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Sociocultural Influences on the Development of Verbal Mediation:
Private Speech and Phonological Recoding
in Saudi Arabian and British Samples

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Abstract

Cross-national stability in private speech (PS) and short-term memory was investigated in Saudi Arabian ($N = 63$) and British ($N = 58$) 4- to 8-year-olds. Assumed differences in child–adult interaction between the 2 nationality groups led to predictions of gender-by-nationality interactions in the development of verbal mediation. British boys used more self-regulatory PS than British girls, while there was no such difference for the Saudi group. Controlling for age, verbal ability, and social speech, boys used marginally more self-regulatory PS than girls. Self-regulatory PS was related to children’s use of phonological recoding of visually presented material in a short-term memory task, suggesting that PS and phonological recoding represent different facets of a domain-general transition toward verbal mediation in early childhood.

Key phrases: private speech, verbal mediation, phonological recoding, gender, cross-national comparisons

Sociocultural Influences on the Development of Verbal Mediation: Private Speech and Phonological Recoding in Saudi Arabian and British Samples

The question of how language and thought become developmentally intertwined in early childhood has long been of interest to psychologists. Vygotsky (1934/1987) proposed that a revolution in cognitive development occurs when children begin to use semiotic systems, primarily natural language, to augment and transform their prelinguistic cognitive capacities. On this account, the phenomenon of private speech (PS)—speech that is not obviously addressed to any interlocutor—represents the process through which language that initially serves a social communicative purpose comes to fulfil a self-regulatory function. Since Berk's (1992) landmark review, which concluded that the evidence largely supports Vygotsky's interpretation of the phenomenon, there has been renewed interest in the self-regulatory functions of PS (Winsler, 2004). Nevertheless, some of the central claims of Vygotsky's theory, such as that PS originates in social interaction and should therefore be influenced by sociocultural variables, have received relatively little attention.

In parallel with this growth of interest in the verbal mediation of behavior and cognitive performance, researchers have continued to investigate the development of linguistic mediation in another domain, that of short-term memory. Within the influential model of working memory presented by Baddeley and Hitch (1974; Baddeley, 1986), verbal mediation of memory performance is made possible by the rehearsal of phonological information in the articulatory loop component of the working memory system. An important shift in children's strategies for remembering occurs when children begin spontaneously to use phonological rehearsal for visually presented material

(Baddeley, 1966, 1986; Conrad, 1971; Gathercole & Hitch, 1993). To date, however, individual differences in the attainment of this developmental milestone, and the environmental and dispositional factors that might underlie them, have not been the focus of research.

Early childhood is therefore a time of profound change in the use of verbal mediation in at least two domains: self-regulation of cognitive performance, and phonological rehearsal of mnemonic material. The aim of the study reported here was to attempt to bring these areas of research together by examining evidence for an across-the-board shift toward verbal mediation in early childhood. Sociocultural influences on these developmental processes are examined in the context of cross-national comparisons and gender differences.

Verbal Mediation of Cognitive Performance

There is now a substantial body of evidence supporting Vygotsky's claims about the self-regulatory functions of PS. Empirical research inspired by his ideas has shown PS use to be related in meaningful ways to social context (Goudena, 1987), task difficulty (Behrend, Rosengren, & Perlmutter, 1989; Kohlberg, Yaeger, & Hjertholm, 1968), and to both concurrent (Fernyhough & Fradley, 2005; Winsler, Diaz, McCarthy, Atencio, & Adams Chabay, 1999) and future (Behrend, Rosengren, & Perlmutter, 1992; Bivens & Berk, 1990) task performance.

Researchers have also investigated Vygotsky's claims about changes in the form and function of PS over childhood. Support has been found for the suggestion that PS drops away in middle childhood as verbal mediation becomes internalized (Kohlberg et al., 1968), although there is also a growing awareness that self-regulatory speech can be a

valuable cognitive strategy well into adulthood (Duncan & Cheyne, 2002). PS has been observed to follow a trajectory from overt, task-irrelevant utterances to utterances that appear to have a role in the self-regulation of behavior, and ultimately to semi-covert whispering and muttering (Kohlberg et al., 1968; Patrick & Abravanel, 2000; Winsler, Diaz, & Montero, 1997). In Berk's (1986) coding scheme, more "advanced" forms of PS (primarily those concerned with self-regulation) are assumed gradually to replace more immature ones (such as task-irrelevant affect expression). Evidence for this developmental progression has been found in a number of studies (Berk, 1986; Berk & Garvin, 1984; Bivens & Berk, 1990; Winsler, de Leon, Wallace, Carlton, & Willson-Quayle, 2003). For example, in their large ($N = 2,156$) cross-sectional sample, Winsler and Naglieri (2003) showed that the use of overt task-relevant PS decreased over middle childhood, while the use of covert varieties of self-talk (presumably reflecting progressive internalization) increased over the same period.

One important, and relatively neglected, question that arises from Vygotsky's theory is the extent to which social and cultural variables influence the shift to verbal mediation. Vygotsky (1934/1987) argued that self-regulatory speech arises out of the gradual internalization of social exchanges between children and adults. Children with impoverished experiences of such exchanges should therefore be delayed in their development of self-regulatory PS. Diaz, Neal, and Vachio (1991) found lower rates of task-relevant PS in a sample of high-risk preschoolers from low-income families with a history of child abuse, contexts in which responsive communication between adults and children could be expected to be severely impaired. In their study of PS in Appalachian children, born into a culture where verbal communication between adults and children is

less extensive than in typical Western samples, Berk and Garvin (1984) found evidence that PS development was delayed. For example, 40% of the private utterances produced by the Appalachian 10-year-olds remained highly audible, whereas Kohlberg et al.'s (1968) data from a predominantly middle-class American sample suggested that PS is typically almost completely internalized by this age. However, Berk and Garvin (1984) did not include in their study a typical American sample for direct comparison with the Appalachian children. To date, no study has examined social and cultural influences on PS development in the context of a cross-cultural study. Attempting such an investigation was the first main aim of the study reported here.

Another important sociocultural variable, which in some circumstances might affect children's opportunities for reciprocal linguistic exchanges with others, is gender. The evidence for gender differences in PS use has been somewhat mixed. Although finding no effects of gender on overall PS rates, Berk and Garvin (1984) reported that the boys in their Appalachian sample used more of the "immature" forms of PS, such as egocentric communication, than their female counterparts. Winsler et al. (1999) found higher PS use among boys during task collaborations with their mothers, although not during individual task performance. In their large cross-sectional study, Winsler and Naglieri (2003) found no effect of gender on overt or covert verbal strategy use. One difficulty in interpreting findings of gender effects is that, in the absence of longitudinal data, it remains uncertain whether children who produce fewer PS utterances are less advanced in the developmental process of internalization, and are yet to reach their hypothesized peak of PS use, or whether, conversely, they have already passed their PS peak and have therefore largely internalized their speech.

Verbal Mediation of Short-Term Memory

The emergence of verbal mediation has also been studied in the area of memory development. One of the most important questions in such research is how young children come to be able to recruit existing cognitive resources to the rehearsal and maintenance of material presented in different modalities. In the preschool years, memory for visually presented stimuli appears to be primarily dependent upon visuospatial working memory, as evidenced by the appearance of the visual similarity effect (Hitch, Halliday, Schaafstal, & Schraagen, 1988; Longoni & Scalisi, 1994; Palmer, 2000a), where sequences of items of similar visual form are recalled less accurately than visually distinct items. At a slightly later stage in development, children show susceptibility to the phonological similarity effect (PSE) in visual presentation, where recall of phonologically similar items (e.g., *man*, *map*, *mat*) is worse than recall of phonologically dissimilar items (e.g., *clock*, *horse*, *fish*) (Baddeley, 1966, 1986; Conrad, 1971; Gathercole & Hitch, 1993). Within the working memory framework (Baddeley, 1986; Baddeley & Hitch, 1974), the PSE is attributed to the phonological recoding of visually presented material so that it can be rehearsed using the articulatory loop. Whereas spoken material is thought to have automatic access to the articulatory loop, visual inputs such as pictures must be recoded phonologically before they can be held in this component of working memory (Gathercole & Baddeley, 1993).

Although there is some disagreement about the precise chronology of the shift to phonological recoding (Ford & Silber, 1994; Hulme, 1987; Palmer, 2000a), there is a consensus that children undergo a fundamental shift in strategy at around age 6, away from visuospatial coding of visually presented material and toward phonological

recoding. This shift has been related variously to children's adoption of a conscious strategy for memorizing visually presented material (Flavell, Beach, & Chinsky, 1966), to the gradual decoupling of the phonological short-term memory system from the stimulus of overt speech (Hitch, Halliday, Schaafstal, & Heffernan, 1991), and to changes in central executive functioning (Palmer, 2000a). Palmer (2000a) has presented evidence that the shift to phonological recoding involves a period of dual coding when information is stored both phonologically and visuospatially. As explained below (see Method), this raises the possibility of determining the extent of phonological recoding by measuring the extra memory capacity available for items that are not susceptible to phonological confusion.

