Child Development, November/December 2003, Volume 74, Number 6, Pages 1857 – 1868

Sources of Inflexibility in 6-Year-Olds' Understanding of Emotion in Speech

J. Bruce Morton, Sandra E. Trehub, and Philip David Zelazo

When utterances contain conflicting emotion cues, 6-year-olds judge emotion from content, even when instructed to judge emotion from paralanguage (Morton & Trehub, 2001). Two experiments examined the nature of this bias. In Experiment 1, priming paralanguage reversed 6-year-olds' normal bias to content. In Experiment 2, 6-year-olds were instructed to listen to paralanguage under various conditions. Children were more likely to follow instructions delivered with feedback than instructions delivered alone. Children who described conflicts between content and paralanguage were more likely to follow instructions than children who did not describe these conflicts. Results suggest that 6-year-olds can judge emotion from paralanguage in the presence of competing content but often remain focused on content because of the way they represent the instructions.

Young children are proficient at judging emotion from cues in speech. For example, 4-year-olds accurately judge emotion from descriptions of familiar situations (Borke, 1971) and from a variety of nonverbal or paralinguistic vocal cues including average vocal pitch, pitch change, pitch contour, and speaking rate (Dimitrovsky, 1964; Morton & Trehub, 2001).

Despite these early achievements, young children's understanding of emotion in speech continues to develop well into the school years. Most striking, young children often fail to use paralinguistic cues to emotion when it is appropriate to do so (Friend, 2000; Friend & Bryant, 2000; Morton & Munakata, 2002a; Morton & Trehub, 2001). In one study, 4- to 10-year-old children and adults were presented with utterances that contained conflicting emotion cues (e.g., "My mommy gave me a treat," spoken sadly), and were instructed to judge the speaker's feelings from the sound of her voice. The youngest children based their judgments almost exclusively on what the speaker said, whereas adults based their judgments on the speaker's paralanguage. Across the intermediate age groups, there was a gradual shift away from content and increasing attention to the speaker's paralanguage (Morton & Trehub, 2001). Similar findings have been reported in other studies (Friend, 2000; Friend & Bryant, 2000; Solomon & Ali, 1972; Solomon & Yaeger, 1969).

Young children's bias to content often persists in the face of elaborated instructions. After completing a task in which they judged a speaker's feelings on the basis of what she said, 6-year-olds were asked to switch and judge the speaker's feelings from the sound of her voice (Morton & Munakata, 2002a). To ensure that children understood the instructions, the experimenter engaged each child in a short dialogue about happy and sad voices, and had them label several examples of hummed paralanguage (i.e., paralanguage with no content). Although children remembered the instructions and provided correct labels for the hummed paralanguage, the majority continued to judge the speaker's feelings from what she said (Morton & Munakata, 2002a).

It is unclear why many 6-year-olds fail to use paralinguistic cues to emotion even when asked to do so. One reason might be the presence of conflicting content. When content is obscured (Friend, 2000; Morton & Trehub, 2001), uninterpretable (Morton & Trehub, 2001), or semantically neutral (Dimitrovsky, 1964), most 4-year-olds have little difficulty judging emotion from paralanguage. However, when the emotional implications of what is said conflicts with a speaker's paralanguage, children typically judge the speaker's feelings from what she says. Thus, it may be difficult for 6-year-olds to judge emotion from paralanguage whenever conflicting content is available.

Alternatively, children may have difficulty keeping the instructions in mind and using them to control their judgments. Children normally judge a speaker's utterances literally, based on the content of

J. Bruce Morton, Department of Psychology, University of Western Ontario; Sandra E. Trehub, Department of Psychology, University of Toronto at Mississauga; Philip David Zelazo, Department of Psychology, University of Toronto.

Funding for this research was provided by a grant from the National Sciences and Engineering Research Council of Canada to Sandra E. Trehub.

Correspondence concerning this article should be addressed to J. Bruce Morton, Department of Psychology, University of Western Ontario, London, ON, N6A 5C2 Canada. Electronic mail may be sent to bmorton3@uwo.ca.

 0009-3920/2003/7406-00018

the utterances. Therefore, when asked to judge emotion on the basis of a speaker's paralanguage, children may need actively to select the appropriate criteria (paralanguage) despite a prepotent tendency to select the usual criteria (i.e., content). According to the cognitive complexity and control theory (e.g., Frye, Zelazo, & Burack, 1998; Zelazo & Frye, 1998), this type of task is demanding because it requires children to reflect on the task structure and then formulate and use a higher order rule for selecting between two competing approaches to a problem. Age-related increases in reflection and rule use occur throughout childhood, and the use of higher order rules continues to be demanding even for adults (Zelazo, Craik, & Booth, 2003).

Another possibility is that difficulty keeping the instructions in mind is more a matter of memory than it is a matter of formulating and using higher order rules. According to this view (Morton & Munakata, 2002b; Munakata, Morton, & Stedron, 2003), the likelihood of using the instructions is determined jointly by the strength of the representation of the instructions in active memory and the strength of a conflicting latent bias to judge on the basis of content. Thus, age-related limitations on the strength of representations in active memory could cause 6-year-olds to rely on content rather than paralanguage.

Unfortunately, the available evidence cannot distinguish between these explanations. Accordingly, the purpose of the present experiments was to investigate why 6-year-old children often judge emotion from the content of a message when instructed to do so on the basis of paralanguage. To determine whether children have difficulty using paralanguage in the presence of conflicting content or whether their judgments reflect the relative salience of content and paralanguage, Experiment 1 examined the effects of priming on subsequent judgments. If children's judgments reflect the relative salience of content and paralanguage, it may be possible to manipulate this salience experimentally through the use of priming. Experiment 2 used a rule-use paradigm to explore further the circumstances in which 6-year-olds have difficulty switching the basis of their judgments from content to paralanguage in response to a verbal directive.

