Parent-delivered compensatory education for children at risk of educational failure: Improving the academic and self-regulatory skills of a Sure Start preschool sample

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Thirty preschoolers from low-income families participated in a 12-month intervention programme, funded by Sure Start, which engaged them in scaffolded educational activities delivered at home by their mothers. Immediately following the programme, the intervention group outperformed matched controls in tests of academic knowledge, receptive vocabulary, and inhibitory control, but not short-term memory or theory of mind. Teachers' ratings of children's capabilities upon school entry favoured the intervention group, especially in terms of listening, responding, writing, mathematics, and personal/social skills. Superior inhibitory control, short-term memory, and numerical skills were associated with higher ratings whereas theory of mind made a unique, negative contribution to responding. We discuss the implications of these findings for efforts to nurture the development of cognitive self-regulation and school readiness during early childhood.

The past few years have witnessed the publication of several large-scale reviews of the effectiveness, or otherwise, of early intervention programmes for disadvantaged children that have aimed to give them a better start in life (e.g., Arnold & Doctoroff, 2003; Blair & Wahlsten, 2002; Campbell, Pungello, Miller-Johnson, Burchinal, & Ramey, 2001; Gorey, 2001). As indicated by such reviews, lack of consensus on this important matter probably reflects the sheer diversity of such programmes. Approaches to early intervention differ on numerous dimensions, including starting age of participants, duration, relative attention to cognitive versus social/emotional development, and breadth of focus (Blok, Fukkink, Gebhardt, & Leseman, 2005).

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Cognitive development and children's home environment

Many early intervention programmes have sought to enhance the role of parents in educating their young children, ranging from efforts to promote joint storybook reading to more structured approaches that deliver specific academic help (review by Brooks-Gunn & Markman, 2005). Proponents of compensatory education cite abundant correlational evidence that important markers of cognitive development during the preschool years are predicted by home-environment variables. One class of variables pertains to parental support for literacy and learning, including storybook reading and teaching of letters and numbers. A voluminous literature on this topic links such behaviours with enhanced development of children's emergent literacy and awareness of the orthographic and phonological structure of language (e.g., Fuligni, Han, & Brooks-Gunn, 2004; Kerr & Mason, 1994; Sammons et al., 2000; Senechal & LeFevre, 2002).

A second class of variables pertains to cognitive aspects of general parenting style, such as extent of maternal scaffolding, mean length of maternal utterance, and type of maternal language. It has been shown that mothers' frequent use of verbal scaffolding predicts superior problem solving and self-control in toddlers (Landry, Miller-Loncar, Smith, & Stewart, 2002; Landry, Smith, Swank, & Miller-Loncar, 2000) whereas a language-rich environment predicts speedier acquisition of vocabulary and grammar (Tamis-LeMonda, Shannon, Cabrera, & Lamb, 2004; Tomasello & Farrar, 1986; Weizman & Snow, 2001). Type of maternal language, in contrast, has been linked with the development of both episodic memory (Nelson, 2005) and theory of mind. Research in the latter domain has indicated that children's acquisition of a theory of mind is positively related to their conversational experience (Peterson & Siegal, 1995).

Notably, both home and cognitive-developmental variables differ in important ways between families of low- versus mid-/high- socio-economic status (SES; Hollingshead, 1975). In terms of home environment, low-SES parents are less likely than mid-/high-SES parents to provide their children with reading-related experiences (Foster, Lambert, Abbott-Shim, McCarty, & Franze, 2005; Whitehurst, 1997). They typically provide less verbal support for children's problem solving (Watson, Kirby, Kelleher, & Bradley, 1996) and evince a shorter mean length of maternal utterance (Hoff, 2003). In terms of cognitive development, low-SES children arrive at school less ready to acquire basic curriculum skills and with a greater likelihood of academic failure later in their school careers (Baydar, Brooks-Gunn, & Furstenberg, 1993). They attain lower IQ scores (Gottfried, Gottfried, Bathurst, Guerin, & Parramore, 2003), and perform more poorly on measures of vocabulary (Noble, Norman, & Farah, 2005; Whitehurst, 1997), theory of mind (Cole & Mitchell, 1998; Holmes, Black, & Miller, 1996; Weimar & Guajardo, 2005), and aspects of executive functioning such as inhibitory control (Ardila, Rosselli, Matute, & Guajardo, 2005; Hughes & Ensor, 2005, 2007; Mezzacappa, 2004; Noble, Norman, & Farah, 2005).

Results of behavioural genetics research suggest that associations between SES and intellectual functioning do not wholly reflect shared genotypes between parents and children. Pettrill, Pike, Price, and Plomin (2004) found that SES status and a measure of chaos in the home were reliable, unique predictors of children's cognitive development, even after controlling for genetic influences. Additionally, it has been reported that the heritability of IQ is substantially smaller in low-SES than mid-/high-SES samples (Rowe, Jacobson, & van den Oord, 1999; Turkheimer, Haley, Waldron, D'Onofio, & Gottesman, 2003). These findings implicate the existence of adverse environmental influences on the cognitive development of low-SES children and bolster calls to improve the prospects of such children through intervention.
Children's self-regulation and school readiness

Home-based compensatory education programmes for disadvantaged preschoolers have achieved notable successes in developing children's emergent literacy and numeracy (review by Brooks-Gunn & Markman, 2005). An important question in relation to such initiatives, however, is whether their focus should really be on academic skills. Teachers report that children's ability to exert self-control is the most significant determinant of the ease with which they make the transition to formal schooling (Rimm-Kaufman, Pianta, & Cox, 2000), suggesting that the aim of early intervention should not so much be to impart knowledge but to develop the self-regulatory skills that children need to adapt successfully to the classroom (Blair, 2002; Brooks-Gunn, 2003; Duncan, Claessens et al., 2007; Mezzacappa, 2004; Noble, Tottenham, & Casey, 2005; Riggs, Jahromi, Razza, Dillworth-Bart, & Mueller, 2006). The construct of self-regulation encompasses a range of capabilities but there is consensus that it subsumes both cognitive and affective components. Whereas the cognitive aspects of self-regulation include the ability to sustain attention to independent goal-directed activity and resist interference from competing external and internal sources (i.e., inhibitory control or executive attention), affective self-regulation represents the capacity to manage positive and negative emotions and to respond effectively in situations that are motivationally significant (Mezzacappa, 2004; Zelazo, Qu, & Muller, 2005).

Two recent studies examined directly the contribution of self-regulatory skills to the academic achievements of young children. In the first study, Blair and Razza (2007) assessed a large sample of children from low-SES families on measures of effortful control (i.e., self-regulation of affect and social behaviour), inhibitory control (i.e., suppressing a pre-potent response in an affectively neutral task), attention shifting (i.e., shifting cognitive set in an object grouping task), and theory of mind as gauged by the understanding of false belief, with results being compared to teacher ratings of participants' attainments in mathematics, phonemic awareness, and letter knowledge at age 5-6 years. Analyses revealed unique, positive associations between inhibitory control and all three domains of academic ability, even after controlling for verbal ability and fluid intelligence, suggesting that preschool executive functioning may be fundamental to both problem solving and knowledge acquisition. Additional contributions of teacher-reported effortful control to both mathematics and letter knowledge, and of theory of mind to letter knowledge, were seen as reflecting an influence of interpersonal skills on children's early school progress. In the second study, Duncan, Claessens et al. (2007) performed a meta-analysis of six large-scale, longitudinal studies of academic progress in disadvantaged children that assessed the relative importance of self-regulation and academic skills measured at the time of school entry. Although it was academic knowledge in kindergarten, particularly in the realm of mathematics, that best-predicted subsequent school success, measures of attention-related cognitive self-regulation were found to make an additional, unique contribution to academic outcomes. Against expectations, however, there was no strong impact of either emotional self-regulation or social skills on children's reading or mathematics achievements.