Despite the wealth of evidence now available on the shift to phonological recoding in early childhood, little is known about the variables that might influence this transition. Studies of individual differences in susceptibility to the PSE have been limited to examining its value as a predictor of later educational achievement, such as literacy acquisition (Palmer, 2000b). To date, no study has investigated phonological recoding as an outcome of development, either in terms of individual differences in pre-existing cognitive capacities, or in terms of the sociocultural variables that might be expected to influence the acquisition of a phonological recoding strategy.

One way of understanding such potential cognitive and sociocultural influences is provided by Vygotsky's theory. According to this account, the gradual internalization of social speech, through the intermediate form of PS, should increase the child's opportunities to benefit from verbal mediation in a range of cognitive domains, including short-term memory. To put it another way, the across-the-board shift toward semiotic

mediation envisaged by Vygotsky should be evidenced in children's developing use of mediational strategies in memory tasks, as well as in their PS on non-memory tasks. Although he did not directly consider the phenomenon of phonological recoding, Vygotsky (1978) was explicit about the developing mediation of memory by artificial means. Drawing on the results of Leont'ev (1932), he argued that, by the time they reach school age, children are able spontaneously to use external artifacts in mediating memory. To date, there have been only limited attempts to replicate Vygotsky and colleagues' findings on the development of mediated memory (see Lloyd & Fernyhough, 1999), and the influence of sociocultural variables on this process has yet to be determined.

What sociocultural factors might be relevant in this respect? One way of approaching this question is to investigate whether the shift to phonological recoding proceeds at different rates in different cultures. For example, some cultural contexts may encourage children to use verbal mediation in cognitive tasks, while others may entail implicit or explicit discouragement of such strategies. In addition, cultural contexts might differ in the extent to which they allow children to engage in the sort of interaction with adults and peers that Vygotsky considered to drive the development of verbal mediation. To date, there has been no systematic investigation of cross-cultural differences in the shift to verbal mediation of short-term memory. Addressing this gap in the literature was the second main aim of the study reported here.

The Development of Verbal Mediation in Sociocultural Context: Rationale for a Cross-

National Comparison

The above review suggests that there are important gaps in our knowledge of how the sociocultural context of development impacts upon children's developing use of verbal mediation. Our rationale for investigating this issue in a cross-national study was that it would allow us to draw on previous observations of cultural differences relevant to our chosen samples. It is important to note that it was beyond the scope of our study to investigate these cultural differences directly. Rather, we based our hypotheses on previous research into the different experiences of boys and girls within these and other similar cultures.

We selected two countries whose dominant cultural practices were likely to have differing effects on children's use of language and verbal strategies: the United Kingdom (UK) and Saudi Arabia. These cultures were chosen because of previously reported differences in (a) societal values relating to individualism and collectivism, (b) societal values relating to gender, and (c) educational practices. Cross-national differences in these practices, and their possible implications for the use of verbal mediation, are examined in turn.

Societal Values Relating to Individualism and Collectivism

Markus and Kitayama (1991, 1994) suggest that cultures can be distinguished by their position along a dimension of individualism and collectivism. Collectivistic cultures emphasize interdependence among individuals and the importance of interlocking responsibilities and obligations within social units such as the family (Markus & Kitayama, 1991). In contrast, individualistic cultures, such as predominate in the US and UK, place greater value on autonomy, independence, individual privacy, and the attainment of personal goals (Hofstede, 1980). In general, Arab societies have been

characterised as collectivistic (Barakat, 1993; Dwairy, 2004; Mikulincer, Weller, & Florian, 1993; Scharf & Hertz-Lazarowitz, 2003). In many Saudi Arabian families, individuals' behavior is strongly organized and influenced by other people, and children's relationships with parents and other family members are governed by respect and deference (Al-Garni, 2000; Al-Sudairi, 2000; Anderson, 2001). Although researchers have not directly investigated whether the collectivistic nature of Saudi society influences children's interactions with others, this question has been addressed in other collectivistic cultures. For example, Mullen and Yi (1995) reported that, compared with their American counterparts, Korean mothers talked to their children less frequently over the course of a day, and conversations about past events focused on social discipline and morals. In contrast, American mothers' conversations tended to center around their children's personal characteristics, preferences, and interests.

Another area in which the collectivistic nature of Saudi culture might influence the social opportunities available to children relates to Baumrind's (1971) distinction between authoritative and authoritarian parenting styles. Authoritative parenting is characterized by parental warmth and positivity in relationships coupled with firmness and consistency. Authoritarian parents, in contrast, can be relatively distant and critical, as well as strict in their adherence to rules. In their study of UK mothers, Thompson, Raynor, Cornah, Stevenson, and Sonuga-Barke (2002) reported roughly equal occurrences of authoritative and authoritarian parenting in mothers' self-reports. Although comparable studies have not been conducted in Saudi Arabia, Al-Garni (2000) noted how parents in Saudi Arabia tend to be authoritarian in their interactions with their children, and to have asymmetrical parent-child relationships, with parents being "the

ones who command and order, and the children... the ones who obey and follow” (pp. 39-40). Although some believe that parenting practices are changing as a result of the economic boom and the spread of formal, Western-style education in Saudi Arabia during the last three decades (Al-Saif, 2003), the traditional adult-centered approach to parenting is still widely adopted (Al-Banyan, 1980; Al-Sudairi, 2000).

The collectivistic nature of Saudi society might therefore affect children’s opportunities for reciprocal social exchanges in different ways. On the one hand, a more collectivistic culture might be expected to knit children more tightly into the social exchanges, particularly with adults and more expert peers, that Vygotsky regarded to underpin the development of verbal mediation. On the other hand, the fact that children’s behavior tends to be organized and influenced by their superiors might mean that their development of strategies to regulate their own behavior might be limited, at least until they reach adolescence and adulthood. In terms of possible hypotheses about cross-national comparisons in the development of verbal mediation, the available evidence relating to individualism and collectivism therefore cuts both ways.

Societal Values Relating to Gender

As in any culture, boys and girls tend to be treated differently in Saudi Arabia. Arab culture in general is often characterised as patriarchal, with power residing with the menfolk, and women generally not party to important decisions (Barakat, 1993). Saudi society is also strongly segregated along gender lines, with boys and men staying together and female family members often occupying different parts of the house (Albers, 1989). Gender segregation, coupled with the fact that power resides primarily with adult males, means that Saudi boys are frequently party to important discussions among the menfolk,

whilst being prohibited from directly contributing (Seginer & Vermulst, 2002). In contrast, the traditional segregation of Saudi females means that girls are encouraged to talk and express themselves during frequent social gatherings with women and other girls. Reporting on a sample of Palestinian-Arab adolescents in Israel (considered representative of Arab populations in general), Dwairy (2004) found that girls reported their own parents to use more authoritative than authoritarian styles, with the direction of effect reversed for boys. Assuming that these findings generalize to Saudi samples, one would therefore expect Saudi girls to enjoy more reciprocal and less controlling interactions with their parents than their male counterparts.

These differences in treatment of boys and girls are distinct from patterns of interaction in many British families, where boys are not typically privileged above girls in their inclusion in adult discussions. In their meta-analysis of studies investigating differential socialization of boys and girls in North American samples, Lytton and Romney (1991) found no significant differences between boys and girls in the amount of time spent interacting with parents, the amount of verbal interaction engaged in, nor in levels of parental restrictiveness or discipline. Assuming that these findings generalize to British samples, previous findings lead us to predict no gender differences in those forms of child–adult interaction that might be considered relevant to the development of verbal mediation.

These postulated cross-national differences led us to hypothesize interactions between nationality and gender in the development of verbal mediation. With regard to the British sample, previous findings of no gender differences in child–adult interaction, and no clear differences in PS use, led us to predict no gender effects in PS use or

phonological recoding. With regard to the Saudi sample, our assumption was that Saudi girls would experience levels of interaction with adults (albeit predominantly with female family members) similar to those of British children. We expected Saudi boys' less extensive participation in interactions with adults to lead to a corresponding delay in the shift to verbal mediation. At the same time, we predicted no main effect of gender on either PS use or phonological recoding.

Cross-National Differences in Educational Practices

Important differences also exist between the two nationality groups in children's educational experience. In educational systems in the US and UK, the early years of primary school are characterized by learning through play, with children generally being afforded opportunities to talk to themselves and others as they learn. Deniz (2004) reported that, although American early-years teachers differed widely in their attitudes to PS among their charges, such utterances were typically tolerated in the classroom. In comparison, Saudi children are taught by a more traditional method from an early age, with "an emphasis on factual knowledge, lecturing, textbooks, memorization, homework, discipline, and testing" (Alotaibi, 1993, p. 80; see also Al-Saif, 2003). Although there have not yet been any studies of teachers' attitudes to PS in non-Western societies, it seems plausible that the formal atmosphere in the typical Saudi classroom might discourage, either implicitly or explicitly, this form of verbal self-regulation.