Experiment 1

This experiment examined the effect of priming paralanguage on 6-year-olds' judgments of utterances with emotional content and the effect of priming content on 6-year-olds' judgments of paralanguage. There were two blocks of trials: a neutral content block containing utterances with emotionally neutral content spoken with happy or sad paralanguage, and an emotional content block containing utterances with emotional content (happy or sad) spoken with either happy or sad paralanguage. Two conditions were created by presenting these blocks in counterbalanced order. Thus, half of the children received the neutral content block before the emotion content block (Condition 1), and half received the emotion content block before the neutral content block (Condition 2).

The effect of priming was assessed by examining the effect of block order on the proportion of judgments to paralanguage. Specifically, to assess the effect of priming paralanguage, we examined whether the proportion of responses to paralanguage in the emotional content block was greater when this block was presented second (Condition 1) rather than first (Condition 2). When content is obscured (Friend & Bryant, 2000; Morton & Trehub, 2001) or emotionally neutral (Dimitrovsky, 1964), 6-year-olds focus on paralanguage when judging emotion. Therefore, in Condition 1 we expected children to base their judgments on paralanguage in the neutral content block, which would effectively prime paralanguage. Of interest was whether 6-year-olds would continue to base their judgments on paralanguage in the subsequent emotional content block.

To assess the effect of priming content, we examined whether the proportion of responses to paralanguage in the neutral content block differed when this block was presented first (Condition 1) rather than second (Condition 2). When cues to emotion in speech conflict, 6-year-olds base their judgments on content. Therefore, in Condition 2, we expected children to base their judgments on content in the emotion content block, which would effectively prime content. Of interest was whether priming content in this way would interfere with children's judgments of paralanguage in the subsequent neutral content block. Together, these conditions allowed us to examine whether children's judgments reflect the relative salience of content and paralanguage, and whether this salience can be manipulated experimentally.

Method

Participants

Thirty-one (14 boys, 17 girls) 6-year-olds ($M = 6$ years 1 month; *range* = 6,0–6,3) participated. Children were from middle-class English-speaking families who volunteered to participate in developmental research.

Apparatus and Stimuli

Testing was conducted in a quiet 3 m × 4 m room by means of a Power Macintosh 8100 computer. The child sat facing the monitor and the experimenter sat beside the child. The experimenter used the computer keyboard to call for trials, and the child responded by pressing a *happy* or *sad* button on a button box connected to the computer. *Happy* and *sad* buttons were denoted by simple depictions of happy and sad faces that covered the buttons.

Stimuli in the neutral content block included 20 utterances with emotionally neutral content (see Table 1). Ten of these utterances were spoken with happy paralanguage and 10 were spoken with sad paralanguage. Stimuli in the emotional content block included 20 utterances with emotional content (see Table 1). Five utterances contained happy content and happy paralanguage, five contained happy content and sad paralanguage, five contained sad content and sad paralanguage, and five contained sad content and happy paralanguage. Previous testing (Morton & Trehub, 2001) confirmed that both the content and the paralanguage of these utterances were readily interpretable to 6-year-olds.

Procedure

Children were tested individually. They were told they would be playing a listening game in which they would hear a friend of the experimenter named Marianne. They were to listen carefully to Marianne and decide whether she was feeling happy or sad. When they thought she felt happy, they were to press the *happy* button; when they thought she felt sad, they were to press the *sad* button. Conditions 1 and 2 were distinguished only by the order of presentation—whether the neutral content block preceded or followed the emotion content block. In both conditions, the second block immediately followed the first block without interruption. Participants were assigned randomly to the two conditions (neutral content block first, $n = 16$: 7 boys, 9 girls; emotion content block first, $n = 15$: 7 boys, 8 girls).

Results

The mean percentage of responses consistent with paralanguage was calculated for the four separate blocks. For the emotion content blocks, mean percentages were based only on responses to the 10 utterances with conflicting cues. Responses to the 10 utterances with consistent cues were not included because all children responded happy to utterances with happy content and paralanguage and sad to utterances with sad content and paralanguage. It was impossible to determine whether these judgments were made on the basis of content or paralanguage.

As predicted, when the emotion content block was presented first, the percentage of responses to paralanguage was low ($M = 9.3\%$, $SE = 6.1$). Also as predicted, when the neutral content block was presented first, the percentage of responses to paralanguage was high ($M = 93\%$, $SE = 2.7$). There were, however, strong order effects. When the

Table 1
Neutral and Emotional Content Sentences

Neutral content sentences
1. I live in Mississauga.
2. My doll is wearing a dress.
3. I made a sweater out of wool.
4. My dad is wearing his glasses.
5. I put my marbles in a bag.
6. I carried water in a pail.
7. I washed my hands with soap.
8. I sat down on the chair.
9. My dad drove his car down the street.
10. I am using the hose.
Emotional content sentences (happy)
1. My mommy gave me a treat.
2. My soccer team just won the championship.
3. I got an ice cream for being good.
4. I came in first place in a race today.
5. Dad gave me a new bike for my birthday.
6. I am having a party and all my best friends are coming.
7. My teacher says that I'm the smartest in the class.
8. I had my favorite cake for dessert.
9. Grandmother told me I'm very special.
10. I won a prize for being the fastest swimmer.
Emotional content sentences (sad)
1. My dog ran away from home.
2. My bike is broken so I can't go riding with my friends.
3. I lost my baseball glove today.
4. I lost my sticker collection.
5. I am not allowed to go outside and play with my friends.
6. My best friend doesn't like me anymore.
7. I fell off my bike and everyone made fun of me.
8. I lost the toy that my grandmother gave me for Christmas.
9. All the kids at camp tease me.
10. I lost all my money on the way to the store.

emotion content block followed the neutral content block, the percentage of responses to paralanguage rose to 78% ($SE = 9.6$). In fact, 70% of participants responded to paralanguage on every trial. And when the neutral content block followed the emotion content block, the percentage of responses to paralanguage dropped to 61% ($SE = 3.9$). Order affected judgments of utterances in both the emotional content block, $t(29) = 5.90$, $p < .01$, and the neutral content block, $t(29) = 6.80$, $p < .01$.