Enhancing children's cognitive self-regulation through intervention

Evidence that cognitive self-regulation plays an important role in children's school progress begs the question of what measures might be taken to foster the relevant skills in at-risk populations, such as children from low-income families. Importantly, it has
been argued that executive functions such as inhibitory control represent capacities of the prefrontal cortex that are not only distinct from general intelligence but more amenable to nurture (Blair, 2006). First, the protracted period of postnatal maturation shown by the prefrontal regions of the brain seems likely to increase the chances of environmental influences on executive functions (Farah et al., 2006). Second, the existence of a neural network integrating areas of the prefrontal cortex with the areas of the limbic system suggests a mechanism by which development of executive functions may be affected adversely by stressful life experiences (Blair, 2006; Mezzacappa, 2004). Consistent with such proposals, impairments of cognitive processes among disadvantaged children are felt most acutely in the domains of executive functioning and language, with lesser disparities between low- and mid-/high-SES groups in visual cognition, visuospatial processing, and incidental memory (Noble, Norman, & Farah, 2005).

While empirical evidence regarding the plasticity of executive functioning is limited, at least for typically developing children, it has been reported that inhibitory skills can be enhanced via specific training (Dowsett & Livesey, 2000; Rueda, Rothbart, McCandliss, Saccamanno, & Posner, 2005). Moreover, the observation that bilingual children outperform monolingual children on tests of inhibitory control adds weight to the suggestion that greater experience of selecting between competing responses during early childhood leads to more rapid maturation of executive functions (Bialystok, 1999). Recently, Diamond, Barnett, Thomas, and Munro (2007) demonstrated benefits to children’s cognitive control from participating in a preschool programme (Tools of the Mind) inspired by Vygotsky’s views about the emergence of self-regulation during early childhood. According to Vygotsky (1978), young children initially require extensive direction from more competent others to control their behaviour and only gradually learn to take responsibility for their own actions by internalizing skills that are conveyed through social interactions (i.e., routines, symbolic systems, and values known as cultural tools), particularly skills that can be verbally coded. In the Tools of the Mind programme, therefore, teachers engage children in activities designed to promote internalized language and attention skills, such as interactive dramatic play and social activities that employ symbol systems as cues for appropriate responding. Importantly, Diamond et al. found that children who took part subsequently showed better performance on tests of executive functioning (jointly requiring inhibitory control, working memory, and cognitive flexibility) than did children who followed a standard preschool curriculum with the same academic content as Tools but lacking the emphasis on self-regulation.

Vygotskian notions regarding the importance of the social environment to children’s emerging powers of self-regulation are consistent with evidence of positive correlations between maternal scaffolding and children’s cognitive development. For example, Landry et al. (2002) reported that mothers’ verbal scaffolding of their children’s learning at age three years predicted both short-term memory and language skills at age four years and executive functioning at age 6 years (gauged in terms of search retrieval in a spatial reversal task and independent goal-directed play). They suggested several ways in which scaffolding might foster executive functioning, such as supporting immature attention skills, teaching task persistence, and facilitating the emergence of inner speech. They nevertheless pointed out the need to evaluate directly the impact of the home environment on the development of children’s executive skills using intervention studies (see also Ford, 2006).
In this paper, we describe the outcomes of a parent-delivered compensatory education programme for socio-economically disadvantaged preschoolers living in Wales, United Kingdom. Our programme, Let's Play in Tandem, was funded by the Sure Start initiative and in line with its objectives (Glass, 1999) had the specific aim of developing participants' school readiness. Importantly, we evaluated the effectiveness of the programme not just for children's academic performance but for prominent markers of their cognitive development, including cognitive self-regulation. We, therefore, sought to determine whether involving low-SES parents in the education of their preschoolers might benefit children in ways that go beyond their acquisition of academic knowledge.

Let's Play in Tandem was inspired by an earlier intervention programme along similar lines (Ford, Evans, & McDougall, 2003), which we extended in both scope and duration. In the present case, children entered the programme around the time of their third birthday and continued for 12 months. During this time, they participated in educational activities in partnership with their mothers that were intended to develop pre-reading skills (e.g., phonological awareness, perceptual discrimination), basic numerical skills (e.g., understanding of size and quantity, counting to 10), and general knowledge. All activities took the form of enjoyable games that were designed to elicit sustained one-on-one verbal interactions, a joint focus of attention, and scaffolding of the children's learning. In accordance with the definition of scaffolding provided by Wood, Bruner, and Ross (1976), mothers' role in such activities was therefore to provide children with prompts, demonstrations, instructions, and encouragement to complete the tasks.

Recipients of the intervention were compared with a control group on three sets of post-intervention measures: (1) measures of academic skills administered immediately following the intervention, (2) measures of cognitive ability administered 4 months later upon entry to Reception class, and (3) measures of school readiness provided upon entry to Reception class by the children's teachers. Our measures of cognitive ability included tests of inhibitory control, short-term memory, receptive vocabulary, and theory of mind as gauged by the understanding of false belief. As reviewed earlier, evidence linking the growth of children's executive functioning with maternal scaffolding has emerged in correlation studies but has not yet been sought in intervention studies. Given our programme's emphasis on complex verbal interactions and scaffolding as a means of developing participants' knowledge and academic skills, we therefore deemed it important to look for evidence of benefits to their cognitive self-regulation as assessed by tests of inhibitory control. Our inclusion of the remaining measures of cognitive development was motivated by evidence linking compensatory education with benefits to children's vocabulary development (review by Duncan, Ludwig, & Magnuson, 2007), scaffolding with benefits to short-term memory skills (Landry et al., 2002), and social experience in general with acquisition of a theory of mind (Peterson & Siegal, 1995).

Our second major goal in evaluating the intervention was to inform the debate concerning the relative importance of entry-level academic knowledge and cognitive self-regulation to school readiness. School readiness was rated by the Reception class teachers in terms of children's emergent literacy and numeracy, as well as their general adaptation to the classroom environment in terms of listening, responding, and personal/social skills. Our predictors included the post-intervention measures of academic and cognitive development. Based on the findings of Duncan, Claessens et al. (2007) and Blair and Razza (2007), we anticipated that academic knowledge, inhibitory
control, and understanding of false belief would all make important contributions to academic performance in Reception class. Extending both earlier investigations, we investigated which academic and cognitive variables were the best predictors of children's general adaptation to school.

Method

Participants

The participants were 60 young children, comprising an intervention group and a control group (16 boys and 14 girls in each case) that were matched on a number of important variables (see Procedure section for details). The intervention group had a mean age of 37.0 months at the start of the intervention, 50.6 months at the time of the first post-intervention assessment, and 54.6 months at the time of the second post-intervention assessment ($SD = 4.3$). The control group had a mean age of 36.7 months at the start of the intervention, 50.3 months at the time of the first post-intervention assessment, and 54.3 months at the time of the second post-intervention assessment ($SD = 4.0$). Participants were recruited from districts identified by the local education authority as having markers of severe social and economic deprivation. Approximately, half the children's families were headed by young, single mothers and the majority were surviving on unemployment or sickness benefits. In 85% of the families, the primary caregiver had left school at or before the age of 16 years. Most families lived on council estates and ethnicity comprised approximately 90% White and 10% Asian. All children came from homes in which English was the primary spoken language.