What implications might such educational differences have for the hypotheses of the present study? Again, we suggest that the available evidence pulls in different directions. On the one hand, the more formal and traditional Saudi educational ethos might be expected to give children fewer opportunities for self-talk and constructive

reciprocal dialogue with peers and teachers. These differences will in turn impact upon the process of internalization of social and private speech. On the other hand, the emphasis on rote learning and memorization might mean that Saudi children will be at an advantage in verbal mediation, at least as it relates to short-term recall performance.

Individual Differences in the Development of Verbal Mediation: Testing Vygotskian Hypotheses

The foregoing review describes sociocultural differences between Saudi Arabia and the UK that would seem to have implications for the development of verbal mediation. Our expectation was that these group differences would not show up in main effects of nationality or gender. Rather, we predicted cross-national stability in the shift to verbal mediation on both a non-memory cognitive task and a task involving immediate serial recall of visually presented material. That is, Saudi and British children were expected to be equivalent in their use of PS and phonological recoding. Our prediction was that differences in cultural practices would be manifested in interactions between nationality and gender in our two measures of verbal mediation: PS and phonological recoding. Specifically, it was expected that Saudi boys would show less verbal mediation than either their female compatriots or children in the UK.

Our first two research aims were therefore to shed light on potential cultural differences in the shift to verbal mediation in two different cognitive domains. The real test of Vygotsky's ideas, however, would come from evidence that the development of verbal mediation in these two domains is linked. Our third main aim was thus to determine whether children's use of self-regulatory PS was related to their tendency to use phonological recoding of visually presented material.

The possibility that children's use of self-regulatory speech might relate to memory performance was first raised in a landmark study by Flavell et al. (1966), who investigated spontaneous verbal rehearsal among children aged 5, 7, and 10 years. In addition to the expected age-related increase in the use of verbal rehearsal strategies, Flavell et al. reported two further important findings. First, within each age group, there were individual differences in children's engagement in verbal rehearsal, with children who used such strategies demonstrating better recall than their same-age peers who did not. This suggests that the use of verbal rehearsal is not solely determined by maturational factors, but is also dependent on children's adoption of verbal strategies to regulate their behavior. Second, Flavell et al. reported that teachers were accurate in predicting which children would engage in subvocal rehearsal during the memory task, highlighting the fact that children who tend to rely on verbal strategies to aid recall also use speech more generally to regulate their behavior.

Although researchers in the field of memory development have continued to be interested in the shift to phonological recoding as part of a general transition toward the verbal mediation of cognitive processes (Ford & Silber, 1994; Hitch et al., 1991), no empirical investigations of this possibility have been conducted since the work of Flavell et al. (1966) and Conrad (1971). Furthermore, these important early studies did not investigate children's use of verbal mediation outside the context of working memory tasks. Our aim was therefore to conduct the first empirical test of the association between mnemonic and non-mnemonic verbal mediation. Specifically, we asked whether children who used more self-regulatory PS on a non-memory task were more likely to engage in phonological recoding in a separate recall task. Evidence that the shift to verbal

mediation is not limited to any particular cognitive domain would provide strong support for Vygotsky's claims about the increasing importance of verbal mediation in children's cognition.

The present study tested five main hypotheses: (1) that there would be cross-national stability in PS use, with no main effect of nationality on PS rates; (2) that there would be an interaction between nationality and gender in PS use, with Saudi boys producing fewer PS utterances than Saudi girls and children in the UK; (3) that there would be cross-national stability in the use of phonological recoding, as indexed by susceptibility to the PSE; (4) that there would be an interaction between nationality and gender in susceptibility to the PSE, with Saudi boys being less susceptible than children in the other groups; and (5) that children's use of phonological recoding would correlate positively with their use of self-regulatory PS.

Method

Participants

The 121 participants were drawn from two countries: the UK and Saudi Arabia. The British sample consisted of 58 children (50% girls) attending a primary school in a small city in the North-East of England. The catchment area for the school included a mix of private and public housing, and the percentage of children entitled to free school meals (indicating socioeconomic disadvantage) was well below the national average. All of the children were White and spoke English as their native language; they ranged in age from 53 to 92 months ($M = 72.6$, $SD = 10.8$). The Saudi Arabian sample consisted of 63 children (44% girls) attending a complex of private schools in a major city. Private schools were used for recruitment of the Saudi sample because of the male researcher's

difficulty in gaining access to all-girl state schools. Private education in Saudi Arabia, although segregated by gender, typically involves boys and girls being taught in the same school complex, which in this case made the task of gaining access to female students considerably easier. Private and public schools in Saudi Arabia are considered to be fully comparable in terms of their curriculum and other educational programmes and activities, as well as educational ideology. All of the children were Saudi Arabian and spoke Arabic as their native language; they ranged in age from 53 to 97 months ($M = 76.6$, $SD = 11.2$). The significance of this small difference in age between the samples is investigated further in the Results section.

Overview of Procedure

The male experimenter was a native Arabic speaker of Saudi Arabian origin who was also fluent in English. Children were tested individually in the school library (UK) or school theatre (Saudi Arabia), with the experimenter sitting adjacent to the child. Participants were seen on three occasions. The first testing session began with an assessment of children's general verbal ability, followed by the PS measures. Approximately 3 weeks later, one of two memory tasks was administered. The second memory task was administered in the final session, conducted approximately 1 week after the second session.

Private Speech Measures

A manual version of an executive planning task, the Tower of London (ToL; Shallice, 1982) was used to elicit children's PS. The ToL has been found to be an appropriate task for eliciting self-regulatory PS (Fernyhough & Fradley, 2005). The task was also considered to be likely to be relatively unfamiliar to children of both

nationalities. The ToL used in the present study consisted of three pegs of differing lengths inserted into a wooden base measuring 20cm × 7cm × 2cm, and three colored cotton reels (red, green, and blue). The lengths of the pegs were such that one would accommodate three reels, one would accommodate two reels, and the shortest peg only one reel. Two identical copies of the ToL were used, one showing the child the target configuration of the reels, the other (which the child manipulated) presented in the same standard initial configuration.

The experimenter showed the child the two ToL puzzles, explaining that the object of the game was to make the standard ToL configuration look like the target configuration. The child was then told that there were some special rules of the game: (a) only one reel could be moved at a time; and (b) every reel had to be on a peg, and reels could not be placed on the table or held in the hand. To help children adhere to these rules, they were asked to place their non-preferred hand behind their backs. Participants were then told: “Some children like to talk out loud to themselves when they play this game. You can do that if you like. I bet in class you have to be quiet, but when you’re playing this game with me, you can talk as much as you like”. This instruction was included in response to Frauenglass and Diaz’s (1985) observation that elicitation of task-relevant PS is maximized when children are given an explicit invitation to talk aloud to themselves when working on a task.

Children were given two practice trials, each involving only two reels (green and blue). The experimenter then added the red reel and presented the first target configuration, saying: “Now, can you make this (indicating the standard apparatus) look like this? (indicating the target apparatus).” Timing for performance measures began as

soon as the experimenter had finished this last utterance, and the same time-point served as the starting point for subsequent videotape coding of children's speech.

Each participant attempted the same four trials, in increasing order of difficulty. The simplest trial required a minimum of two moves to achieve the target configuration, the next trial three moves, the next four moves, and the final trial five moves. If a child became stuck, distracted or upset, the experimenter intervened, resetting the puzzle if necessary. In such instances, which were rare (less than 5% of trials), only the second attempt at the problem was coded. At all other times the experimenter sat quietly to one side, answering any direct questions but otherwise keeping his involvement to a minimum.

Speech was coded from videotapes of the ToL sessions. The procedure involved assigning each utterance to a superordinate category (social or private), and then further sub-dividing private utterances according to overtness and task relevance. An utterance was defined as any segment of speech containing (a) no temporal pause that exceeded 2s, and (b) no semantic discontinuity (i.e., a change of content or subject, whether or not it was preceded by a 2s pause). Utterances were classified as social speech if: (a) the child sustained eye contact with the experimenter during or within 2s of the utterance; (b) the child's behavior involved the experimenter (e.g., through physical contact or extension of arm toward the experimenter) during or within 2s of the utterance; (c) the experimenter's behavior involved the child (through physical contact or an action attracting the child's gaze) during or within 2s of the utterance; (d) the utterance had the same topic as the experimenter's preceding utterance (one that ended no more than 2s before the child's began); (e) the utterance was a question directed to the experimenter, where an answer

appeared to be expected; (f) the utterance contained a vocative or name; (g) the utterance occurred less than 2s after any social speech utterance. Any utterance that did not meet any of the above criteria was classified as PS.

All PS utterances were further categorized in terms of their overtness and relevance to task behavior using Berk's (1986) three-level scheme. Level 1 private speech (PS1) consisted of task-irrelevant overt utterances, including word play and repetition, task-irrelevant affect expressions, and comments to absent, imaginary, or nonhuman others. Level 2 private speech (PS2) consisted of task-relevant, overt utterances, including describing one's own activity and self-guiding comments, self-answered questions, and task-relevant affect expressions (e.g., "I did it!", "This is hard"). Level 3 private speech (PS3) consisted of task-relevant partially covert utterances, including inaudible muttering and whispering, and silent, verbal lip and tongue movements.

