3 Future scenarios

3.1 The impact of important drivers

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This chapter looks ahead to the next 20 years and considers important factors that will affect the prevalence and impact of learning difficulties. The interactions of these "drivers" are presented in three "influence diagrams" relating to functional literacy, functional numeracy, and also executive function.

Drawing upon the diagrams, possible approaches to the identification and treatment of learning difficulties are introduced. They form the basis for further work which will be presented in the final Project report, to be published in October 2008.

3 Future scenarios

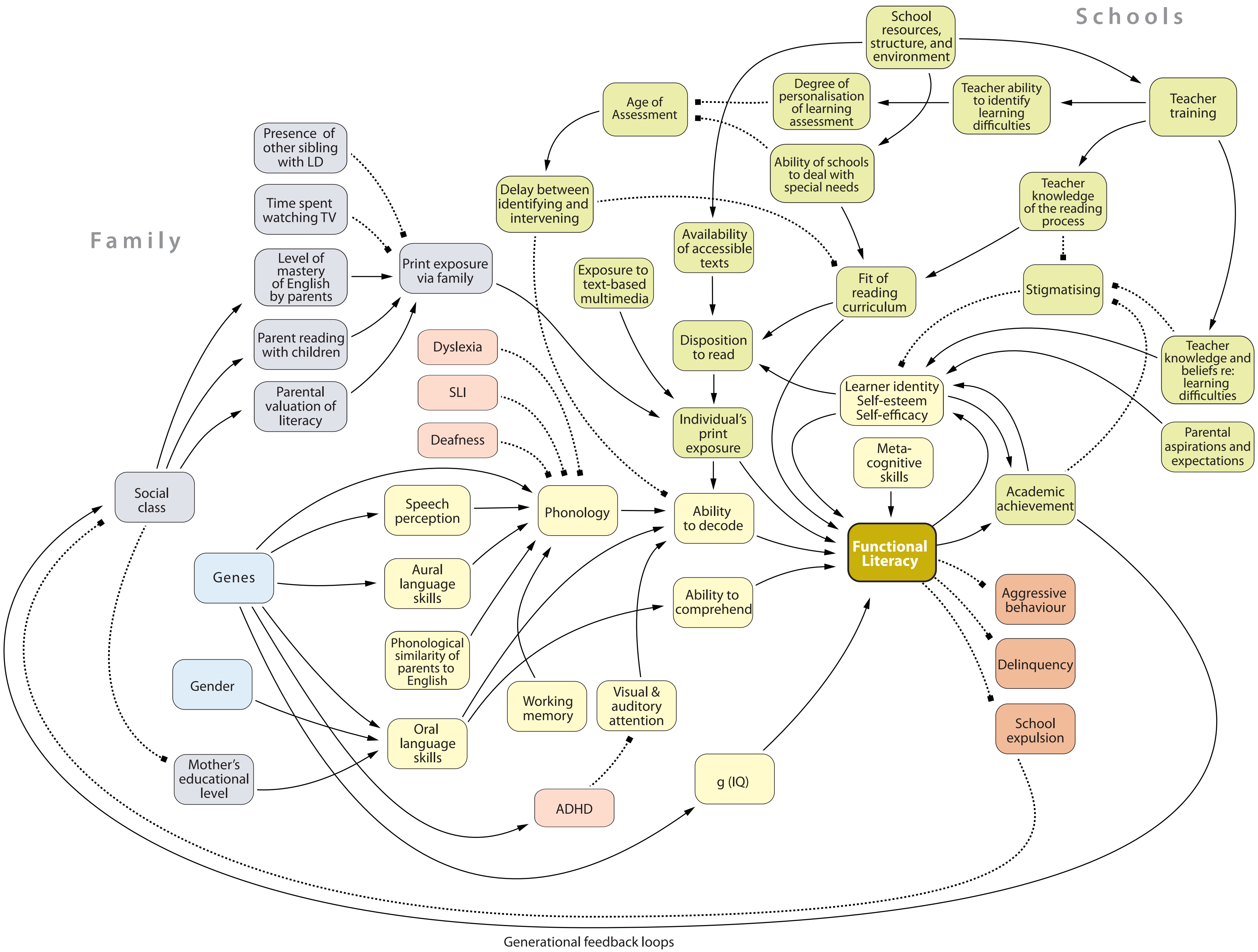
The previous chapters have demonstrated that learning difficulties hamper the development of mental capital and wellbeing in many children in the UK today. As shown, genetic influences are operative, but environments and genes interact, so that environments determine the impact of carrying certain genes. Environments also affect the overall developmental trajectory. This means that learning difficulties can be ameliorated by environmental interventions. Environmental interventions offer a means for resetting developmental trajectories, and research suggests that as the mechanisms whereby (say) inefficiencies in sensory processing cause cognitive problems are identified, more efficient interventions can be designed.