Materials

The materials were a selection of educational toys and children's storybooks (commercially available) and paper-based activities (devised and generated by the researchers). The activities were intended to enhance children's vocabulary and general knowledge, pre-reading skills, and numerical skills. Activities in the first category encouraged parents to recognize and respond to opportunities for children's learning in the course of everyday life (e.g., helping children to complete a simple jigsaw puzzle, recalling and discussing events together, playing snap, and visiting the library) and were largely based on activities from the widely used Peers Early Education Partnership (Evangelou, Brooks, & Smith, 2007). Pre-reading and numerical activities aimed to practice skills argued in the literature to underpin the development of literacy and numeracy, such as phonological awareness and understanding of quantity. Pre-reading activities included reciting nursery rhymes, engaging in perceptual discrimination (e.g., same/different judgments, searching for hidden shapes and objects in pictures), and analysing the sounds of words (e.g., singing songs, and judging whether depicted objects had rhyming names). Numerical activities were designed to teach children concepts about amounts and size, to develop counting skills and recognition of written numerals, and to link children's concepts about quantity with the number system. Such activities made use of play dough, building-blocks, size sorters, nursery rhymes involving number sequences, follow-the-leader games, and paper-based games (e.g., helping a toy frog to jump across a numbered sequence of lily pads, arranging a dolls' tea party and ensuring an equal division of utensils and food items).

All activities were accompanied by concise written instructions in plain language. Given low levels of literacy among the children's primary caregivers, we made it a
priority to demonstrate the activities during the home visits. Activities were presented to children in the guise of 'games' and typically required verbal guidance and prompts from the adult, for example, 'Watch me and see how I do it', 'It's best to start with the corners', and 'You only need to count each one once'. It was emphasized to caregivers that the activities were intended to be fun, to stimulate conversation and discussion, and to be accompanied by plenty of praise.

Procedure

Recruitment of participants

Initially, head teachers of our targeted schools provided us with contact details for children on the enrolment lists for entry to half-time nursery class and letters were despatched to the children's families that briefly described the project and advised we would be contacting them by phone to discuss it further. Following the phone calls, families that expressed interest in hearing more about the project and in which the child was presently being looked after at home by their mother were visited by the project workers (about 60% of the families). During these visits it was explained that we were conducting a research study, in conjunction with Sure Start, investigating ways that parents could help to prepare their children for formal schooling. It was made clear at this initial meeting that families who agreed to participate would be randomly assigned to one of two groups, the first being offered the 12-month programme and the second taking the form of a no-intervention comparison group. The nature of the proposed project was outlined, examples of the games were presented, and reassurance was provided about the levels of support families could expect to receive if they were selected for the intervention. For interested families, a further home visit was arranged during which the project worker assessed children using four subscales of the Schedule of Growing Skills (SGS II; Bellman, Langam, & Aukett, 1997), namely, manipulative skills, hearing and language skills, speech and language skills, and self-care skills. Two children whose SGS profile was suggestive of developmental delay (i.e., a score indicating a developmental level more than 8 months below chronological age on one or more subscales; Bellman et al., 1997) were excluded from our sample and, in line with Sure Start's policy, referred to an appropriate agency (e.g., hearing assessment, speech therapy). Additionally, the primary caregiver was interviewed to ascertain basic demographic information such as highest level of education and current occupation.

The final sample represented two cohorts that entered the programme 1 year apart. On both occasions, most families who consented to a home visit also expressed willingness to participate in the intervention and thus assignment to the intervention was decided by a lottery conducted by the university researchers. In carrying out the lottery, families were grouped according to child's age and gender, intended school, highest level of education of the primary caregiver, and whether the family had any paid employment. Six families assigned to the intervention condition failed to complete the programme due to moving out of the area, producing a final sample of 30 children that participated in the post-intervention assessments. Of 37 control children available to us at the time of the post-intervention assessments, 30 children were selected for testing.

Due to our project's small budget, we were unable to provide the intervention to more than 18 families per year. Families assigned to the control group could not have been included in our programme due to insufficient resources.
that represented the best match to the intervention group in terms of age and gender, school attended, highest level of education of the primary caregiver, and family income.

For the duration of the intervention and subsequent assessments, all participants in the intervention and control groups were classmates in the same half-time nursery groups at our targeted schools where they followed the prescribed curriculum for pre-statutory Foundation Phase education in Wales. Whereas the schools were aware that the intervention was taking place and had provided permission for its evaluation to be carried out on their premises, they were not informed about which children were involved.

The intervention
Families not chosen for the intervention were encouraged to attend other Sure Start services operating in their area such as play groups and the mobile toy library. Families chosen for the intervention were assigned to a project worker and invited to commence the programme. Each week, they received a pack containing three activities, one designed to promote vocabulary and general knowledge, one designed to develop pre-reading skills, and one designed to develop numerical skills. Activities in the second and third categories were designed to last about 20 min whereas activities in the first category could take longer, with families being requested to engage in each of the activities at least once and preferably more often. The project workers visited each family once a week, for between 90 and 120 min, to deliver and demonstrate new activities and to answer questions. Breaks from the intervention were permitted as needed to accommodate holidays and other disruptions to the families' routines. As for our earlier study (Ford et al., 2003), we made concerted efforts to bolster parents' motivation for the programme with regular newsletters and invitations to participate in Sure Start social events, as well by asking them to record their experiences with the activities in a diary. The diary entries were used as a basis for discussing children's progress with the activities with the project workers and for highlighting any difficulties that needed to be addressed.

The intervention was delivered in four stages, each lasting 10 weeks, and was designed such that activities became more advanced as children progressed from one stage to the next. Activities carried out during Stage 1 included familiarizing the children with simple nursery rhymes and songs (pre-reading), using play dough to illustrate the meaning of 'big' versus 'small', and 'more' versus 'less' (numerical), and playing such activity rhymes as 'head, shoulders, knees, and toes' (knowledge). Activities carried out during Stage 4 included playing phonological 'I Spy' and teaching children to write their name (pre-reading), counting, and number recognition (numerical), making a toy with specially provided materials and asking children to recount a recently experienced, novel event (knowledge). There were several activities in all categories that involved the mother in reading a picture book to the child and engaging them in discussion about its content. By the end of the programme, children had been exposed to a variety of books and more than 20 nursery, activity, and counting rhymes. They had received extensive practice in counting to 10 and recognizing the numerals 1-5, naming basic colours and shapes, describing aspects of size and quantity (e.g., longer, shorter, wider, and narrower), and judging 'same' versus 'different'. They had also been exposed to numerous activities designed to build vocabulary relevant to discussing and recalling such everyday events as visiting the library, posting a letter, helping with shopping, and preparing a meal.
Early intervention and children's self-regulation

First post-intervention assessment

The impact of the intervention was first evaluated during the final weeks of half-time nursery class, by which time all participants in the intervention group had completed the programme. Testing was carried out individually in secluded locations at the children's schools (e.g., the library, school assembly hall) by three research assistants employed specifically for data collection who were unaware of which children had received the intervention. Tests were typically administered in a single session lasting about 30 min unless children were unwilling to complete them, in which case testing was discontinued and resumed at a more favourable time in order to produce a complete data set. The tests were designed to assess children's skills in the domains targeted by our intervention, that is, general knowledge (i.e., knowledge of name and address, ability to identify colours), pre-reading skills (i.e., rhyme detection, non-word repetition, perceptual discrimination, and letter recognition), and numerical skills (i.e., judgments about size, length and quantity, number recognition, counting small sets of objects, and free counting). Most tests used attractive pictures and all were presented in the form of games (see Appendix A for further details).