Discussion

A simple task that primed paralanguage had a dramatic effect on 6-year-olds' judgments of utterances with conflicting cues to emotion. In the absence of priming, most children judged the speaker's feelings from her message content, which is consistent with previous findings (Friend, 2000; Friend & Bryant, 2000; Morton & Trehub, 2001). After paralinguistic priming, however, children tended to base their judgments of the same utterances on paralinguistic cues. Whether priming paralanguage has additional effects on children's interpretation of emotion in speech—such as modulating or enriching their interpretation of message content—remains an important question for future research.

Priming content also affected children's use of paralinguistic cues. In the absence of priming, children's judgments of neutral utterances were based largely on paralinguistic cues. After the content-priming procedure, however, children's use of paralanguage dropped significantly.

The findings indicate that under certain circumstances, 6-year-olds can judge a speaker's feelings from her paralanguage even in the presence of conflicting content. Therefore, their usual limitations in the use of paralanguage (e.g., Friend, 2000; Friend & Bryant, 2000; Morton & Munakata, 2002a; Morton & Trehub, 2001) cannot be attributed to the presence of conflicting content alone. Instead, 6-year-olds seem to have difficulty acting on the basis of the task instructions. The ability to modify one's actions in light of instructions, or verbal directives more generally, is often regarded as an important index of higher order, voluntary control over thought and behavior (e.g., Cohen, Dunbar, & McClelland, 1990; Goschke, 2000; Luria, 1961; Mecklinger, von Cramon, Springer, & Matthes-von Cramon, 1999; Vygotsky, 1962). Thus, the findings raise important questions about the development of higher order control processes. The purpose of Experiment 2 was to clarify why it is difficult for some 6-year-olds to follow a verbal directive to attend to paralanguage.

One possibility is that 6-year-olds form a relatively weak representation of the task instructions. In recent neural network simulations (Morton & Munakata, 2002b; Munakata et al., 2003), young networks (i.e., networks with weak recurrent connections) that represented task instructions weakly were unable to strengthen paralinguistic representations and, consequently, perseverated on content. Older networks (i.e., those with strong recurrent connections) that represented task instructions strongly were able to strengthen paralinguistic representations and switch to paralanguage. In principle, strengthening children's representation of the instructions by means of frequent reminders could help them act on those instructions.

Difficulty following instructions may also arise from children's inability to formulate and use a higher order rule for selecting between the two competing means of judging emotion. When content and paralanguage conflict, inference rules based on content (e.g., "If she says something happy, respond happy; if she says something sad, respond sad") and paralanguage (e.g., "If she sounds happy, respond happy; if she sounds sad, respond sad") specify opposite responses. Therefore, children may need to reflect on the distinction between listening to what is said and how it is spoken, and formulate a higher order rule for selecting between these two types of inference rules. According to cognitive complexity and control theory, the ability to reflect on rules and formulate higher order rules emerges as early as 4 years of age but remains challenging even for adults (for a review, see Zelazo & Frye, 1997). From this view, children who describe the conflicting emotional cues in the utterances—a sign of reflection—should be more likely to follow a verbal directive to attend to paralanguage than should children who do not.

Finally, some 6-year-olds may consider the relevance of the instructions superficially, which leads them to analyze the problem improperly and solve it in a familiar way (i.e., by listening to what is said; Aguiar & Baillargeon, 2000; Deák, 2000). In this view, alerting children to the relevance of the instructions through the use of performance feedback should help children compute the appropriate solution. These issues were investigated in Experiment 2.

Experiment 2

Children's ability to follow a verbal directive to attend to paralanguage was assessed using a rule-use paradigm (see Zelazo & Jacques, 1996). Following a preswitch phase in which children were instructed to respond to message content, there was a postswitch phase in which children were instructed to attend to its paralanguage. There were three types of instructions in the postswitch phase: uninformative instructions, informative instructions every five trials, or informative instructions every trial. Half of the children in these three conditions received feedback about the accuracy of their performance on each trial and half received no feedback.

Probe trials with consistent cues to emotion (e.g., happy content and paralanguage) were presented at the end of the preswitch and postswitch phases. These trials distinguished children who followed the instructions (i.e., children who attended to paralanguage) from those who generated correct responses by attending to the inappropriate dimension and providing the opposite response. For example, in the postswitch phase, children were instructed to respond to paralanguage. Those who did were expected to respond happy to the probe in the previous example, whereas those who generated correct responses by attending to content and giving the opposite response were expected to respond sad.

By examining postswitch performance across the six conditions and its relation to children's descriptions of the utterances, we hoped to gain insight into children's difficulty following simple verbal directives to attend to paralanguage (Friend, 2000; Friend & Bryant, 2000; Morton & Munakata, 2002a). An effect of instruction frequency would indicate the importance of strengthening a representation of the task instructions (Morton & Munakata, 2002b). An association between descriptions and postswitch performance would imply that following verbal directives is related to children's ability to reflect on the structure of the task (Zelazo & Frye, 1997). Finally, an interaction between instructions and feedback (i.e., enhanced performance when instructions and feedback were delivered in combination rather than independently) would indicate that children's consideration of the relevance of task instructions affects their likelihood of following verbal directives (Aguiar & Baillargeon, 2000; Deák, 2000).

Method

Participants

One hundred and seven (61 girls, 46 boys) 6-year-olds ($M = 6{,}1$; $range = 6{,}0 - 6{,}3$) participated. Children were from middle-class English-speaking families who volunteered to participate in developmental research. Seven of these participants were excluded from the final sample because of equipment failure ($n = 6$) or parent-reported developmental delay ($n = 1$).

Apparatus and Stimuli

Testing took place in the same room with the same equipment as that used in Experiment 1. Stimuli consisted of 22 utterances used in Experiment 1, 20 with conflicting and 2 with consistent emotion cues. An additional 8 utterances with conflicting cues (same speaker) were created for use in bias assessment trials (see the following). Utterances with conflicting cues were used as test stimuli, whereas the utterances with consistent cues were used as probe stimuli. The order of presentation was randomized for each participant.

