleinke, Staneski and Berger (1975) found that interviewees gave longer responses and rated their interviewers more highly when the interviewers gazed relatively frequently compared with when gaze frequency was low.

There is evidence that young children do not perceive the social functions of visual signals in the way in which adults do. For example Scheman and Lockard (1979) found that younger children (18 months to 4 years) were less likely to avert their gaze, from staring at a strange adult, than older children (5–9 years). This suggests that the social conventions associated with gazing behaviour are not acquired until after 5 years of age.

We investigated whether this is the case. If social facilitation is a function served by visual signals in children's conversations it would be expected that the children will give more extensive responses when interacting face-to-face than in an audio-only context. It is therefore expected that fewer turns will be required to elicit the same amount of information in the face-to-face interviews compared with the audio-only interviews, and that conversational turns will be longer in the face-to-face interviews.

Method

Subjects. Twenty of the 3- to 4-year-old subjects that had taken part in Experiment 2 took part in Experiment 3 (mean age = 43.6 months; range: 36.5– 52 months). Data from one child is not included because it was later discovered that the child had not been well on the testing day.

Design. A between-subjects design was used. Each subject was interviewed once either face-to-face or in an audio-only context. Half were interviewed face-to-face, and half in the audio-only context.

Procedure. The subjects attend the playgroup which is situated within the Psychology Department of Stirling University. A staged incident paradigm was used (this is commonly used in empirical studies of recall during interview, for example Geiselman, Fisher, Firstenberg, Hutton, Sullivan & Prosk, 1984; Saywitz, Geiselman & Bornstein, 1992). Early in the day a confederate, dressed as a clown, visited the playgroup. The confederate was given a set protocol of things to do which were as follows:

(i) Say hello.
(ii) Juggle some coloured balls.
(iii) Inform the children that it was the clown's birthday but all her friends had forgotten.
(iv) Ask the children to sing Happy Birthday to the clown.
(v) Give all the children a colourful sticker.
(vi) Shake hands with each child.
(vii) Say goodbye.

During the same day the children were interviewed individually about the events which had taken place that morning. This was done either face-to-face across a table, or with a screen between the interviewer and the child. The interview continued until the interviewer had elicited all of the information about the clown's activities from the child, in other words, the child had told the interviewer about all seven events. The interview was in a semi-structured format. The interviewer had a set of questions about the different events, and these ranged from very general open questions to specific questions about events. The interviewer worked from the general to the more specific as necessary (this is a recognised technique for interviewing children, see for example, Timm, 1983; Saywitz, Geiselman & Bornstein, 1992). The criterion for ending an interview was that all seven events were recalled accurately. The measure of communicative success used here, is therefore, how many questions and conversational turns it took to reach that criterion. The number of questions was defined as the number of questions from the question set (including repetitions) which were asked.

All of the dialogues were recorded using two microphones (Sony F-V610) and a Sony TC-FX320 analogue tape deck. The interactions were also video-recorded on a Sony SLV-E70 video recorder, using two Panasonic F10 CCD VCT 650 cameras and a Panasonic Production Mixer.

Results

Number of questions. No difference was found between the face-to-face and audio-only interviews in terms of the number of questions which were required to elicit the desired information.

Number of turns. A one-way ANOVA with one between-subjects factor, Visibility Context (two levels), was carried out. The dependent variable was the number of conversational turns which occurred per interview. A significant effect of Visibility Context was found $F(1,17) = 7.93$, $p < .05$. It took significantly more conversational turns to elicit the same amount of information in the audio-only context (mean = 38.4) as it did in face-to-face interaction (mean = 27.4).

One reason for the shorter face-to-face interviews was the use of nonverbal responses (with no verbal accompaniment) by the children in the audio-only condition. The following is an extract from a face-to-face interview (extract 3).

Extract 3:

Interviewer: Did anything special happen at play group today?
Child: A clown
Interviewer: A clown? \{**child nods**\} Yes, OK. Did the clown do anything?
Child: Juggled
Interviewer: Juggled. Did the clown talk to you? \{**child nods**\} What did she talk about?
Child: Happy birthday
Interviewer: About happy birthday, yes. Anything else happen after that? Did the clown ask you to do something?
Child: No
Interviewer: Did the clown ask you to sing Happy Birthday? \{**child nods**\}Yes? OK.

Extract (3) illustrates an important difference between the face-to-face and the audio-only interviews. The child uses nodding without any verbal accompaniment on three occasions. The mean number of "non-verbal only" responses made in the face-to-face condition was 4.7 per interview. The mean number in the audio-only condition was 0.4 per interview. The information carried by nods and shakes of the head in the face-to-face interviews is therefore replaced by verbal utterances in the audio-only context.

Length of turns. The length of the children's conversational turns (in terms of words) was investigated in both visibility contexts. Turn length was not found to differ between the face-to-face (mean = 2.49 words per turn) and audio-only interviews (mean = 2.13 words per turn).