Second post-intervention assessment

During the first term of Reception class, approximately 4 months after their initial post-intervention assessment, children's academic and social skills were evaluated by their teachers using the Four Counties Foundation Phase Profile. This instrument is administered as standard practice to all children in their first year of full-time schooling in Wales and is intended to provide a baseline against which to monitor individual academic development over the early school years (see Appendix B). Additionally, research assistants who were blind to group membership assessed children for receptive vocabulary using the British Picture Vocabulary Scale (BPVS 2nd ed.; Dunn, Dunn, Whetton, & Burley, 1997), verbal short-term memory using the Digits Forward subtest of the British Ability Scales (Elliott, 1996), inhibitory control, and theory of mind. Tests of inhibitory control were selected from Carlson and Moses (2001) and comprised the Day/Night test, the Bear/Dragon test, the Whisper test (adapted for British children), and the Dimensional Change Card Sort. Whereas the processing requirements of such tests have been construed in different ways in the literature (review by Garon, Bryson, & Smith, 2008) the measures we used were argued by Carlson and Moses (2001) to confront children with the challenge of inhibiting a salient response in favour of a less salient response. Theory-of-mind tests were designed to gauge understanding of false belief and had been identified in the literature as tests that children typically begin to pass between the ages of 4 and 5 years. They comprised the Sally-Ann test (Baron-Cohen, Leslie, & Frith, 1985), the deceptive-box test (both 'own' and 'other' false belief; Perner, Leekam, & Wimmer, 1987), and Linda's false belief test (Riggs & Simpson, 2005). Testing was carried out on an individual basis in relatively quiet areas of the children's schools, in random order of test administration, using as many sessions as necessary to obtain a complete data set.

Results

In evaluating the programme, we compared the performance of the intervention and control groups on three sets of measures: (1) the Schedule of Growing Skills
administered prior to the intervention, (2) the measures of academic ability administered immediately following the intervention, and (3) the measures of cognitive ability and teachers' ratings of school readiness obtained upon children's entry to Reception class. To determine the best predictors of children's school readiness, we conducted regression analyses that used the seven domains of teachers' ratings as dependent variables and the measures of entry-level academic skills and cognitive ability as independent variables.

**Pre-intervention assessment**

Independent-samples *t* tests were used to compare the performance of the intervention group and the control group on the individual subscales of the Schedule of Growing Skills. These analyses revealed no reliable group difference in developmental age (in months) in any of the domains, manipulative skills: intervention *M* = 35.4, *SD* = 5.3, control *M* = 35.2, *SD* = 6.0, *t* = 0.14; hearing and language skills: intervention *M* = 33.4, *SD* = 5.8, control *M* = 33.6, *SD* = 5.1, *t* = −0.14; speech and language skills: intervention *M* = 33.4, *SD* = 5.6, control *M* = 34.4, *SD* = 4.1, *t* = −0.79; self-care skills: intervention *M* = 35.0, *SD* = 4.7, control *M* = 34.8, *SD* = 5.3, *t* = 0.15 (all *p* values > .05, two-tail).

**First post-intervention assessment**

Table 1 shows group means of attainments on the measures of academic ability in nursery, expressed as percent accuracy. Results for all measures were converted to *z* values and averaged to produce composite scores for knowledge, pre-reading skills, and numerical skills. A series of independent-samples *t* tests indicated that the intervention group outperformed the comparison group in all domains (knowledge: *t*(58) = 4.02; pre-reading skills: *t*(58) = 5.18; numerical skills: *t*(58) = 3.23; all *p* < .01 two-tail).

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<tr>
<th>Table 1. Group means (and standard deviations) of percent accuracy on the preschool tests of academic ability</th>
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<tr>
<td><strong>Domain</strong></td>
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<tr>
<td>Knowledge</td>
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<td>Pre-reading</td>
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<td>Numerical</td>
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Second post-intervention assessment

Table 2 shows group means of teacher ratings of children's skills during first term of Reception class. Independent-sample *t* tests found that the intervention group received significantly higher ratings than the control group for listening and communication (*t*(58) = 2.69, *p* < .01 two-tail), responding (*t*(58) = 1.92, *p* < .05 two-tail), writing (*t*(58) = 2.33, *p* < .01 two-tail), mathematics (*t*(58) = 3.68, *p* < .01 two-tail), and personal and social skills (*t*(58) = 2.04, *p* < .05 two-tail).

<table>
<thead>
<tr>
<th>Domain</th>
<th>Intervention</th>
<th>Control</th>
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<tr>
<td>Listening and communication</td>
<td>3.60 (0.50)</td>
<td>3.00 (1.11)</td>
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<tr>
<td>Responding to stimuli</td>
<td>3.03 (0.62)</td>
<td>2.63 (0.96)</td>
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<tr>
<td>Reading</td>
<td>2.67 (0.48)</td>
<td>2.40 (0.62)</td>
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<tr>
<td>Writing</td>
<td>2.77 (0.57)</td>
<td>2.17 (0.91)</td>
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<tr>
<td>Number</td>
<td>2.43 (0.90)</td>
<td>2.07 (1.26)</td>
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<tr>
<td>Mathematics</td>
<td>2.90 (0.31)</td>
<td>2.20 (0.99)</td>
</tr>
<tr>
<td>Personal and social skills</td>
<td>3.77 (0.50)</td>
<td>3.47 (0.63)</td>
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Note. Maximum possible rating on each measure was 4.

Table 3 shows group means of accuracy on the tests of cognitive ability. Results for the tests of inhibitory control were converted to *Z* values and averaged to produce a composite inhibition score for each participant. An independent-samples *t* test applied to the composite scores revealed that inhibitory control was reliably greater in the intervention group than the control group (*t*(58) = 4.49, *p* < .01 two-tail). Results for the theory-of-mind tests were summed to produce a total false-belief score for each participant. Applied to the total scores, an independent-samples *t* test found no reliable difference between the group means (*t*(58) = 1.25, *p* > .05 two-tail). Analysis of the BPVS data revealed a significantly higher mean age-equivalent score in the intervention group than the control group (*t*(58) = 2.72, *p* < .05 two-tail). However, the groups failed to differ reliably in their age-equivalent scores on the Digits Forward test (*t*(58) = .07, *p* > .05 two-tail).