Procedure

Participants were tested individually. The procedure consisted of three blocks of trials. For all participants, the first two blocks were identical, consisting of a bias-assessment procedure and a preswitch phase in which children were instructed to respond to content. Two variables, instructions and feedback, were varied in the final block (i.e., the postswitch phase) to create six different experimental conditions.

Bias-assessment trials. Because differences in bias could affect performance, eight bias-assessment trials with conflicting stimuli were administered to assess each participant's initial bias. Although most 6-year-olds show a bias to respond to content, some children show the opposite bias (Morton & Trehub, 2001). As in Experiment 1, children were told they were going to play a short game in which they would hear a friend of the experimenter's named Marianne. Children were told to listen carefully to Marianne and judge whether she was feeling happy or sad. If they thought she was happy, they were to press the *happy* button, but if she was sad, they were to press the *sad* button. Children were told that there were no right or wrong answers, and they received no feedback. Following the assessment trials, children were asked a series of probe questions about the test utterances: whether they had noticed anything silly about the way Marianne spoke, whether the game was tricky, and whether Marianne had done a good job of expressing her feelings. Affirmative responses were probed for more detail.

Preswitch trials. Following the bias-assessment trials, children were told that they would be listening to Marianne again, but that in this game, there were right and wrong answers. To get the answers right, they had to listen to what Marianne was saying. They had to press the *happy* button if Marianne was saying something happy and the *sad* button if she was saying something sad. On each trial, children heard a single utterance and received automated feedback. Correct responses led to a flashing computer screen and a beep followed by a simple expression (e.g., ''Wow, good for you!''). Incorrect responses led to the computer screen going blank and a ''boing'' sound followed by a simple expression (e.g., ''Oops, you missed that one''). When children achieved eight consecutive correct responses, the preswitch phase ended and a probe trial featuring an utterance with sad content and sad paralanguage was presented. Children whose preswitch responses were consistent with content and who responded sad on the probe trial were judged as having correctly responded to content in the preswitch phase. Those whose preswitch responses were consistent with content but who responded happy on the probe trial were judged as having responded to paralanguage but given the opposite response.

Postswitch trials. In the postswitch phase, six experimental conditions were created by crossing three levels of verbal instruction (uninformative, low-, and high-frequency instructions) with two levels of feedback (no feedback and feedback). Children in the uninformative instructions condition were told that they were going to play a new game in which they had to get the answers right, and that sometimes the right answer was happy and sometimes it was sad. Children in the low- and high-frequency instructions conditions were told that they were going to play a new game in which they would not listen to what Marianne was saying but would listen instead to how her voice sounded. When her voice sounded happy, they were to press the *happy* button. When it sounded sad, they were to press the *sad* button. To clarify the notion of listening to someone's voice, and to ensure that children could label examples of affective paralanguage, the experimenter engaged each participant in a short dialogue about happy and sad voices. Children were asked how people's voices sound when they feel happy and when they feel sad. They were then told that the experimenter was going to provide examples of happy and sad voices that they would judge as happy or sad. The experimenter then hummed one example each of happy and sad paralanguage (i.e., a happy or sad voice with no words), which all children labeled correctly. The experimenter then reiterated that in the new game, they were to listen to Marianne's voice, not to what she was saying. To demonstrate that the children understood the rules, the experimenter asked the child: ''Okay, so if Marianne's voice sounds like this (hummed sad paralanguage) what button will you press?'' All children responded correctly. The question was repeated with an example of happy paralanguage and again all children responded correctly. For children in the low-frequency instructions condition, these instructions were repeated every five trials; for children in the high-frequency instructions condition, they were repeated every trial. Reminders were as follows: ''Remember, listen to Marianne's voice, not to what she is saying. So if her voice sounds like this (hummed happy paralanguage) I want you to press the happy button. But if it sounds like this (hummed sad paralanguage) I want you to press the sad button.''

Children's memory for the instructions was tested after every five trials, preceding the reminder on that trial. First, children were asked what they were listening to in the new game, and what they were not listening to. Then they were asked: ''If Marianne's voice sounds like this (hummed happy paralanguage) what button will you press? And if Marianne's voice sounds like this (hummed sad paralanguage) what button will you press?''

Children in the feedback condition received feedback on their performance on every trial in the postswitch phase. Responses consistent with the paralanguage received positive feedback; those consistent with content received negative feedback. Feedback was identical to that provided in the preswitch trials. Children in the no-feedback condition received no feedback after their responses in the postswitch phase.

Postswitch trials using conflicting stimuli were administered until children either reached a criterion of eight consecutive correct responses or completed 40 trials. As in the preswitch phase, a single probe trial was administered to determine whether participants had switched to paralanguage or had attended to content while giving the opposite response.

Results

Overview

Bias assessment and preswitch performance were analyzed to identify possible differences among the six experimental groups and to ensure that these differences did not affect postswitch performance. The remaining analyses examined the effect of instructions and feedback on postswitch performance. Performance was measured both continuously (i.e., number of trials required to reach a criterion of eight consecutive correct responses) and categorically (i.e., whether participants switched from content to paralanguage). Three effects were of interest. First, was postswitch performance affected by the frequency of instructions? Fewer trials to criterion and a greater likelihood of switching with more frequent instructions would imply that performance was related to the strength of the representation of the instructions. Second, did children who described the conflicting nature of the utterances reach criterion faster and switch dimensions more readily than those who failed to describe the conflict? This outcome would imply that postswitch performance was related to the ability to reflect on the structure of the task. Third, was there an interaction between instructions and feedback, such that instructions and feedback had a greater effect on performance when combined than when presented separately? Such a finding would imply that children follow instructions that are perceived as relevant.