All of the ToL sessions were coded for social speech and PS by a trained researcher who was blind to the other measures, and a randomly-chosen quarter of the tapes was coded by a second, blind researcher. Inter-rater agreement for assignment of speech across the social speech and the three PS categories was $\kappa = 0.77$. Disagreements mainly concerned whether children's lip movements indicated PS3, and were resolved by discussion. Children received frequency scores for the number of social speech, PS1, PS2, and PS3 utterances made during the session. Rate measures (utterances per minute) for the different speech categories were derived by dividing these frequency scores by the total amount of time spent on the task.

Memory Measures

Memory for phonologically similar and dissimilar items was assessed in separate sessions. Children were randomly assigned to start with either the similar or the dissimilar items. The memory task was selected to be equally appropriate to both samples, with children in both nationality groups assumed to be familiar with rote learning.

Phonologically similar items. For both the British and Saudi children, the test stimuli consisted of a set of eight simple line drawings of common objects, mounted on cards sized 35 by 25 cm. For the British children, the pictures were taken from a selection of early word books published by Ladybird Books. All object names were high-frequency, monosyllabic, concrete nouns that were familiar to the children: cat, car, clown, cow, clock, cake, keys, cot.

Preparation of a comparable set of pictures suitable for the Saudi children involved several stages. First, Arabic names of common objects familiar to children were collected. A selection of books published by Dar Al-Manhal for Publishing and Distributing, Amman, Jordan, was used for this purpose. The requirement that the to-be-remembered words were monosyllabic was not always met because most monosyllabic Arabic words have abstract meanings, unfamiliar to young children. The set of selected pictures was then piloted on a separate, small ($N = 6$) group of children aged between 4 and 8 years in order to establish whether any of the words were poorly understood. None of the children encountered any problems with comprehension. The set of phonologically similar Arabic words was (with transliterations in parentheses): pencil (qalam), boat (qareb), monkey (qerred), cat (qet), cage (qafas), foot (qadam), train (qetar), moon (qamar).

Phonologically dissimilar items. The stimuli for the British children consisted of eight line drawings representing the following set of high-frequency monosyllabic nouns: house, dog, lamp, glass, tree, flag, shoe, ball. For the Saudi children, the procedure outlined above was used to identify suitable phonologically dissimilar items, although again it was not possible to meet the requirement of being monosyllabic. The test items for the Saudi children were: scissors (maqus), eye (aain), bell (jaras), duck (butta), box (sandoq), horse (hessan), clock (sa' ah), apple (toffaha).

Both of the memory sessions (phonologically similar items and phonologically dissimilar items) began with the picture cards being laid on the table. The child was then asked to name the pictures one by one. None of the children had any difficulty in naming all of the pictures. The experimenter then introduced the memory task, stating that the point of the game was to try to remember the names of the objects shown on the cards, and to recall them in the order in which they had been presented.

The present study's focus on the spontaneous emergence of verbal mediation of memory meant that steps were taken to eliminate overt naming of the items at presentation. Overt naming has been shown to encourage phonological recoding of visually presented material in an immediate recall task (Ford & Silber, 1994). We were interested in children's spontaneous use of covert phonological recoding, as a manifestation of the use of a verbal mediation strategy, which would have been confounded by individual differences, perhaps related to impulsivity, in children's tendency spontaneously to name items presented to them. Accordingly, the experimenter explained that the child had to be silent during presentation of the stimuli, and had to place a finger over his or her lips in order to ensure silence. Palmer (2000a) showed that

prohibiting overt labelling using the same ‘finger on lips’ procedure had no effect on 3- to 7-year-old children’s recall of sequences of pictures in a similar task, concluding that labelling neither enhances nor hinders recall for any type of visual stimulus. That said, the requirement of keeping a finger to one’s lips while remaining silent clearly contributes an executive component to the demands of the task, the possible implications of which are considered in the Discussion.

The experimenter then demonstrated the memory task by looking silently at a series of two pictures, viewing each picture for 2s before placing it face down, and repeating the items pictured in order of presentation. Children were told that they could say “don’t know” in place of an item whose position they knew but whose name they had forgotten, and that they should recall the items as soon as the last card had been placed face down. The child was then given 3 two-word lists as practice, with a reminder of the prohibition on labelling at presentation and the importance of recalling the items in the correct order. None of the children had any difficulties with the practice trials.

The test trials consisted of 10 trials for both the phonologically similar items (PSI) and phonologically dissimilar items (PDI), each of which involved the visual presentation of three picture cards. Each picture was held in front of the child for 2s, and then placed face down on the table. The child was given 30s to recall the list. The same 10 three-picture combinations were used for all children, but the presentation of the trials within the PSI and PDI sets was randomized. All sessions were videotaped for later scoring.

For each of the PSI and PDI trials, children received 2 points for recalling an item in the correct position, and 1 point if a correct item was recalled in the wrong position.

Perfect recall for a three-item trial therefore received a score of 6, giving a maximum score of 60 for the block of 10 PSI trials, and 60 for the PDI block.

Determining the extent of phonological recoding. As noted in the Introduction, previous research has tended to treat the PSE as an all-or-nothing phenomenon, with little consideration of how individual differences in the effect relate to developmental precursors and sequelae. In line with previous studies, we investigated the presence of the PSE by conducting within-subject comparisons between recall for PSI and PDI stimuli. Our assumption was that the difference between PDI and PSI scores represents the extra memory capacity gained by the shift to phonological recoding. If this assumption is correct, PSI scores represent the memory capacity provided by a non-verbal, predominantly visual store which, before the onset of phonological recoding, is presumably primarily responsible for the encoding of visually presented material. The extra capacity provided by phonological recoding, during a period of dual visual and phonological coding (Palmer, 2000a), makes the difference between PDI and PSI scores (see Figure 1). Thus, PDI scores can be taken as a measure of verbal mediation of short-term memory, when PSI scores are simultaneously controlled for in regression analyses. This method of analysis (detailed further in the Results section) allowed us to control for children's baseline memory performance in a way that a simple subtraction method (PDI–PSI) would not.

Verbal Ability

Verbal ability was measured in light of previous findings of a relation with PS (Berk & Spuhl, 1995; Frauenglass & Diaz, 1985; Kohlberg et al., 1968). The British children's verbal ability was assessed using the British Picture Vocabulary Scale II

(BPVS II: Dunn, Dunn, Whetton, & Burley, 1997), and the Saudi children were assessed using the Verbal Development Scale (VDS). The VDS is a sub-scale of the Children's Adaptive Behavior Scale (Richmond & Hicklighter, 1980) that was standardized on Saudi children aged between 4 and 12 years by Al-Shukhs (1998).

Results

Descriptive Statistics and Preliminary Analyses

Table 1 shows the descriptive statistics for background variables, speech measures derived from the ToL, and memory task performance, as functions of nationality and gender. (Note that the raw speech frequency and memory means are given for descriptive purposes, and therefore statistically significant differences are not marked on the table.) An alpha level of .05 was used for all statistical tests except where stated. A 2 (nationality) \times 2 (gender) ANOVA with age as the dependent variable showed that the Saudi children were marginally significantly older, $F(1, 117) = 3.92, p = .05, \eta^2 = 0.032$. There was no relation between age and gender, $F < 1, n.s.$, and no interaction. Verbal ability scores for the two nationality groups were found to have acceptable homogeneity of variance, Levene's $F(1, 119) = 3.14, n.s.$, and were therefore treated as a single variable. A 2 (nationality) \times 2 (gender) ANOVA with verbal ability as the dependent variable showed no differences between nationality groups, $F < 1, n.s.$, or gender groups, $F(1, 117) = 2.65, n.s.$, and no interaction. Age and verbal ability were positively correlated, $r(119) = 0.20, p < .05$, two-tailed, $r^2 = .041$, a relation that appeared due to a positive association between these variables in the Saudi sample, $r(61) = 0.29, p < .05$, two-tailed, $r^2 = .086$, but not the British sample, $r(56) = 0.07, n.s.$. In the analyses that follow, the general strategy was to include age and verbal ability as covariates.

Before further analysis, the association between PS measures and age was explored. As noted in the Introduction, the observation that PS peaks in middle childhood and then drops away means that it can be difficult to determine the developmental significance of instances where children do not use any PS. Children who produce no such utterances may be doing so because they have not yet begun to engage in PS, or alternatively because they have already completed the internalization process described by Vygotsky. In the absence of longitudinal data on PS use in our sample, our strategy was first to examine correlations between PS use and age, in order to determine where our participants lay on the inverse-U curve of PS development. Because of violations of normality in the untransformed data (see below), these correlations were computed using Kendall's tau. As expected, correlations with age shifted from negative to positive with progress through the developmental hierarchy of PS sub-types postulated by Berk (1986). That is, age was significantly negatively correlated with PS1 rates, $\tau(119) = -0.17, p < .025$, uncorrelated with PS2 rates, $\tau(119) = 0.09$, n.s., and significantly positively correlated with PS3 rates, $\tau(119) = 0.29, p < .001$ (all tests two-tailed). Inspection of scattergrams showed these relations to be linear. It was therefore concluded that the present sample was on the up-slope of the inverted-U trajectory described by previous PS researchers, and that the process of internalization was still in progress for the children in this sample. These findings are in line with those of Winsler and Naglieri (2003), who reported that use of covert PS (corresponding to PS3 in the present study) increased linearly between ages 4 and 8, while use of overt PS (corresponding to PS2 in the present study) decreased over the same time period.