Predictors of school readiness

Initially, partial correlations were calculated to determine the extent of shared variance between the predictor variables after holding constant the influence of chronological age and group membership. These analyses revealed robust, positive associations between vocabulary and inhibitory control (partial *r* = .48), vocabulary and theory of mind (partial *r* = .45), inhibitory control and theory of mind (partial *r* = .49), and inhibitory control and short-term memory (partial *r* = .36; *p* < .05, two-tail). Given the further existence of numerous positive correlations between the cognitive and academic measures, simultaneous-entry regression analyses were carried out to examine their unique associations. The dependent variables were knowledge, pre-reading skills, and numerical skills, and the independent variables were age, group membership, vocabulary, inhibitory control, theory of mind, and short-term memory. When knowledge was the dependent variable, the overall regression model was significant.
Table 3. Group means (and standard deviations) of performance on the tests of cognitive ability

<table>
<thead>
<tr>
<th>Domain</th>
<th>Task</th>
<th>Intervention</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vocabulary</td>
<td></td>
<td>52.40 (13.8)</td>
<td>44.60 (7.6)</td>
</tr>
<tr>
<td>Short-term memory</td>
<td></td>
<td>53.00 (13.9)</td>
<td>53.30 (15.9)</td>
</tr>
<tr>
<td>Inhibitory control</td>
<td>DCCS</td>
<td>2.60 (0.55)</td>
<td>2.13 (1.01)</td>
</tr>
<tr>
<td></td>
<td>Whisper</td>
<td>1.70 (0.40)</td>
<td>1.33 (0.45)</td>
</tr>
<tr>
<td></td>
<td>Day/Night</td>
<td>13.07 (2.23)</td>
<td>10.07 (5.24)</td>
</tr>
<tr>
<td></td>
<td>Bear/Dragon</td>
<td>11.00 (4.83)</td>
<td>8.25 (5.64)</td>
</tr>
<tr>
<td>Theory of mind</td>
<td>Deceptive Box own FB</td>
<td>0.33 (0.49)</td>
<td>0.31 (0.48)</td>
</tr>
<tr>
<td></td>
<td>Deceptive Box other's FB</td>
<td>0.58 (0.51)</td>
<td>0.54 (0.52)</td>
</tr>
<tr>
<td></td>
<td>Unexpected transfer (Sally)</td>
<td>0.58 (0.51)</td>
<td>0.46 (0.52)</td>
</tr>
<tr>
<td></td>
<td>Unexpected transfer (Linda)</td>
<td>0.42 (0.51)</td>
<td>0.15 (0.38)</td>
</tr>
</tbody>
</table>


\( R^2 = .559, F(6, 53) = 11.21, p < .01 \) and showed a unique contribution of inhibitory control to the explained variance \( (\beta = 0.421, t = 2.56, p < .05) \). When pre-reading skills were the dependent variable, the overall model was significant \( R^2 = .633, F(6, 53) = 15.24, p < .01 \), and showed unique contributions of group membership \( (\beta = 0.282, t = 2.47) \), inhibitory control \( (\beta = 0.317, t = 2.11) \), and theory of mind \( (\beta = 0.251, t = 2.04) \) to the explained variance \( (all p \text{ values } < .05) \). When numerical skills were the dependent variable, the overall model was significant \( R^2 = .375, F(6, 53) = 5.29, p < .01 \), but none of the predictors made a unique contribution to the explained variance \( (all p \text{ values } > .05) \).

To determine which predictors, if any, contributed unique variance to teachers' ratings, two sets of nested hierarchical regression analyses were conducted. In both cases, the dependent variables were the seven dimensions of school readiness estimated by the teachers. For the first set of analyses, the independent variables were (1) chronological age and group membership entered on the first step, (2) entry-level academic skills entered on the second step (i.e., pre-reading skills, numerical skills, and knowledge), and (3) the measures of cognitive ability entered on the third step (i.e., BPVS age-equivalent scores, inhibitory control, theory of mind, and digits forward age-equivalent scores). For the second set of analyses, we reversed the order of entry of the academic and cognitive variables in the second and third steps. Prior to conducting the regression analyses, all predictor and dependent variables were inspected for kurtosis and skew (Tabachnick & Fidell, 2007) and were found to show distributions that were reasonably normal (i.e. absolute z values <3.3).

Table 4 shows, for each dependent variable, the \( R^2, \Delta R^2 \), overall \( F \) and \( F \) change values associated with each step of the initial regressions together with any predictors that made a unique contribution to the explained variance \( (i.e., p < .05) \). As can be seen, entry-level academic skills related meaningfully to teachers' ratings of emergent literacy and numeracy, with pre-reading skills predicting attainments in reading and writing, and numerical skills predicting attainments in number. Of the cognitive variables, the best predictors of teachers' ratings were inhibitory control (making a
Table 4. Results of nested hierarchical regression analyses predicting teachers’ ratings of children’s school readiness as a function of chronological age and group membership (Step 1), entry-level academic skills (Step 2), and cognitive ability (Step 3)

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>$R^2$</th>
<th>$\Delta R^2$</th>
<th>Overall $F$</th>
<th>$F$ change</th>
<th>Reliable predictors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Listening and communication</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 1</td>
<td>.317</td>
<td>.317</td>
<td>13.25**</td>
<td>13.25**</td>
<td>Age ($\beta = 0.455$), group ($\beta = 0.317$)</td>
</tr>
<tr>
<td>Step 2</td>
<td>.386</td>
<td>.068</td>
<td>6.78**</td>
<td>2.00</td>
<td>Age ($\beta = 0.318$)</td>
</tr>
<tr>
<td>Step 3</td>
<td>.624</td>
<td>.238</td>
<td>9.20**</td>
<td>7.91**</td>
<td>Numerical skills ($\beta = 0.380$), IC ($\beta = 0.733$), STM ($\beta = 0.340$)</td>
</tr>
<tr>
<td>Responding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 1</td>
<td>.133</td>
<td>.133</td>
<td>4.38**</td>
<td>4.38*</td>
<td>Age ($\beta = 0.272$), group ($\beta = 0.234$)</td>
</tr>
<tr>
<td>Step 2</td>
<td>.308</td>
<td>.175</td>
<td>4.81**</td>
<td>4.55**</td>
<td>Numerical skills ($\beta = 0.419$)</td>
</tr>
<tr>
<td>Step 3</td>
<td>.599</td>
<td>.291</td>
<td>8.30**</td>
<td>9.07*</td>
<td>Numerical skills ($\beta = 0.461$), IC ($\beta = 0.892$), ToM ($\beta = -0.468$)</td>
</tr>
<tr>
<td>Reading</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 1</td>
<td>.181</td>
<td>.181</td>
<td>6.31*</td>
<td>6.31*</td>
<td>Age ($\beta = 0.354$)</td>
</tr>
<tr>
<td>Step 2</td>
<td>.314</td>
<td>.132</td>
<td>4.94*</td>
<td>3.47*</td>
<td>Pre-reading skills ($\beta = 0.609$)</td>
</tr>
<tr>
<td>Step 3</td>
<td>.639</td>
<td>.325</td>
<td>9.84*</td>
<td>11.27*</td>
<td>IC ($\beta = 0.716$), STM ($\beta = 0.517$)</td>
</tr>
<tr>
<td>Writing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 1</td>
<td>.328</td>
<td>.328</td>
<td>13.93**</td>
<td>13.93**</td>
<td>Age ($\beta = 0.436$), group ($\beta = 0.356$)</td>
</tr>
<tr>
<td>Step 2</td>
<td>.379</td>
<td>.051</td>
<td>6.60**</td>
<td>1.48</td>
<td>Age ($\beta = 0.311$), Pre-reading skills ($\beta = 0.372$)</td>
</tr>
<tr>
<td>Step 3</td>
<td>.414</td>
<td>.035</td>
<td>3.93*</td>
<td>0.75</td>
<td>–</td>
</tr>
<tr>
<td>Number</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 1</td>
<td>.236</td>
<td>.236</td>
<td>8.78**</td>
<td>8.78**</td>
<td>Age ($\beta = 0.456$)</td>
</tr>
<tr>
<td>Step 2</td>
<td>.559</td>
<td>.324</td>
<td>13.69**</td>
<td>13.21**</td>
<td>Numerical skills ($\beta = 0.512$)</td>
</tr>
<tr>
<td>Step 3</td>
<td>.610</td>
<td>.051</td>
<td>8.69**</td>
<td>1.63</td>
<td>Numerical skills ($\beta = 0.591$)</td>
</tr>
<tr>
<td>Mathematics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 1</td>
<td>.368</td>
<td>.368</td>
<td>16.61**</td>
<td>16.61**</td>
<td>Age ($\beta = 0.423$), group ($\beta = 0.419$)</td>
</tr>
<tr>
<td>Step 2</td>
<td>.410</td>
<td>.042</td>
<td>7.51**</td>
<td>1.28</td>
<td>Age ($\beta = 0.312$)</td>
</tr>
<tr>
<td>Step 3</td>
<td>.554</td>
<td>.143</td>
<td>6.89**</td>
<td>4.02**</td>
<td>IC ($\beta = 0.431$), STM ($\beta = 0.393$)</td>
</tr>
<tr>
<td>Personal and social skills</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 1</td>
<td>.164</td>
<td>.164</td>
<td>5.61**</td>
<td>5.61**</td>
<td>Age ($\beta = 0.313$), group ($\beta = 0.247$)</td>
</tr>
<tr>
<td>Step 2</td>
<td>.226</td>
<td>.062</td>
<td>3.16*</td>
<td>1.44</td>
<td>–</td>
</tr>
<tr>
<td>Step 3</td>
<td>.472</td>
<td>.245</td>
<td>4.96**</td>
<td>5.80**</td>
<td>IC ($\beta = 0.880$)</td>
</tr>
</tbody>
</table>