Bias Assessment

For each of the eight bias-assessment trials, responses to content and paralanguage received scores of 1 and 0, respectively, so that scores could range from 0 (*bias to paralanguage*) to 8 (*bias to content*). Means are shown in Table 2. A 3 (instructions) × 2 (feedback) analysis of variance (ANOVA) revealed an effect of instructions, $F(2, 92) = 3.72$, $p < .05$. A Tukey's honestly significant difference (HSD) test revealed that scores in the low- and high-frequency instructions conditions differed ($p < .05$), but no other comparisons were significant. This unanticipated difference occurred despite random assignment of children to conditions. To preclude the possibility of this difference affecting performance in the postswitch trials, further analyses were conducted. These analyses, reported next, confirmed that bias scores were related to preswitch performance but not to postswitch performance.

Table 2
Mean Bias Scores (Out of 8) as a Function of Experimental Condition (Experiment 2)

Instructions	Feedback	*n*	*M*	SD
Uninformative	No	15	7.53	1.55
	Yes	16	7.19	1.75
Low frequency	No	18	6.39	2.27
	Yes	16	6.19	2.97
High frequency	No	17	7.23	1.52
	Yes	15	7.73	0.45

Table 3
Mean Number of Preswitch Trials to Criterion as a Function of Experimental Condition (Experiment 2)

Instructions	Feedback	*n*	*M*	*SD*
Uninformative	No	15	8.73	1.71
	Yes	16	8.63	1.54
Low frequency	No	18	9.22	3.30
	Yes	16	9.25	3.02
High frequency	No	17	9.59	2.73
	Yes	15	8.93	2.09

Preswitch Performance

As expected, preswitch performance was similar across conditions. Means are displayed in Table 3. A 3 (instructions) × 2 (feedback) ANOVA confirmed that there was no difference in the number of trials to criterion across conditions. Although every participant reached criterion, the probe trial data indicated that 3 participants did so by responding to paralanguage but giving the opposite response. Because this investigation focused on factors affecting the ability to switch to paralanguage, all participants had to have an initial bias to content. Therefore, these 3 participants were removed from the analysis. Performance in the preswitch trials correlated negatively with participants' initial bias, $r(97) = -.28$, $p < .01$, indicating that participants with a strong bias to content required fewer trials to reach criterion.

Postswitch Performance

Trials to criterion. Postswitch trials continued until participants achieved eight consecutive correct responses or completed 40 trials. Participants who completed 40 postswitch trials without reaching criterion received a score of 40. The number of trials required to reach criterion was unrelated to participants' bias scores, $r(97) = .06$, $p = .53$. Table 4 shows the average number of trials required to criterion in each condition. A 3 (instructions) × 2 (feedback) ANOVA confirmed an effect of instructions, $F(2, 91) = 13.35$, $p < .01$; feedback, $F(1, 91) = 53.79$, $p < .01$; and Instructions × Feedback interaction, $F(2, 91) = 4.44$, $p < .05$. In view of the interaction, we examined the simple effect of instructions at each level of feedback. In the no-feedback condition, there was an effect of instructions, $F(2, 47) = 8.73$, $p < .01$. Tukey's HSD tests revealed that trials to criterion differed in the uninformative and high-frequency instructions conditions ($p < .05$), but not in the low- and high-frequency conditions. There was also an effect of instructions in the feedback condition, $F(2, 44) = 12.78$, $p < .01$. Tukey's tests revealed that trials to criterion in both the low- and high-frequency instructions conditions differed from trials to criterion in the uninformative instructions condition ($p < .05$) but did not differ from each other. An analysis of the simple effects of feedback at each level of instructions using Tukey's HSD tests revealed the source of the interaction. Feedback had an effect on performance in the uninformative and low-frequency instructions conditions, ($p < .05$), but not in the high-frequency instructions conditions.

Orientation to paralanguage. After the postswitch phase, participants responded to a single probe trial containing happy content and paralanguage. Analyzing responses to the probe and postswitch trials together (Table 5) revealed that postswitch performance also varied qualitatively. For example, some participants responded consistently on the basis of content on postswitch trials and responded happy on the probe trial, indicating that they continued to attend to content. Some responded consistently with paralanguage on postswitch trials but responded sad on the probe trial, indicating that they attended to content but provided the opposite response. Finally, some responded consistently with paralanguage on postswitch trials and responded happy on the probe trial, implying that they oriented to paralanguage. The incidence of these strategies varied across the six conditions, $\chi^2(10, N = 97) = 87.10$, $p < .01$, with the difference remaining significant when data from the uninformative instructions, no-feedback condition were excluded, $\chi^2(8, N = 82) = 54.2$, $p < .001$. To examine the effect of instructions and feedback on the likelihood of orienting to paralanguage, children were categorized as paralanguage oriented if they reached criterion by orienting to paralanguage and content oriented if they performed otherwise. The likelihood of orienting to paralanguage in the postswitch phase was unrelated to participants' bias scores, $r(97) = -.09$, $p = .4$. Table 6 displays the results for each condition. To test for specific effects, simple comparisons were conducted using a Bonferroni corrected alpha level of .01.

Informative instructions (either low or high frequency) were more effective than uninformative instructions in producing an orientation to paralanguage, with 57% of children who received informative instructions orienting to paralanguage as compared with 6% who received uninformative instructions, $\chi^2(1, N = 50) = 10.98$, $p < .01$. By contrast, high-frequency instructions were no more effective than low-frequency

Table 4
Trials to Criterion as a Function of Experimental Condition (Experiment 2)

Instructions	Feedback	*n*	*M*	*SD*
Uninformative	No	15	37.9	8.3
	Yes	16	16.7	6.2
Low frequency	No	18	27.3	15.4
	Yes	16	10.9	4.2
High frequency	No	17	18.1	14.7
	Yes	15	9.0	1.3

Table 5
Probe Trial Analysis (Experiment 2)

Condition		Response			
Instructions	Feedback	RC	RCsr	RP	Totals
Uninformative	No	14	0	1	15
	Yes	0	10	6	16
Low-frequency	No	10	0	8	18
	Yes	0	2	14	16
High-frequency	No	5	0	12	17
	Yes	0	2	13	15
Totals		29	14	54	97

Note. RC = response to content; RCsr = response to content and switched responses; RP = response to paralanguage.

instructions in generating an orientation to paralanguage, although there was a trend in this direction. Seventy-one percent and 44% of children oriented to paralanguage in the high- and low-frequency instructions conditions, respectively, $\chi^2(1, N = 35) = 2.44$, *ns*.