As Table 1 shows, the speech measures derived from the ToL task had high standard deviations relative to means (cf. Berk & Garvin, 1984), and analysis showed unsatisfactory skewness and kurtosis. Accordingly, all speech measures were log-transformed before further analysis, reducing skewness and kurtosis to acceptable levels. Across both nationality samples, 58 children (47.9%; 27 Saudi) produced no PS2, and 19 (15.7%; 12 Saudi) produced no PS3. In order to preserve statistical power after log-transformation, these two sub-types were collapsed together to give a single rate measure of task-relevant, self-regulatory PS (PS2 + PS3). Only 12 children (9.9% of the sample; 7 Saudi) produced no such speech on the ToL task as a whole. Log-transformed self-regulatory PS was positively correlated with age, $r(107) = 0.36, p < .001, r^2 = .13$, verbal ability, $r(107) = 0.25, p < .01, r^2 = .063$, and rate of social speech, $r(107) = 0.73, p < .001, r^2 = .53$. Higher levels of PS were associated with older children and with those who were more verbally able. The very strong correlation with social speech mirrors previous findings with this task (Fernyhough & Fradley, 2005), and suggests that children's PS rates might relate to their overall talkativeness. Self-regulatory PS was significantly negatively correlated with log-transformed time spent on the task, $r(105) = -0.52, p < .001, r^2 = .27$ (all tests two-tailed), when age and verbal ability were partialled out. Thus, children who used more PS solved the four trials of the ToL task more quickly, lending support to the idea that self-regulatory PS can enhance children's performance on this task (Fernyhough & Fradley, 2005).

Cross-National Comparisons of Private Speech Use

Our first hypothesis stated that there would be cross-national equivalence in PS use, and our second hypothesis entailed the prediction of an interaction between

nationality and gender, with Saudi boys producing less self-regulatory PS than Saudi girls or children in the UK. Relations with nationality and gender were investigated using analyses of covariance, with self-regulatory PS as the dependent variable, and age and verbal ability as covariates. Both of these variables had been shown to be positively correlated with self-regulatory PS, and a further reason for controlling for age was that the Saudi children were slightly older than their British counterparts (see above). A 2 (nationality) \times 2 (gender) ANCOVA showed no main effects of nationality or gender, $F_s < 1$, n.s., but a significant interaction, $F(1, 103) = 7.48, p < .01, \eta^2 = 0.068$. The interaction was investigated using separate one-way ANCOVAs on the two nationality groups, with self-regulatory PS as the dependent variable, gender as the independent variable, and age and verbal ability as covariates. A Bonferroni adjustment to alpha ($\alpha = 0.025$) was made to allow for multiple comparisons. For the British sample, gender had a significant effect on PS rates, $F(1, 49) = 8.63, p = .005, \eta^2 = 0.15$, with boys producing more self-regulatory PS than girls. For the Saudi sample, there was no statistically significant effect of gender, although there was a non-significant trend in the opposite direction to the British sample, with Saudi girls using more self-regulatory PS than Saudi boys, $F(1, 52) = 1.23$, n.s., $\eta^2 = 0.023$. The cause of the interaction would therefore appear to be boys' greater use of self-regulatory PS in the British sample, coupled with no such gender effect in the Saudi sample.

As reported above, levels of self-regulatory PS in this sample were highly correlated with social speech. In order to determine whether the interaction between nationality and gender was specific to PS or applied to children's speech in general, the same analyses were conducted on social speech measures. A 2 (nationality) \times 2 (gender)

ANCOVA with log-transformed social speech as the dependent variable showed no main effects of nationality or gender, $F_s < 1$, n.s., but a significant interaction, $F(1, 114) = 7.54$, $p < .01$, $\eta^2 = 0.062$. As before, the interaction was investigated using separate one-way ANCOVAs on the two nationality groups, with social speech as the dependent variable, gender as the independent variable, age and verbal ability as covariates, and a Bonferroni adjustment to alpha ($\alpha = 0.025$). For the British sample, gender had no significant effect on social speech rates, $F(1, 54) = 3.87$, $p = .054$, although there was a medium-sized effect ($\eta^2 = 0.067$) in the direction of higher social speech rates among boys. For the Saudi sample, there was a marginally significant effect of gender, $F(1, 58) = 4.67$, $p = .035$, $\eta^2 = 0.075$, with girls producing slightly more social speech than boys.

This pattern of findings for private and social speech therefore suggests that the interaction between nationality and gender might apply to children's speech in general, rather than to PS in particular. In order to investigate this further, the two-way ANCOVA with self-regulatory PS as the dependent variable was repeated with a further covariate included, namely the log-transformed rate of social speech. The result was that the Nationality \times Gender interaction disappeared, $F < 1$, n.s., but now the main effect of gender was marginally significant, $F(1, 102) = 3.94$, $p = .05$, $\eta^2 = 0.037$, with boys using more PS than girls across both nationality samples. This gender effect represents a small effect according to Cohen's (1988) criteria. The disappearance of the interaction with the inclusion of social speech as a covariate suggests that, when overall verbosity is taken into account, the greater tendency of boys to engage in self-regulatory PS applies across nationality groups. This pattern of findings is considered further in the Discussion.

Cross-National Comparisons in the Shift to Phonological Recoding

The second main aim of the present study was to investigate cross-national stability in the shift to phonological recoding. First, the association between recall scores and the two background variables was investigated. As expected, the two memory scores, PDI and PSI, were strongly associated, $r(119) = 0.76, p < .001, r^2 = .58$. Recall of PDI and PSI items was also significantly positively correlated with age, $r(119) = 0.55, p < .001, r^2 = .30$, and $r(119) = 0.61, p < .001, r^2 = .37$, respectively, and with verbal ability, $r(119) = 0.32, p < .001, r^2 = .10$, and $r(119) = 0.35, p < .001, r^2 = .12$, respectively (all tests two-tailed). Given that the Saudi children were marginally significantly older, it was necessary to determine whether memory scores and age were related in both nationality groups. For the Saudi group, recall of PDI and PSI items was significantly positively correlated with age, $r(61) = 0.66, p < .001, r^2 = .43$, and $r(61) = 0.74, p < .001, r^2 = .54$, respectively. For the British group, recall of PDI and PSI items was also significantly positively correlated with age, $r(56) = 0.43, p = .001, r^2 = .18$, and $r(56) = 0.48, p < .001, r^2 = .23$, respectively. Cross-national comparison of these correlation coefficients showed that memory scores and age were more strongly correlated in the Saudi sample than in the British sample (for PDI, $z = 1.82, p < .05$; for PSI, $z = 2.26, p < .05$).

Our third hypothesis was that there would be cross-national stability in the use of phonological recoding, as indexed by susceptibility to the PSE. In the terms of the present study, any cross-national differences in such susceptibility would be demonstrated by an interaction between nationality and phonological similarity. Our fourth hypothesis entailed the prediction that nationality, gender, and phonological similarity would interact, with Saudi boys being less susceptible to the PSE than children in the other

groups. These hypotheses were tested with a 2 (nationality) \times 2 (gender) \times 2 (phonological similarity) mixed-design ANOVA with recall score as the dependent variable. There was a main effect of phonological similarity, $F(1, 117) = 30.70, p < .001, \eta^2 = 0.21$, with PDI items recalled better than PSI. There was a main effect of nationality, $F(1, 117) = 4.33, p < .05, \eta^2 = 0.036$, with Saudi children scoring more highly on the recall task. There were no other main effects or interactions. In order to determine whether the nationality effect resulted from the fact that the Saudi sample were slightly older (see above), the analysis was rerun as an ANCOVA, with age and verbal ability as covariates. In this case the main effect of nationality disappeared, $F(1, 115) = 1.46, n.s.$, as did the main effect of phonological similarity, $F(1, 115) = 1.15, n.s.$, although both remained as small (Cohen, 1988) non-significant effects, $\eta^2 = 0.013$ and $\eta^2 = 0.01$ respectively. (Note that these main effects also disappeared when age and verbal ability were entered as separate single covariates on separate ANCOVAs, suggesting that neither covariate was predominantly responsible for the diminution of either of these effects.)