Discussion of Experiment 3

It takes fewer conversational turns to elicit the same amount of information from a child in face-to-face interaction compared with audio-only interaction. This suggests that visual signals facilitate interaction for children. The interviewer gained "yes", "no", and even "don't know" responses from the children in a non-verbal format only in face-to-face interaction (approximately every fourth turn was of this nature in the face-to-face interviews). This propositional information has a significant impact on the communicative process both in terms of the information it supplies and in terms of the structure of the verbal dialogue. This highlights that important information is lost if audio-only recordings of face-to-face interviews are relied upon. However, the second prediction made, that turns would be longer in face-to-face interaction, is not supported. The face-to-face benefit is therefore, not due to visual signals causing social facilitation and longer responses.

General Discussion

These experiments show that young children cannot communicate as effectively when visual signals are not available. This contrasts with adults and older children who maintain the same task performance in both face-to-face and audio-only communication. It appears that this is due in part to the younger children transmitting a significant amount of information non-verbally. In Experiment 1 the use of gesture to intentionally communicate information was found to be most prevalent for the younger subjects. In Experiment 3 non-verbal answering of questions was found to be a frequent strategy used in the face-to-face interviews which was replaced by verbal answering in the audio-only interviews. The following is an extract of a face-to-face Map Task dialogue between 6-year-olds. The underlined words represent speech which was accompanied by communicative gesture. The speech marked by * represents non-verbal vocalisations which were used to add affect to the gestures which they accompanied.

Extract 4: G = Instruction Giver 4; H = Instruction Follower 4

Turn 1(**G**): Ehm, now do three straight lines.
Turn 2(**H**): Straight?
Turn 3(**G**): Uh huh.
Turn 4(**H**): Like this?
Turn 5(**G**): No.
Turn 6(**H**): Like this, like this?
Turn 7(**G**): No * "dunk" "dunk" * straight down the way.
Turn 8(**H**): Down? Then * do do do *.
Turn 9(**G**): No, just three lines straight down the way, just three.

This example illustrates how poor the verbal attempts could be, and how poor the comprehension of the listener could be. The Instruction Giver wants the Instruction Follower to draw three straight lines vertically down. He does not at first specify that the direction is down. In Turn 4 the Instruction Follower shows that he has misinterpreted the instruction to mean horizontal straight lines when he accompanies his utterance with a gesture showing a horizontal line straight across. In Turn 5 the Instruction Giver says "No" and gestures straight lines vertically down the way, but has not yet verbalized the downwards information. The Instruction Follower then asks "Like this, like this?" while gesturing curving lines first vertically down and then horizontally across. The Instruction Giver repeats his instruction in Turn 7, this time verbalizing that the lines are to be drawn down the way, and again accompanies the utterance with gestures designating straight lines vertically down the way. The Instruction Follower is still confused and accompanies his utterance "Down?" with a downwards gesture, but accompanies "do, do, do" with horizontal curvey gestures. The exasperated Instruction Giver then repeats his instruction accompanying his verbal utterance with vertical downward gestures, and for the first time verbalizes all the relevant information.

The results support previous claims that non-verbal communicative strategies are easier for young children (e.g. Goldin-Meadow et al., 1992; Feyereisen & de Lannoy, 1991). The face-to-face benefit for young children may be due to two aspects of the communicative process given that young children have various language and cognitive limitations (Asher & Wigfield, 1981). First, the speaker finds it easier to convey information non-verbally and conveys information in his/her visual signals which is never expressed verbally. Second, the young listeners may find it easier to process visual signals than they do verbal messages, for example a shape drawn in the air may give them a more comprehensible representation of an object than a verbal description of that object. When the verbal descriptions are opaque the listener's difficulties will be compounded. We are not suggesting that children are better decoders of non-verbal information, indeed there is evidence that young children are less skilled non-verbal communicators than adults (Doherty-Sneddon, 1995). What is claimed is that, relative to linguistic expressions, gestures and other visual signals may be easier for children.

It has yet to be shown that young children have the

ability to alter their communication strategies in response to different communicative media and styles in the way which many adults can. In his book on how to interview suspected child abuse victims, Jones (1992) advises the interviewer that "direct gaze fixation is often too intrusive for children" (Jones, 1992, p.38), and that techniques should be employed which avoid this. The present results suggest that this may not help to elicit information from young children, since they seem to be especially dependent upon the informational cues in visual signals. Similarily, Otteson and Otteson (1980) found that children's recall of stories was better when the adult reader gazed at them while telling the story compared with when gaze did not occur.

A more specific application of the present findings is for the use of video mediated interviewing in court. Video links are now implemented in several courts in Britain to be used in cases where children are involved as witnesses (Davies & Noon, 1991; Murray, 1995). There is evidence that video mediated communication is not equivalent to face-to-face interaction for adults, and indeed may be more similar to audio-only communication (O'Connaill, Whittaker & Wilbur, 1993; O'Malley & Langton, 1994; Doherty-Sneddon, Anderson, O'Malley, Langton, Garrod & Bruce, under revision). The present results show that visual signals have a particular importance in the communication of young children. The question which must be answered is whether the visual signals provided by video links are an appropriate substitute.

In summary, visual signals play an important role in children's communication in two ways. First, children express information non-verbally which they find difficult to express verbally and this must be attended to. Second, young listeners may find it easier to process visual information, and verbal information which is accompanied by visual cues. Children communicate best in face-to-face interaction and do not cope well with a lack of visual signals. Both of these aspects of visual communication should be noted when communicating with, assessing and interviewing young children.

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