Informative instructions combined with performance feedback were more effective than instructions or feedback alone, with 87% of participants orienting to paralanguage when informative instructions (low and high frequency combined) were combined with feedback as compared with 57% when instructions were delivered alone, $\chi^2(1, N = 66) = 7.20$, $p < .01$. This effect was not simply due to the feedback, which in itself did not generate a significant shift in orientation to paralanguage, $\chi^2(1, N = 31) = 4.21$, *ns*. Instead, the majority (62%) of children who received performance feedback but no instructions oriented to content while providing the opposite response (see Table 5).

Relation Between Descriptions and Postswitch Performance

Children were coded as describing the conflict if, in response to the probe questions that followed the

Table 6
Number of Participants Oriented to Paralanguage and Content in Postswitch Phase as a Function of Experimental Condition (Experiment 2)

	Instructions						
	Uninformative		Low frequency		High frequency		
	Feedback						
Orientation	No	Yes	No	Yes	No	Yes	Total
Paralanguage	1	6	8	14	12	13	43
Content	14	10	10	2	5	2	54
Total	15	16	18	16	17	15	97

bias-assessment trials, they described how content and paralanguage conflicted. Acceptable descriptions included: ''Whenever she was happy she was sad,'' ''Everything she was happy about she was actually sad about,'' ''She sounded happy whenever she was sad,'' and ''She sounded mixed up.'' Children were coded as describing the conflict even if they offered these descriptions while insisting that it was easy to figure out how the speaker felt or that the speaker had done a good job expressing her feelings, or both. (The analysis included data from 96 participants because data from 1 participant were lost.) Some 27 (of 96) children described the conflicting nature of the utterances. These children required fewer trials to reach criterion ($M = 15.2$, $SD = 11.2$) than children who did not describe the conflict ($M = 22.0$, $SD = 14.4$), $t(95) = 2.24$, $p < .05$. As well, probe trial analysis revealed that 46% of children who described the conflict switched to paralanguage as compared with 27% of children who did not describe the conflict, $\chi^2(1, N = 96) = 7.74$, $p < .01$.

Recall of Postswitch Instructions

Recall of the instructions was tested in two ways. First, children were presented with examples of hummed paralanguage and asked how they would respond if the speaker's voice sounded that way. All children in all groups indicated they would respond happy and sad after hearing the examples of happy and sad paralanguage, respectively. Second, children were asked to recall what they were and were not listening to in the postswitch trials. Examples of correct responses to the first question were: ''her voice,'' ''the way she sounds,'' and ''how she sounds.'' Examples of incorrect responses were: ''I forget,'' ''what she says,'' ''her speaking,'' ''her sounds,'' and ''Marianne.'' Correct responses to the second question included: ''what she says,'' ''what she is saying,'' ''her saying,'' and ''her words.'' Incorrect responses included: ''I forget,'' ''her voice,'' ''her sounds,'' and ''her speaking.'' Proportions of correct responses to these questions for participants receiving low- and high-frequency instructions approached ceiling levels at 86% ($SE = 25\%$) and 95% ($SE = 12\%$), respectively, but the difference was marginally significant, $t(64) = 1.90$, $p = .06$.

Discussion

The present experiment investigated factors affecting 6-year-olds' propensity to follow a verbal directive to respond to a speaker's paralanguage. In postswitch trials, informative instructions led approximately half of the children to orient to the speaker's paralanguage, whereas uninformative instructions (i.e., ''play a new game'') led almost no children to do so. However, children were no more likely to orient to paralanguage when instructions were repeated on every trial rather than every five trials. Performance feedback alone was ineffective in generating an orientation to paralanguage. Instead, it led most children to continue attending to content while switching their responses (i.e., respond sad when the speaker said something happy). Feedback and instructions interacted such that children were more likely to orient to paralanguage when instructions and performance feedback were delivered together rather than separately.

Feedback and instructions also affected how quickly children reached the performance criterion (i.e., eight consecutive correct responses) in the postswitch phase. Children receiving informative instructions required fewer trials to criterion than did those receiving uninformative instructions, but repeating the instructions more frequently had no consequences. Children who received performance feedback required significantly fewer trials to criterion than those who did not receive feedback. Feedback and instructions also interacted such that feedback led to fewer trials to criterion for children receiving uninformative and low-frequency instructions, but not for children receiving high-frequency instructions. This interaction may have stemmed from ceiling effects for children receiving high-frequency instructions. Finally, children who described the conflicting nature of the stimuli reached criterion more quickly and were more likely to orient to paralanguage in the postswitch phase than were children who did not provide such descriptions. The findings may shed light on why many 6-year-olds have difficulty following a verbal directive to orient to a speaker's paralanguage (Morton & Munakata, 2002a).

The association between descriptions of the stimuli and the likelihood of orienting to paralanguage on postswitch trials implies that following a simple directive to listen to the sound of a speaker's voice is easier for children who can reflect on the structure of the problem at hand. This finding is broadly consistent with the tenets of cognitive complexity and control theory (e.g., Zelazo & Frye, 1997), namely, that the ability to control thought and action voluntarily develops in association with reflection and the use of higher order representations.

Instructions and performance feedback interacted both in terms of trials to criterion and the likelihood of orienting to paralanguage on postswitch trials. Approximately half of the children who were instructed to orient to paralanguage complied on postswitch trials, but almost all children receiving combined instructions and feedback did so. Children receiving feedback alone typically remained focused on content while reversing their responses. Feedback, then, may have alerted children to the relevance of the instructions and the need to treat the problem at hand in a novel way (Aguiar & Baillargeon, 2000; Deák, 2000).