The present study therefore demonstrated some support for our third hypothesis, which predicted cross-national stability in the shift to phonological recoding. Although Saudi children performed better on the recall tasks overall, this effect disappeared when age and verbal ability were included as covariates, suggesting that the nationality effect may have been an artifact of the Saudi children's greater age. There was no interaction between nationality and phonological similarity, suggesting that neither nationality group was more susceptible to the PSE. There was no support for our fourth hypothesis, which predicted a three-way interaction between nationality, gender and phonological similarity.

The present study provided a further opportunity to test previous hypotheses about the emergence of the PSE. As noted in the Introduction, there has been some controversy over the timetable for the shift to phonological recoding of visually presented material, particularly regarding the question of whether the PSE obtains in children under age 6 (Ford & Silber, 1994; Palmer, 2000a). Given that a large proportion (38.8%; $N = 47$; 20 Saudi) of our sample were under the age of 72 months, we were able directly to examine cross-national stability in the shift to phonological recoding in this younger sub-sample. To preserve statistical power, gender (which had not had any main effect in the larger sample) was not included as a variable in this analysis. A 2 (nationality) \times 2 (phonological similarity) mixed-design ANOVA with recall score as the dependent variable showed a main effect of phonological similarity on recall scores, $F(1, 45) = 6.82$, $p < .05$, $\eta^2 = 0.13$, with PDI items recalled better than PSI. There was no main effect of nationality, $F < 1$, n.s., and no interaction. As before, the analysis was rerun as an ANCOVA with age and verbal ability as covariates. Once again, the main effect of similarity disappeared, $F < 1$, n.s., $\eta^2 = 0.00$. There was no main effect of nationality, $F < 1$, n.s., $\eta^2 = 0.00$, and no interaction. Power to detect the PSE in this sub-sample, based on an effect size of $\eta^2 = 0.13$ for the PDI–PSI difference, was estimated to be 97%.

The present study thus provides evidence that susceptibility to phonological similarity, and hence presumably the beginning of phonological recoding, appears before the age of 6. However, this effect may not be independent of individual differences in age and verbal ability, as demonstrated by the disappearance of the PSE when these variables were included as covariates.

Private Speech and Phonological Recoding: Evidence for a Transition to Verbal Mediation

The third main aim of the present study was to investigate relations between PS use and phonological recoding. As suggested in the Introduction, empirical support for an across-the-board transition toward verbal mediation would come from evidence of a positive correlation between (a) use of verbal mediation on a non-memory task and (b) phonological recoding of visually presented material. As outlined in the Method, PDI scores were taken as a measure of phonological recoding, when PSI scores were simultaneously controlled for in a regression analysis. Hierarchical multiple regressions were constructed as follows. In the first series of analyses, PDI scores were used as the dependent variable, representing the memory capacity resulting from the employment of phonological recoding in addition to visual coding (see Figure 1). On the first block, the background variables of nationality, gender, age, and verbal ability were entered. On the second block, PSI scores were entered, as a measure of memory ability based on purely visual coding. Finally, on the third block, log-transformed self-regulatory PS was entered. In order to test specificity, the analysis was then re-run using PSI as the dependent variable, and entering PDI on the second block. If the target variable (self-regulatory PS) were indeed a predictor of PDI when PSI is held constant, then its inclusion should account for significant extra variance in the first model, but not in the second.

Table 2 shows the results of the first of these analyses. Neither nationality nor gender emerged as predictors of PDI recall on the first step. As expected from the exploratory correlational analyses (see above), age, verbal ability and PSI scores were strong predictors of PDI recall. Table 2 demonstrates that the inclusion of self-regulatory

PS on the third step added significantly to the variance accounted for by the model, $\Delta R^2 = .02$, $p < .05$. The same pattern was not found, however, when PSI was the dependent variable and PDI entered on the second step (Table 3). The value of self-regulatory PS as a predictor, therefore, seems to be specific to PDI scores, rather than to recall performance in general. Table 4 shows the result of the hierarchical regression analysis with the same variables, when log-transformed social speech rates were entered on the third step instead of PS. Including social speech on the third step did not add to the variance accounted for by the model, suggesting that any association between speech and memory performance is specific to self-regulatory PS, rather than to speech in general.

Thus, in support of our fifth hypothesis, use of self-regulatory PS was associated with recall of PDI items when PSI scores were held constant in a hierarchical regression. This finding suggests that children who used higher levels of self-regulatory PS on a non-memory task engaged in more phonological recoding of visually presented material. The fact that nationality did not make any independent contribution to the variance in PDI scores suggests that this relation between self-regulatory PS and phonological recoding is cross-culturally stable.

Discussion

The aim of the study reported here was to present cross-national comparisons of children's PS use and phonological recoding, and to investigate relations between these two varieties of verbal mediation. Our first hypothesis was that there would be cross-national equivalence in PS use, with no effect of nationality on the rate of self-regulatory PS. This prediction was borne out. In our second hypothesis, we predicted that nationality would interact with gender in ways reflecting the differing treatment of boys and girls in

Saudi society. Previous findings from Saudi Arabia and other collectivist cultures led us to predict that Saudi boys would have relatively limited opportunities for active participation in reciprocal exchanges with adults. On the basis of this assumption, Saudi boys were predicted to use less self-regulatory PS than their female compatriots and British children of both genders. The prediction of an interaction between nationality and gender was supported. Contrary to our hypothesis, the cause of this interaction was a greater use of self-regulatory PS among British boys compared with British girls, coupled with a non-significant trend in the opposite direction for the Saudi sample. A similar pattern of findings emerged when social speech was used as the dependent variable, leading us to repeat the analysis of PS scores with social speech entered as a further covariate. The result was that the interaction between nationality and gender disappeared, to be replaced by a marginally significant main effect of gender, with boys using more self-regulatory PS than girls across both nationality groups. This finding suggests a small underlying gender effect in PS use when social speech is controlled for in analyses of covariance.

Our third hypothesis was that there would be cross-national stability in susceptibility to the PSE, with the shift to phonological recoding occurring at the same rate in both nationality groups. In support of this hypothesis, there was no interaction between nationality and phonological similarity when recall score was the dependent variable. Our fourth hypothesis predicted a three-way interaction between nationality, gender, and phonological similarity, with Saudi boys proving less susceptible to the PSE than Saudi girls and British children. No such interaction was observed. For the group as a whole, PDI items were recalled better than PSI items. There was a main effect of

nationality, with Saudi children scoring more highly on the recall task. However, both of these main effects disappeared when age and verbal ability were entered as covariates. The disappearance of the nationality effect was consistent with the Saudi children being marginally significantly older than the British participants. The unexpected disappearance of the phonological similarity effect is considered in more detail below.

Our final hypothesis concerned the association between PS use and phonological recoding. We predicted that children's use of PS would be a significant predictor of PDI recall scores, when PSI scores were controlled for in hierarchical regressions. In line with these predictions, self-regulatory PS accounted for a significant amount of extra variance when entered after background variables and PSI scores. Testing for the specificity of this effect, by switching PSI and PDI in a second hierarchical regression, suggested that the effect was specific to PDI recall rather than to recall in general. A final regression analysis showed that social speech did not contribute significantly to the model, leading us to conclude that it is self-regulatory PS in particular, rather than speech in general, that is related to the use of phonological recoding.

A number of other findings are worthy of note. Firstly, our results add to a growing body of evidence that PS is a very common, almost universal phenomenon in early and middle childhood. The vast majority of our participants (> 90%) used self-regulatory PS on the ToL task. These high levels of PS are in line with recent findings that almost all children engage in PS (Matuga, 2003; Winsler et al., 2003). Secondly, children who used more self-regulatory PS solved the 4 trials of the ToL task more quickly. This finding corroborates recent evidence of an association between self-regulatory PS and concurrent task performance on both this (Fernyhough & Fradley,

2005) and other (Winsler et al., 1999) cognitive tasks. Our findings therefore add to a growing body of evidence that self-regulatory private speech can enhance children's cognitive performance in a range of contexts. Thirdly, our results speak to the issue of the age at which children begin phonological recoding of visually presented material.

Analysis of the recall data from a subset of children aged below 6 showed evidence for the PSE, in terms of a significant difference between PDI and PSI recall. These results suggest that phonological recoding may already be well established in the preschool years. As with the analysis for the complete sample, this similarity effect disappeared when age and verbal ability were entered as covariates, an unexpected result that is considered in more detail below.

Several of the findings reported here warrant further discussion. The similarity of the pattern of main effects and interactions in the analysis of PS and social speech is consistent with the fact that PS was highly correlated with social speech, as would be expected if PS has its ontogenetic roots in social speech (Furrow, 1984; Vygotsky, 1934/1987). When social speech was included as a covariate in a further analysis of the PS scores, the interaction between nationality and gender was replaced by a marginally significant main effect of gender. If social speech can be taken as a measure of talkativeness that is not specifically concerned with self-regulation, we can conclude that the two nationality groups' PS profiles became more similar when overall verbosity was controlled for. The appearance of an underlying gender effect is particularly interesting in this regard, not least because it seems to be specific to self-regulatory PS rather than to verbosity in general. One possible cause of this gender effect might have been the presence of an unfamiliar male experimenter, which might be expected to make girls of

both nationalities more inhibited in their speech (both social and private). This explanation seems unlikely, however, given the relatively high rates of both kinds of speech shown by the Saudi girls (see Table 1).