Note. IC, inhibitory control; ToM, theory of mind; and STM, short-term memory.

* $p < .05$; ** $p < .01$. 
unique contribution to the explained variance in five of seven domains) and short-term memory (making a unique contribution to the variance in three of seven domains). Vocabulary as assessed by the BPVS did not emerge a reliable predictor in any domain, whereas theory of mind showed a reliable and negative association with responding. Although prior academic capabilities were less prominent than cognitive capabilities in the final regression models, numerical skills nevertheless accounted for a unique portion of the explained variance in the domains of listening/communication, responding, and number.

Reversing the order of entry of the academic and cognitive variables showed that inclusion of the measures of cognitive ability in the second step produced a significant $\Delta R^2$ in the domains of listening/communication ($F$ change (4, 53) = 7.70), responding ($F$ change (4, 53) = 11.06), reading ($F$ change (4, 53) = 11.46), number ($F$ change (4, 53) = 3.60), mathematics ($F$ change (4, 53) = 4.49), and personal/social skills ($F$ change (4, 53) = 6.45). When the measures of academic skills in nursery were added in the third step, $\Delta R^2$ was significant for responding ($F$ change (3, 50) = 2.98), reading ($F$ change (3, 50) = 3.61), and number ($F$ change (3, 50) = 9.03).

**Discussion**

We have reported here the findings of an intensive compensatory education programme for economically disadvantaged children that took place over a period of 12 months prior to their entry to Reception class at age 4 years. Results indicated that we achieved our aim of enhancing children's preparedness for full-time education. Soon after completing the programme, the intervention group outperformed a matched control group on measures of general knowledge, pre-reading skills, and numerical skills. When rated 4 months later for their baseline attainments upon entry to Reception class, the intervention group were judged by their teachers as showing a greater degree of school readiness across a range of domains. These findings confirm those of previous research showing impressive short-term effects of early intervention for children at risk of educational failure (review by Arnold & Doctoroff, 2003). Moreover, they indicate that the benefits conferred by the intervention were clearly discernible to the children's teachers.

In relation to the cognitive developmental measures, the intervention group also achieved superior outcomes on measures of receptive vocabulary and inhibitory control. Results for the BPVS indicated that vocabulary development among the intervention group was both nearly commensurate with chronological age and, on average, 8 months in advance of the control group. In terms of inhibitory control, the intervention group surpassed the control group on a battery of tests that required them to withhold a salient verbal or motor response in favour of a less salient verbal or motor response. Our findings in relation to language concur with many previous studies showing delayed acquisition of receptive vocabulary among children from low SES backgrounds, as well as significant vocabulary growth among those who participate in intensive compensatory education programmes (e.g. Evangelou *et al.*, 2007; review by Duncan, Ludwig *et al.*, 2007). Outcomes of the indices of inhibitory control confirm and extend a fledgling body of evidence that has implicated environmental influences on young children's developing capacity to resolve interference between competing responses, including dedicated executive-function training studies (e.g. Dowsett & Livesey, 2000; Rueda *et al.*, 2005) and centre-based preschool programmes that are designed to develop children's cognitive self-regulation through a combination of
Early intervention and children's self-regulation

While we cannot exclude the possibility that our groups differed in inhibitory control prior to the intervention, this seems unlikely given our random allocation of participants to either the intervention or control condition. Moreover, there was no evidence of reliable group differences in our initial screening measure (i.e., the SGS) or on the subsequent measures of short-term memory and theory of mind.

The present findings are consistent with the suggestion that maternal scaffolding is a driving force in the development of children's executive functioning (e.g., Landry et al., 2002). Activities delivered to the intervention group were designed to elicit prolonged bouts of concentration on the part of the children and the maintenance of a joint focus of attention with the adult teacher. Many of the academic exercises also involved extensive verbal guidance that typically encouraged children to pause and consider a variety of potential courses of action before responding. Superior conflict inhibition among the intervention group could thus reflect the extensive practice they had in sustaining attention to a cognitively demanding task and the opportunities they encountered for developing internalized language to support strategic, rule-governed behaviour. Notions about the importance of internalized language to children's growing ability to regulate their behaviour can explain the present observation of a unique, positive association between receptive vocabulary and inhibitory control, consistent with the findings of many previous studies (review by Barkley, 1997). They also accord with the outcomes of microgenetic research (e.g., Winsler, Diaz, & Montero, 1997) and with longitudinal evidence that early verbal ability continues to predict later development of executive functions after holding constant the effects of initial executive capabilities (Hughes & Ensor, 2007).

On the other hand, it must be acknowledged that the intervention group might have benefited from improved mothering in general rather than scaffolding in particular. While we did not strive to improve the affective aspects of mothers' care for their young children it nevertheless seems plausible that our intervention promoted good mother/child relations and, consequently, a reduction in confrontation and stress within the family. Previous research has linked parental warmth, stimulation, and responsiveness with improved regulation of the hypothalamic–pituitary–adrenal axis and its end-product cortisol (Gunnar & Donzella, 2002). Because cortisol exerts an important influence on the development of the medial and dorsolateral prefrontal regions of the brain, it has been suggested that stressful life-events and poor parenting during early childhood might interfere with the development of executive functioning (Blair, 2006; Mezzacappa, 2004). Consistent with this proposal, children from low SES families have been found to show raised basal cortisol levels and diminished selective attention relative to children from more affluent families (Lupien, King, Meaney, & McEwen, 2001).