More frequent repetition of instructions did not significantly increase the likelihood of orienting to paralanguage, nor did it affect trials to criterion, although there was a trend in this direction. Although these results appear inconsistent with the view that children are more likely to follow task instructions that are strongly represented (Morton & Munakata, 2002b; Munakata et al., 2003), this null effect is difficult to interpret because children in the high- and low-frequency groups were both near ceiling when recalling the task instructions. Perhaps a stronger representation of the task instructions would lead to improved performance if the difference in the strength was of sufficient magnitude. Further research is required to clarify this issue.

General Discussion

Two experiments explored factors affecting 6-year-olds' judgments of emotion in speech. As in previous studies, 6-year-olds were more likely to respond to content than to paralanguage when these cues conflicted (Friend, 2000; Friend & Bryant, 2000; Morton & Trehub, 2001; Solomon & Ali, 1972; Solomon & Yaeger, 1969). In the absence of priming, children in Experiment 1 responded to content when the available emotion cues conflicted. In Experiment 2, almost all children exhibited an initial bias to respond to content, which is consistent with previous findings.

Reversing this bias proved to be relatively easy. Following a simple priming procedure, children in Experiment 1 judged emotion from paralanguage on 78% of the trials, despite the presence of competing emotional content. With appropriate preparation, then, 6-year-olds can judge a speaker's feelings from paralinguistic cues in the face of conflicting content. Nevertheless, many children failed to shift the basis of their judgments from content to paralanguage after explicit instructions to do so. In Experiment 2, only 57% of the children switched their orientation from content to paralanguage despite excellent recall of the instructions. It would seem that the relative strength of competing response tendencies can be modified through bottom-up processes such as priming, but that constraints on top-down control make it difficult for 6-year-olds to modulate the strength of competing response tendencies voluntarily. The findings suggest that these constraints may be multifaceted.

According to cognitive complexity and control theory (Zelazo & Frye, 1997) age-related advances in control over thought and action are attributable to the development of reflection and the use of higher order representations. Specifically, young children behave inflexibly across a variety of domains because they are unable to subordinate lower order rules to a higher order rule. Age-related increases in the representation and use of higher order representations leads to greater mental flexibility across a variety of domains, including moral-reasoning (Zelazo, Helwig, & Lau, 1996), theory-of-mind (Frye, Zelazo, & Palfai, 1995), and dimensional-shifting tasks (e.g., Dimensional Change Card Sort; Zelazo, Frye, & Rapus, 1996). The association between descriptions of the conflicting cues and compliance with instructions is consistent with this view. Formulating a representation of the stimuli in terms of two distinct but conflicting dimensions (content and paralanguage) may enable children to select either dimension as the basis for responding. In the absence of such higher order representations, children may rely primarily on the prepotent dimension.

Interactive models of working memory and inhibitory control (Morton & Munakata, 2002b; Roberts & Pennington, 1996) offer a different perspective. The active–latent account (Morton & Munakata, 2002b; Munakata, McClelland, Johnson, & Siegler, 1997) views performance on a variety of tasks as arising out of competition between latent biases and active memory traces. Drawing on evidence from neural network simulations, proponents of this view argue that latent biases to respond to a particular stimulus feature—simulated as the strength of the connections between units processing that feature—vary continuously in strength. Success in overcoming these biases is thought to depend on the strength of the prepotent bias and on the strength of the representation of the task instructions in active memory. Young children who are limited to weak active representations have difficulty overcoming latent biases when instructed, whereas older children and adults, who can form strong active representations, are more effective in overcoming biases.

The active–latent account (Morton & Munakata, 2002b) provides a fairly comprehensive account of the present findings. Neural network models predict that priming paralanguage should establish a latent bias for paralinguistic cues by strengthening connections between units processing those cues. This paralinguistic bias should increase the likelihood of paralinguistic interpretations of utterances with conflicting emotional cues, an effect that was observed in Experiment 1. In analogous fashion, priming content should strengthen a latent bias to respond to content, which should interfere with judgments of paralanguage from utterances with emotionally neutral content, a finding that was also observed in Experiment 1.

The active–latent account accommodates some of the findings of Experiment 2 by assuming that feedback strengthened the representation of the task instructions. Although current models of age-related performance in various speech interpretation tasks (Morton & Munakata, 2002b) do not directly address the effects of performance feedback, similar models of Stroop task performance have shown how error signals can modulate the strength of active (or contextual) representations (Botvinick, Braver, Barch, Carter, & Cohen, 2001). More troubling for the active–latent account was the null effect of repeated instructions. More frequent repetition should have improved performance by strengthening the representation of instructions. Although there was a trend in this direction, it did not reach conventional levels of statistical significance.

Finally, children may only think superficially about the task instructions unless alerted to their relevance (Aguiar & Baillargeon, 2000; Deák, 2000). Consequently, they tend to miscategorize novel problems as familiar, which leads them to retrieve previously appropriate solutions (Aguiar & Baillargeon, 2000; Deák, 2000). Thus, feedback may succeed not because it strengthens the representation of instructions but because it increases their apparent relevance. Further research is required to arbitrate between these perspectives.

Whatever the underlying reason, many 6-year-olds focused on the content of messages despite explicit instructions to focus on their paralanguage. The findings raise important questions about children's sensitivity to the demands of different listening contexts. Such sensitivity is essential to the communication process because any utterance can support a multitude of interpretations. The interpretations that are brought to bear on a particular utterance are largely determined by the context (Rogers & Monsell, 1995). Although most contexts necessitate attention to the content of messages, some types of communication place a special premium on the manner of expression (Bolinger, 1989; Labov & Fanshel, 1977). The present findings are consistent with the view that children have difficulty adjusting to the changing demands of different listening contexts (Mazzocco, 1999; Solomon & Ali, 1972).

It is possible, however, that children's difficulties are confined largely to decontextualized experimental contexts that obscure their skills and sensitivities. Indeed, the present findings underscore the importance of task demands in studies of child development. They draw attention therefore to the importance of exploring children's judgments of speech in more naturalistic settings (Friend, 2003). Research of that nature would clarify the implications of the present findings for interpersonal communication and socioemotional development.