A more plausible explanation is that the greater use of self-regulatory PS by British boys reflects the different ways language is used by boys and girls in western cultures. Although the evidence points to no extensive gender differences in child–parent interaction in such cultures (Lytton & Romney, 1991), recent research has reported reliable gender differences in children’s use of speech for different communicative purposes. In their meta-analysis, Leaper and Smith (2004) showed that, while girls in their representative studies were more talkative overall, boys used more self-assertive speech (concerned with giving commands and influencing others), while girls used more affiliative speech (concerned with establishing and maintaining connections with others). Given Vygotsky’s (1934/1987) claim that self-regulatory private speech represents the turning inwards, onto the self, of verbal directives that were previously used to regulate the behavior of others, it is perhaps not surprising that, on a task involving considerable cognitive challenge, boys’ greater use of directive speech acts is manifested in a gender effect in self-regulatory PS use.

Our findings may have implications for the rather equivocal body of evidence on PS and gender. Specifically, underlying gender differences in self-regulatory PS may become apparent when overall verbosity is controlled for, a precaution that is not commonly taken in PS research. If this gender effect is confirmed by future studies on western samples, it would seem to go against our assumption that equivalence in child–adult interaction in children of both sexes will be reflected in equal rates of PS in boys

and girls. One interesting avenue for future research is to determine whether boys' greater use of verbal directives to the self on cognitive tasks is mirrored by girls' increased use of self-directed affiliative speech acts such as emotion expression and self-encouragement.

As noted above, the present findings indicate cross-national stability in the shift to phonological recoding, along with evidence that phonological recoding is in place before children reach the age of 6. One surprising feature of our findings, however, is that the main effect of phonological similarity on recall scores disappeared when age and verbal ability were included as covariates, an analytical step that is not commonly taken in developmental research on phonological recoding. At first glance, this finding might be taken to weaken the case that the PSE is present in our sample. Alternatively, it may be that certain aspects of our methodology served to reduce the strength of the PSE when these covariates were included. One possibility is that our prohibition on overt labelling at presentation may have generally reduced children's phonological recoding. A second possibility is that the labelling prohibition may have introduced other task demands, not specifically related to memory. For example, children below the age of about 5 find it difficult to obey a 'do not speak' command (Luria, 1966). Future studies might address both of these issues by including a comparison between overt labelling and enforced silence at presentation. In the meantime, it is worth noting that children's performance on the recall task was good, with means ranging between about 45 and 50 out of a total possible of 60 in each condition. This is consistent with Palmer's (2000a) finding of no effect of overt labelling on children's recall of pictures of any type. Also, the original rationale for prohibiting labelling was to avoid the possible confound of individual differences in children's tendency spontaneously to name items aloud. For example, more

impulsive children might have been more likely overtly to name any pictorial stimulus placed in front of them, which may in turn have influenced their use of phonological recoding.

Perhaps the most intriguing finding of the study reported here is the relation between children's use of self-regulatory PS and their tendency to use phonological recoding, as indexed by their recall of PDI items when PSI performance was held constant in regression analyses. These findings are consistent with the early insights of Flavell et al. (1966) on the link between domain-general verbal self-regulation and memory performance. Flavell et al. reported that teachers accurately predicted those children who would rely on subvocal rehearsal in the memory task on the basis of their use of language to regulate their behavior during everyday classroom activities. Our study extended this finding by taking objective measures of children's use of PS during a separate, non-memory cognitive task. Generally speaking, the assumption that the shift to verbal mediation represents an across-the-board transition is supported by findings that individual differences in PS are stable over time and across task contexts (Winsler et al., 2003). Children who use verbal mediation in one context, such as a cognitive task with a high executive component, are therefore likely to be the same children who use it in a different context, such as a memory task. Taken together, our findings represent evidence that self-regulatory PS and phonological recoding are instances of a domain-general shift to verbal mediation in the preschool years.

This possibility has received relatively little attention in previous work on working memory development. Although some researchers have made reference to the internalization of speech in accounting for the shift to phonological recoding (Ford &

Silber, 1994; Hitch et al., 1991), none has fully recognized the significance of PS as an empirically observable intermediary in this process. On the contrary, a Vygotskian internalization account of children's phonological recoding has been explicitly rejected by some researchers. Drawing on the fact that children process language from the earliest days of life, and thus must be depending upon the pre-existence of some underlying phonological processing capacity, Hitch et al. (1991) argued that the development of a such a capacity could not itself be the result of a gradual process of internalizing overt speech. However, the fact that the articulatory loop is a necessary prerequisite of language development does not preclude the possibility that children's internalization of speech can influence their changing strategies for how they deploy their pre-existing phonological processing capacities. What is at issue is not how the articulatory loop is formed, but how it is recruited to help the child cope with constantly changing cognitive challenges. Adopting a Vygotskian position on verbal mediation development does not therefore have to entail that internalization actually forms the phonological short-term memory system.

A further potential problem for the Vygotskian account of the development of phonological recoding concerns the presence of the PSE in anarthric (Bishop & Robson, 1989) and deaf (Conrad, 1971) children. Hitch et al. (1991) suggest that children who have never been able to hear speech (in the case of deaf children) or produce it (in the case of anarthric children) will not have had the opportunity to internalize speech in the Vygotskian sense. What remains to be determined is the extent to which the children in these studies were able to rely upon sign systems other than natural language to mediate their behavior. For example, deaf children have been observed to engage in apparently

self-regulatory dialogues with themselves using sign language (Goldin-Meadow, 1999). Determining the extent to which anarthric and deaf children can mediate their behavior using sign systems other than natural language suggests a promising avenue for future research.

Related to this is the possibility that the direction of causation has been incorrectly described. That is, it may be that the internalization of PS and the corresponding shift to verbal mediation is driven by, rather than is a determinant of, changes in memory capacity and strategy. One reason for assuming the direction of causation followed here is that PS appears well before any evidence for phonological recoding (e.g., Furrow, 1984). That said, it is inconceivable that the process of internalization could be unaffected by maturational changes in processing capacity. Again, what is at issue is not the memory resources available, but the manner in which they are recruited by the child to the retention and recall of information. Future research will benefit from a closer examination of how maturational changes in processing capacity interact with the emergence and internalization of PS and the development of phonological recoding.

Another issue for future research concerns how the onset of phonological recoding augments pre-existing capacities for visuospatial encoding of pictorial information. Palmer (2000a) presents evidence that, instead of phonological strategies immediately replacing visuospatial ones, children's recall is underpinned by a period of dual coding when both visuospatial and phonological resources are employed in parallel. One way of determining more precisely the balance between visual and phonological strategies would be to investigate children's susceptibility to the visual similarity effect.

In addition, the use of suppression tasks selectively to interfere with these components of working memory may allow us to understand better the roles of visuospatial and phonological coding in both memory tasks and cognitive tasks in general. Future research might also examine children's developing understanding of their own mnemonic strategies (Palmer 2000a), as has been done in recent studies of children's awareness of their self-regulatory PS (e.g., Winsler & Naglieri, 2003). More generally, replication of the present study with a larger sample would allow us to gather richer data on the timescale of the shift to verbal mediation, by including age as an independent variable in age-group comparisons.

Any such study will do well to consider these forms of cognitive activity within a sociocultural context. One limitation of the present study is that we were unable to obtain direct measures of the interactional variables that we assumed, on the basis of previous findings, to differ between our two nationality groups. Generally speaking, there is a need for more cross-cultural work in the area of interpersonal interaction within families and larger social groups. For example, it would be useful to know whether our assumptions about the social opportunities available to Saudi boys and girls, based in part on evidence from other collectivistic cultures, are borne out by observational and interview data. Only such careful documenting of family and institutional interactional contexts will allow us to pay full attention to the sociocultural context within which PS and verbal mediation develop.

Finally, it may be useful to note that the present findings provide a link between two important conceptions of the phenomenon of inner speech. On the one hand, there is the Vygotskian notion of inner speech as the end-product of the gradual internalization of

social and private speech. On the other hand, there is the conception of inner speech as the “voice in the head” (Baddeley, 1986) that underpins our capacity to operate with phonological material in working memory tasks, speech planning, reading, and so on. We suggest that these two kinds of inner speech may be the same thing. If this suggestion is correct, the inner speech that mediates many of our most important cognitive processes may turn out to be influenced by similar social and cultural variables to those that have been shown to affect its external precursor, private speech.