As discussed earlier, we looked for gains in short-term memory and theory of mind based on evidence that: (1) mothers' scaffolding when children are aged 3 years predicts short-term memory skills when they are aged 4 years (Landry et al., 2002), and (2) the development of theory of mind is positively linked with conversational experience (Peterson & Siegal, 1995). Group means of performance on the Digits Forward test were at age-appropriate levels, raising the possibility that the development of short-term memory capacity during early childhood is little affected by environmental variables. Consistent with our null findings, Martin-Rhee and Bialystok (2008) reported that bilingual 4-year-olds outperformed monolingual 4-year-olds on tests of inhibitory control but not on a test of forward Digit Span. In contrast, the negligible effect of the attention-skills training and interactive socio-dramatic play (Diamond et al., 2007).
intervention on theory of mind might be considered surprising given its sizable benefits to both vocabulary and inhibitory control. Like many previous investigations, our observation of robust, positive correlations between children's performance on the false-belief tests and their language and inhibitory skills suggests a contribution of the latter variables to either the emergence or expression of theory of mind (review by Perner & Lang, 1999). Such evidence implies that developmental gains in either language or inhibitory control should be matched by developmental gains in theory of mind, an hypothesis supported by demonstrations that training young children on executive tasks lead to improvements in their performance in false-belief tasks and vice versa (e.g. Kloo & Perner, 2003).

Possibly, the transfer of training effects observed in previous studies might have stemmed from benefits to aspects of executive functioning that differed from those developed here. An alternative conclusion is that other criteria important to the development of theory of mind, such as relevant social experience, were not met by the intervention. Environmental bootstrapping for theory of mind might be highly specific to certain kinds of inputs, for example, social interactions that expose children to mental-state language coupled with direct references to causality (Meins et al., 2002; Slaughter, Peterson, & Mackintosh, 2007). Whereas our intervention aimed to increase the amount of verbal communication between children and their primary caregivers, it did not seek specifically to foster conversations of this type. Similar dissociation between theory of mind and inhibitory control was reported by Sabbagh, Xu, Carlson, Moses, and Lee (2006) in a cross-cultural study. They found that Chinese children outperformed North American children on tests of cognitive inhibition but performed equivalently to North American children on tests of the understanding of false belief. Because inhibitory control and theory of mind were nevertheless positively correlated in the Chinese sample, Sabbagh et al. proposed that superior inhibition makes it easier for children to capitalize on those social experiences that are uniquely suited to developing their theory of mind.

Predictors of school readiness
The second major goal of our study was to evaluate the relative impact of entry-level academic skills and cognitive functioning on children's school readiness as estimated by their Reception class teachers. Hierarchical regression analyses revealed that both academic and cognitive variables were important to teachers' perceptions of children's adjustment to formal learning. When the measures of cognitive ability were included last, they added significantly to the explained variance in all domains of the teachers' ratings except number. When the measures of academic ability were included last, they added significantly to the explained variance in the domains of responding, reading, and number. As gauged by the final regression models, teachers' ratings reflected in large measure children's performance on the tests of inhibitory control, with outcomes on these tests making a unique, positive contribution to the explained variance in listening/communication, responding, reading, and mathematics. Although verbal ability and theory of mind were not uniquely advantageous to children's attainments in any domain, short-term memory was reliably and positively associated with ratings of listening/communication, reading, and mathematics. Of the measures of academic ability, only numerical skills emerged as an important predictor of school readiness in their own right, showing reliable, unique associations with ratings of listening/communication, responding, and number. This latter finding mimics that of
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Duncan, Claessens et al. (2007), who reported that early numerical capabilities outweighed early reading-related capabilities as predictors of children's later school progress.

Several previous studies have documented positive associations between children's inhibitory and academic skills (Blair & Razza; 2007; Bull & Scerif, 2001; Duncan, Claessens et al., 2007; Espy et al., 2004), although only one of these (Espy et al., 2004) involved participants as young as those tested here. Similarly, the present study has extended to 4-year-olds a growing body of evidence linking verbal short-term memory with reading (Wadsworth, DeFries, Fulker, Olson, & Pennington, 1995) and mathematical capabilities (Swanson & Kim, 2007). In relation to inhibitory control, Blair and Razza (2007) speculated that superior inhibition might support both acquisition and manipulation of knowledge. In their study, for example, inhibitory control showed unique associations with emergent literacy as estimated by letter recognition and phonemic awareness. Because teacher ratings of reading ability in the present study pertained primarily to children's interest and confidence in handling books, the relevance of inhibitory control to such ratings might reflect the need to resist distraction when learning generally about written materials. In accord with Blair and Razza's findings, inhibitory control was also uniquely correlated with Nursery measures of pre-reading skill that focused on children's ability to make perceptual and phonological discriminations and to identify letters.

Extending previous research, teachers' ratings of listening/communication, responding, and personal/social skills enabled us to demonstrate that inhibitory control is a salient dimension of individual differences underlying children's general adaptation to the classroom environment. Given that inhibitory control was a reliable predictor of outcomes on all three dimensions, children's capacity for resisting distraction would appear fundamental to their ability to sit still, focus their attention on the teacher, and heed his or her instructions, all qualities that are likely to be vital to school readiness (Blair, 2002; Duncan, Claessens et al., 2007; Riggs et al., 2006). The further contribution of short-term memory to children's listening and communication could thus reflect a heavy dependency of such behaviours on effective processing of multiple environmental inputs. Whereas it could be argued that teachers' ratings of such behaviours were contaminated by their impressions of children's academic expertise, other findings suggest that they differentiated successfully between academic and non-academic domains. When entered after the measures of cognitive ability, entry-level academic capabilities made a significant contribution to the explained variance only in the domains of responding, reading, and number. When entered beforehand, they related meaningfully to teachers' ratings, specifically, such that pre-reading skills emerged as a reliable predictor of reading and writing, whereas numerical skills emerged as a reliable predictor of number.

Although superior theory-of-mind capabilities were not shown to benefit the academic aspects of children's school readiness, this may reflect the young age of our participants. For example, theory of mind might assume prominence as a predictor of children's school performance in later grades due to an increasing emphasis on working effectively in groups. Notably, theory of mind was positively linked with nursery pre-reading skills, even after controlling for the remaining predictor variables, a finding in accord with Blair and Razza's (2007) observation of a unique contribution of theory of mind to letter knowledge in 5- to 6-year-olds. Theory of mind might be important to the acquisition of reading-related skills because experiences of reading during early childhood are primarily social experiences. Our failure to find a positive association
between theory of mind and children's general classroom behavior may indicate that the latter measures were too broad. For example, teachers supplied a composite score to express children's capacity for independent self-care and success at interacting cooperatively with their peers, raising the possibility that theory-of-mind performance might have predicted peer relations had it been graded in isolation. On the other hand, it might be unwise to assume that individual differences in theory of mind in young children relate to their school adjustment in any straightforward way. An unexpected outcome of our regression analyses was the discovery of a significant, negative association between children's theory-of-mind skills and teachers' ratings of their willingness to respond to questions and other prompts. Whereas this finding contradicts research highlighting positive links between theory of mind and social behavior, there are at least some precedents for supposing that a well developed theory of mind might be disadvantageous in some aspects of children's educational experience. It has been reported that children's understanding of minds at age 40 months is negatively associated with their initial perceptions of school at age five years (Dunn, 1995) and positively associated with sensitivity to criticism from teachers and other authority figures (Cutting & Dunn, 2002; Dunn, 1995). Additionally, it appears that superior theory of mind is a risk factor for self-worth problems in children who are harshly parented (Cahill, Deater-Deckard, Pike, & Hughes, 2006). Any one of these factors could account for our finding that children who performed well on the theory-of-mind battery were relatively poor at complying with teachers' requests for verbal answers and other public displays of their knowledge.