References

Aguiar, A., & Baillargeon, R. (2000). Perseveration and problem-solving in infancy. *Advances in Child Development and Behavior*, *27*, 135–180.

Bolinger, D. (1989). *Intonation and its uses: Melody in grammar and discourse*. Stanford, CA: Stanford University Press.

Borke, H. (1971). Interpersonal perception of young children: Egocentrism or empathy? *Developmental Psychology, 5*, 263–269.

Botvinick, M. M., Braver, T. S., Barch, D. M., Carter, C. S., & Cohen, J. D. (2001). Conflict monitoring and cognitive control. *Psychological Review, 108*, 624–652.

Cohen, J. D., Dunbar, K., & McClelland, J. L. (1990). On the control of automatic processes: A parallel distributed processing account of the Stroop effect. *Psychological Review, 97*, 332–361.

Deák, G. O. (2000). The growth of flexible problem-solving: Preschool children use changing verbal cues to infer multiple word meanings. *Journal of Cognition and Development*, *1*, 157–192.

Dimitrovsky, L. (1964). The ability to identify the emotional meaning of vocal expressions at successive age levels. In J. Davitz (Ed.), *The communication of emotional meaning* (pp. 69–86). New York: McGraw-Hill.

Friend, M. (2000). Developmental changes in sensitivity to vocal paralanguage. *Developmental Science*, *3*, 148–162.

Friend, M. (2003). What should I do? Language, paralanguage, and behavior regulation in early childhood. *Journal of Cognition and Development*, *4*, 161–183.

Friend, M., & Bryant, J. B. (2000). A developmental lexical bias in the interpretation of discrepant messages. *Merrill-Palmer Quarterly, 46*, 342–369.

Frye, D., Zelazo, P. D., & Burack, J. A. (1998). Cognitive complexity and control: I. Theory of mind in typical and atypical development. *Current Directions in Psychological Science*, *7*, 116–121.

Frye, D., Zelazo, P. D., & Palfai, T. (1995). Theory of mind and rule-based reasoning. *Cognitive Development*, *10*, 483–527.

Goschke, T. (2000). Intentional reconfiguration and involuntary persistence in task-set switching. In S. Monsell & J. Driver (Eds.), *Control of cognitive processes: Attention and performance XVIII* (pp. 331–355). Cambridge, MA: MIT Press.

Labov, W., & Fanshel, D. (1977). *Therapeutic discourse: Psychotherapy as conversation*. New York: Academic Press.

Luria, A. R. (1961). *The role of speech in the regulation of normal and abnormal behavior* (Tizard, J. Ed.). New York: Liveright.

Mazzocco, M. M. M. (1999). Developmental changes in indicators that literal interpretations of homonyms are associated with conflict. *Journal of Child Language*, *26*, 393–417.

Mecklinger, A., von Cramon, D. Y., Springer, A., & Matthes-von Cramon, G. (1999). Executive control functions in task switching: Evidence from brain injured patients. *Journal of Clinical and Experimental Neuropsychology, 21*, 606–619.

Morton, J. B., & Munakata, Y. (2002a). Are you listening? Exploring a developmental knowledge-action dissociation in a speech interpretation task. *Developmental Science*, *5*, 435–440.

Morton, J. B., & Munakata, Y. (2002b). Active versus latent representations: A neural network model of perseveration, dissociation, and decalage. *Developmental Psychobiology, 40*, 255–265.

Morton, J. B., & Trehub, S. E. (2001). Children's understanding of emotion in speech. *Child Development*, *72*, 834–843.

Munakata, Y., McClelland, J. L., Johnson, M. H., & Siegler, R. S. (1997). Rethinking infant knowledge: Toward an adaptive process account of successes and failures in object permanence tasks. *Psychological Review, 104*, 686–713.

Munakata, Y., Morton, J. B., & Stedron, J. M. (2003). The role of prefrontal cortex in perseveration: Developmental and computational explorations. In P. Quinlan (Ed.), *Connectionist models of development* (pp. 83–114). East Sussex, England: Psychology Press.

Roberts, R. J., & Pennington, B. F. (1996). An interactive framework for examining prefrontal cognitive processes. *Developmental Neuropsychology, 12*, 105–126.

Rogers, R. D., & Monsell, S. (1995). The costs of a predictable switch between simple cognitive tasks. *Journal of Experimental Psychology: General*, *124*, 207–231.

Solomon, D., & Ali, F. A. (1972). Age trends in the perception of verbal reinforcers. *Developmental Psychology, 7*, 238–243.

Solomon, D., & Yaeger, J. (1969). Determinants of boys' perceptions of verbal reinforcers. *Developmental Psychology, 1*, 637–645.

Vygotsky, L. S. (1962). *Thought and language*. Cambridge, MA: MIT Press.

Zelazo, P. D., Craik, F. I. M., & Booth, L. (2003). *Executive function across the lifespan*. Manuscript under review.

Zelazo, P. D., & Frye, D. (1997). Cognitive complexity and control: A theory of the development of deliberate reasoning and intentional action. In M. Stamenov (Ed.), *Language structure, discourse, and the access to consciousness* (pp. 113–153). Amsterdam: John Benjamins.

Zelazo, P. D., & Frye, D. (1998). Cognitive complexity and control: II. The development of executive function. *Current Directions in Psychological Science*, *7*, 121–126.

Zelazo, P. D., Frye, D., & Rapus, T. (1996). An age-related dissociation between knowing rules and using them. *Cognitive Development*, *11*, 37–63.

Zelazo, P. D., Helwig, C. C., & Lau, A. (1996). Intention, act, and outcome in behavioral prediction and moral judgment. *Child Development*, *67*, 2478–2492.

Zelazo, P. D., & Jacques, S. (1996). Children's rule use: Representation, reflection, and cognitive control. *Annals of Child Development*, *12*, 119–176.