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Table 1

Descriptive Statistics for Background Variables, Speech Measures on Tower of London, and Performance on Memory Task, as Functions of Nationality and Gender

	British		Saudi				Whole Group					
	(N = 58)		(N = 63)				(N = 121)					
	Girls		Boys		Girls		Boys		Girls		Boys	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
<i>Background Variables</i>												
Age (months)	72.3	11.4	72.9	10.4	76.3	10.4	76.9	11.9	74.2	11.0	75.1	11.3
Verbal ability	99.0	8.6	104.3	9.9	101.3	12.5	102.7	12.8	100.1	10.7	103.4	11.5
<i>Tower of London</i>												
Level 1 PS	0.17	0.32	0.28	0.54	0.07	0.24	0.23	0.65	0.12	0.28	0.25	0.60
Level 2 PS	0.31	0.58	0.99	1.62	2.04	3.40	1.21	2.17	1.16	2.55	1.12	2.23
Level 3 PS	1.63	1.12	2.64	2.17	2.09	2.16	1.41	1.62	1.86	1.71	1.97	1.97

Self-regulatory PS (PS2+PS3)	1.94	1.37	3.67	2.72	4.18	4.73	2.65	3.11	3.04	3.61	3.11	2.96
Social speech	4.66	1.82	6.21	2.76	9.98	10.17	5.47	4.30	7.27	7.66	5.81	3.67
Time taken (minutes)	2.88	1.79	2.44	1.94	2.36	1.74	2.12	1.43	2.63	1.77	2.27	1.67
<i>Memory Task</i>												
Phonologically dissimilar items	47.8	9.97	50.5	9.24	52.8	7.03	50.9	8.79	50.3	8.93	50.7	8.93
Phonologically similar items	45.7	10.0	45.8	8.64	49.9	6.30	48.4	8.23	47.7	8.61	47.2	8.45

Note. PS: private speech (utterances per minute).

Table 2

Summary of Hierarchical Regression Analysis for Variables Predicting Recall of Phonologically Dissimilar Items

Variable	<i>B</i>	SE <i>B</i>	β
Step 1			
Nationality	1.45	1.36	.09
Gender	0.35	1.35	.02
Age	0.36	0.06	.48 ^{***}
Verbal ability	0.15	0.06	.20 [*]
Step 2			
Nationality	0.34	1.12	.02
Gender	1.08	1.10	.06
Age	0.12	0.06	.16 [*]
Verbal ability	0.04	0.05	.05
PSI	0.63	0.09	.62 ^{***}
Step 3			
Nationality	0.56	1.10	.03
Gender	0.87	1.09	.05
Age	0.08	0.06	.12
Verbal ability	0.02	0.05	.03
PSI	0.61	0.08	.60 ^{***}
Self-regulatory PS	3.34	1.50	.16 [*]

Note. $R^2 = .33$ for Step 1 ($p < .001$); $\Delta R^2 = .23$ for Step 2 ($p < .001$); $\Delta R^2 = .02$ for Step 3 ($p < .05$). PSI = phonologically similar items; PS = private speech.

* $p < .05$, *** $p < .001$.

Table 3

Summary of Hierarchical Regression Analysis for Variables Predicting Recall of Phonologically Similar Items

Variable	<i>B</i>	SE <i>B</i>	β
Step 1			
Nationality	1.75	1.28	.11
Gender	-1.15	1.27	-.07
Age	0.38	0.06	.52 ^{***}
Verbal ability	0.18	0.06	.23 ^{**}
Step 2			
Nationality	0.95	1.04	.06
Gender	-1.35	1.03	-.08
Age	0.18	0.06	.25 ^{**}
Verbal ability	0.09	0.05	.12
PDI	0.55	0.07	.56 ^{***}
Step 3			
Nationality	0.89	1.05	.05
Gender	-1.31	1.03	-.08
Age	0.18	0.06	.25 ^{**}
Verbal ability	0.09	0.05	.13
PDI	0.56	0.08	.57 ^{***}
Self-regulatory PS	-0.80	1.47	-.04

Note. $R^2 = .39$ for Step 1 ($p < .001$); $\Delta R^2 = .21$ for Step 2 ($p < .001$); $\Delta R^2 = .00$ for Step 3 (n.s.). PDI = phonologically dissimilar items; PS = private speech.

* $p < .05$, ** $p < .005$, *** $p < .001$.

Table 4

Summary of Hierarchical Regression Analysis for Variables Predicting Recall of Phonologically Dissimilar Items, Substituting Social Speech for Private Speech

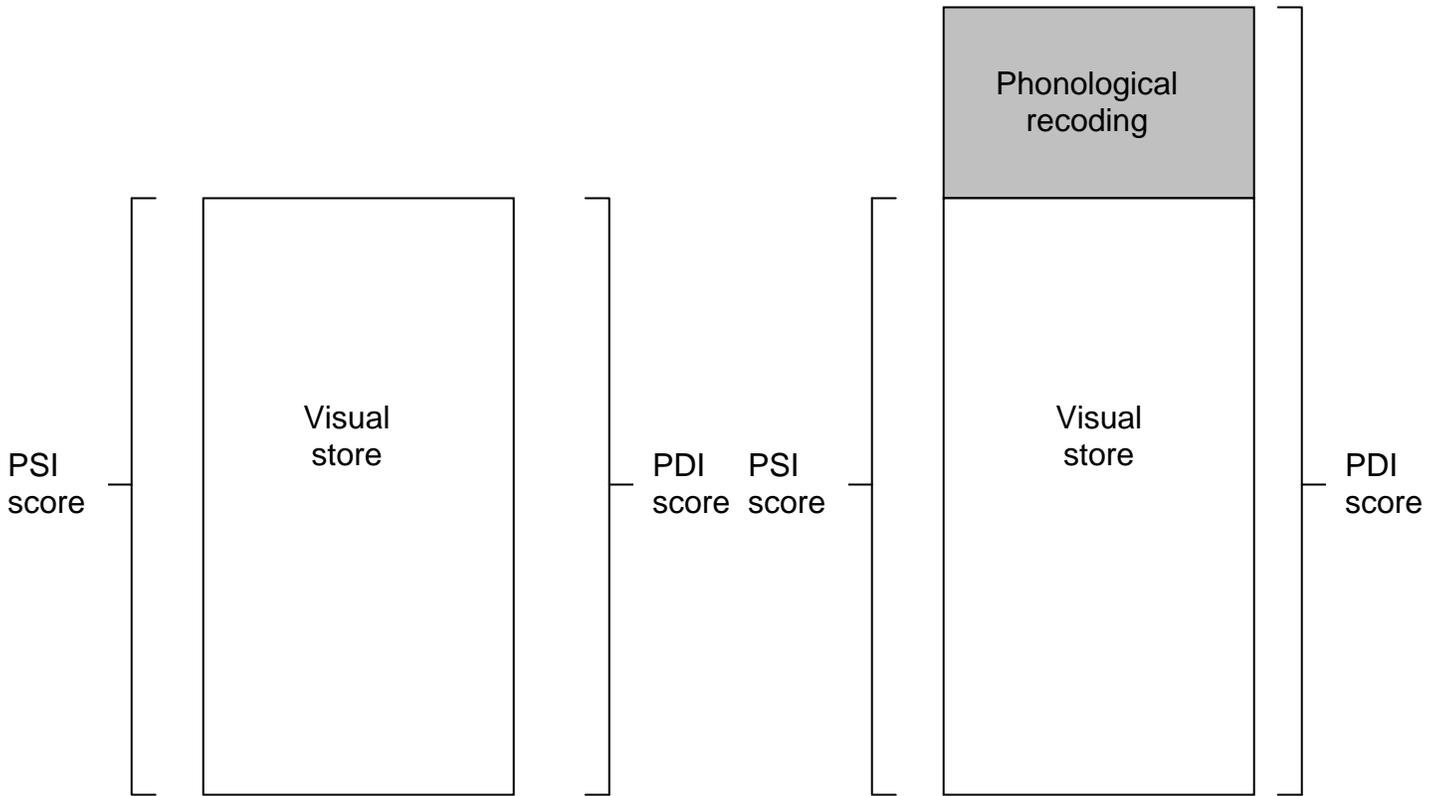
Variable	<i>B</i>	SE <i>B</i>	β
Step 1			
Nationality	0.91	1.36	.05
Gender	-0.57	1.36	-.03
Age	0.39	0.06	.49***
Verbal ability	0.18	0.06	.20*
Step 2			
Nationality	-0.21	1.10	-.01
Gender	0.55	1.10	.03
Age	0.11	0.06	.14
Verbal ability	0.04	0.05	.06
PSI	0.69	0.08	.65***
Step 3			
Nationality	-0.22	1.10	-.01
Gender	0.58	1.10	.03
Age	0.10	0.06	.14
Verbal ability	0.05	0.05	.06
PSI	0.69	0.08	.66***
Social speech	0.40	1.86	.01

Note. $R^2 = .34$ for Step 1 ($p < .001$); $\Delta R^2 = .24$ for Step 2 ($p < .001$); $\Delta R^2 = .00$ for Step 3 (n.s.). PSI = phonologically similar items.

* $p < .05$, *** $p < .001$.

Figure Caption

Figure 1. Visual and phonological coding in single-strategy (visual) and dual-strategy (visual and phonological) memory task performance.



Single strategy (no phonological recoding)

Dual strategy (some phonological recoding)