**Future research**

In this paper, we have described a comprehensive, multifaceted early intervention programme that clearly benefited its recipients. Whereas there is ample documentation regarding the benefits of compensatory education for children's language and academic skills, our data provide important new information about the potential of such programmes to improve children's cognitive self-regulation in ways that enhance their school readiness.

Future studies could compare the consequences of the various kinds of parenting behaviours encouraged by our intervention as a means of identifying those that are most influential in developing children's self-regulation (e.g., reading to the child, conversing with the child, providing academic instruction, etc.). By additionally measuring the general sensitivity and responsiveness of parental care, it might also be possible to distinguish between cognitive and affective sources of influence. Such studies would thus help to establish the value of involving parents in early intervention beyond efforts to foster children's executive functioning through either computer-based training (e.g., Rueda et al., 2005) or specially designed preschool programmes (e.g., Tools of the Mind; Diamond et al., 2007).

Another way forward would be to include pre-intervention assessments of our outcome measures. As well as strengthening the interpretation of any post-intervention group differences, such an approach would reveal whether pre-existing skills mediate the effectiveness of the programme. In our previous research, for example, we assessed children for pre-reading and numerical skills both before and after a short-term intervention carried out just prior to their entry to Reception class (Ford et al., 2003). We found that BPVS scores obtained on the first occasion predicted gains on the academic measures, but only for the intervention group and only for aspects of phonological processing. BPVS scores thus appeared to index children's ability to capitalize on training directed specifically at their phonological awareness.
Conclusions could be further strengthened by examining the long-term outcomes of our project. Numerous reviews have documented a declining impact of early compensatory education over time, suggesting that the continued adversity experienced by disadvantaged children may counteract the initial benefits of the intervention (Brooks-Gunn, 2003; Foster et al., 2005). In line with this view, the consequence of continued intervention appears to be to combat progressive declines in IQ scores that are observed in untreated control groups (Gottlieb & Blair, 2004). Given evidence that supplementing centre-based programmes with a parenting component adds significantly to their effectiveness (Blok et al., 2005), it is important to determine whether discontinuation of such home-based programmes as ours leads to similar ‘fade out’. Even if the improvements to children’s inhibitory control are not maintained, it is possible that providing an early boost in this respect has positive ramifications for later development, for example, as might be the case if inhibitory control underpins knowledge acquisition (Blair & Razza, 2007; Duncan, Claessens et al., 2007). Moreover, home-based programmes could have a lasting beneficial impact on caregivers’ motivation to assist their child academically (Ford et al., 2003).

On a practical level, there is considerable scope for exploring alternative ways of carrying out the intervention. For example, replacing the home visits with group workshops or simply handing over the intervention materials to the mothers with an instruction manual would shed light on the importance of the project workers. In the present case, the chief project worker was herself a single parent who had grown up in the locality targeted by our study. Given the strong likelihood that these attributes made it easier for her to gain the trust of the mothers and thus to motivate them in carrying out the activities, it remains to be seen whether the intervention would be equally effective using more impersonal methods of delivery to the families.

Finally, it is imperative to extend the existing, small literature detailing the contributions of entry-level academic and cognitive abilities to children’s progress during subsequent years of schooling (Blair & Razza, 2007; Duncan, Claessens et al., 2007). Only a longitudinal approach will reveal whether there are valid grounds for instructing preschoolers in pre-reading and numerical skills, beyond efforts to improve their self-regulation. Given the dearth of knowledge in this field, more research on these important matters will not only inform education policy but help to guide the development of more targeted and cost effective interventions for children at risk of educational failure.

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References


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### Appendix A

#### Nursery tests of academic ability

Children's knowledge of their name and address was assessed by asking them to recall these details (score two points for remembering first name and surname, and score two points for remembering street name and number). Their knowledge of colours was
assessed using a recall procedure in which they were requested to identify the colours of a series of coloured rectangles presented by the examiner (12 colours to be identified in total). The non-word repetition task scored children for their ability to repeat after the examiner various nonsense words (e.g. ballop), starting with two syllables and progressing to four syllables (10 non-words in total). For the perceptual discrimination test, children were presented with six sets of abstract shapes and, for each set, were asked to find two shapes 'the same'. In the letter recognition test, children were asked to search for particular letters from a selection of letters shown on an A4 page (with 10 letters to be identified in total). In the number recognition test, children were asked to search for particular numbers from a selection of numbers shown on an A4 page (numbers 1-10 to be identified). The rhyme test assessed children's rhyme detection indirectly by asking them to select one picture from a set of three (e.g., boy, ball, and clown) to complete a sentence (e.g. Down, down, fell the . . . ?). Children's understanding of size, length, and quantity was estimated by asking them to make judgments about pairs of pictures that were identical apart from one attribute (e.g., 'Which cat has the shorter tail?' and 'Which jug has more juice?'). The counting-objects test involved a tea party using pictures of five dolls, five teddies, and five cups, with children being assessed for their ability to count these sets of objects consistently. Finally, in the free-counting test children were asked to count as high as they could (with a limit of 100) and their score was the highest number they reached without making any errors.

Appendix B

Scoring criteria of the Four Counties Foundation Profile

Listening and communication

(1) Listens on occasions to instructions and/or comments and shows understanding.
(2) Listens to questions and responds by producing some intelligible words.
(3) Expresses needs and information in simple phrases.
(4) Communicates through extended language in various contexts.

Responding to stimuli

(1) Expresses some enjoyment and interest in stories, songs, and rhymes.
(2) With teacher support, repeats songs and rhymes.
(3) Memorizes and performs songs, verses, and rhymes.
(4) Re-tells familiar stories in a simple way from memory.

Reading

(1) Looks at books with or without an adult and shows an interest in their content.
(2) Handles books as a 'reader'.
(3) Understands that written symbols have sounds and meaning.
(4)Recognizes some letters and/or common words.
Writing

(1) Tries out a variety of instruments to make marks on paper or other appropriate material.
(2) Holds writing instruments appropriately whilst making marks.
(3) Grasps writing patterns and exercises.
(4) Forms/writes some letters and familiar words legibly.

Number skills

(1) Recites numbers from 1 to 10.
(2) Recognizes and names numbers from 1 to 5.
(3) Understands the number concepts 1 to 5.
(4) Can carry out a simple addition exercise.

Mathematical skills

(1) Shows understanding of simple mathematical concepts of size and position.
(2) Uses simple but appropriate terminology to describe size and position.
(3) Sorts and orders objects according to two criteria.
(4) Recognizes/names basic 2D and 3D shapes.

Personal and social skills

(1) Settles in the classroom environment.
(2) Able to cater for most personal needs independently.
(3) Plays alongside peers, takes part in co-operative play on occasions.
(4) Associates, co-operates, and communicates appropriately with peers and familiar adults.