The research commissioned for this area of the Project has also enabled the development of a conceptual model for describing learning difficulties in the developing brain (Figure 1.2). A key objective of the Project is to use this analysis to inform our understanding of how the prevalence and impact of these learning difficulties could evolve in the UK over the next 20 or so years with a view to identifying effective strategic interventions. Clearly the course of development will depend on the interactions of many varied factors – termed "drivers".

These varied factors are captured by the conceptual model. Using the conceptual model as a starting point, experts involved in the Project then developed "influence diagrams" which form visual representations of the interactions of important drivers in the case of functional literacy, functional numeracy and also for executive function (see Figures 3.1, 3.2 and 3.3 respectively; note that the complexities of gene-environment correlations, gene-gene interactions and gene-environment interactions are not represented on the diagrams). By considering how the various drivers might change in the future, these diagrams have been used to explore how mental capital and wellbeing might evolve in the face of different learning difficulties (most importantly developmental dyslexia, developmental dyscalculia, and ADHD, which all have high prevalence). In particular, this has been achieved by considering how the drivers might develop in three alternative, but equally plausible, future socio-economic scenarios. Taken together, the influence diagrams and the scenarios form a tool with which to explore uncertainties in the future, and to test the robustness of possible interventions.

Further details of the scenarios may be found in the final Project report. Also, descriptions of the scenarios and the three influence diagrams will be provided in Project contractual reports that will be made available through www.foresight.gov.uk. However, the following outlines some of the key findings, and provides a preliminary discussion of the implications for possible interventions – these are currently the subject of detailed analysis and will be reported more fully in the final Project report, to be published in October 2008.

Figure 3.1: Influence diagram for functional literacy



3.1 The impact of important drivers

Consideration of the scenarios shows that major drivers such as globalisation and growth of information technology are likely to result in a world in future decades where the knowledge economy is primary, where there will be increasing complexity and intensification of work, and increasingly individualised management of a person's career and old age. For individuals with learning difficulties, such a future world presents a bleak outlook. Those who lack functional literacy and numeracy and/or who lack the ability to plan flexibly and to self-regulate their cognitive and emotional behaviours (i.e. who lack effective metacognitive and executive function skills) are unlikely to be able to participate effectively in or contribute to the "knowledge economy".

Looking across the other parts of the Project (see Appendix A), it is striking that the same factors emerge with respect to mental capital and wellbeing, namely attributes of the individual, characteristics of families and aspects of wider social context. "Influencing skills" and "literacy skills" have been identified as important by those parts of the Project considering the future of work, since they are crucial for the future economic performance of the UK. Therefore, for learning difficulties, a key theme for future policy development should be to seek to enhance the attributes of affected individuals. As noted above, this is most effective when done early, while the sensory systems in the brain are still building the cognitive system. This should become achievable in the next 10–20 years, although there are important ethical considerations.

The fundamental importance of functional literacy and functional numeracy skills both to the individual's mental capital and to future UK economic performance suggests that current priority should be given to establishing the conditions so that all children can acquire these skills. Similarly, significant benefits are likely to accrue to all children from improving environments with respect to the development of cognitive and emotional self-regulation (executive function).

The influence diagrams for literacy and numeracy (Figures 3.1 and 3.2) show possible nodes for cognitive interventions. For example, they indicate that the enhancement of phonological processing for developmental dyslexia and the improvement of counting and the "number sense" for developmental dyscalculia would be particularly beneficial. The diagrams show that early interventions should focus on the biological systems and precursor skills for literacy and numeracy in tandem with boosting social and/or environmental support, rather than provide extensive focused practice of the target skills themselves (e.g. training in "phonics"). This strategy is likely to be more effective when interventions are being provided for younger children. Clearly, any interventions would require piloting in order to optimise their efficacy. Critically, the effectiveness of any planned intervention should then be assessed under optimal research conditions such as Randomized Controlled Trials before it is launched universally[140].

Regarding cognitive and emotional regulation, the enhancement of self-regulation skills through the delivery of early years education in ways facilitating the development of executive function would improve cognitive flexibility and "influencing skills". These skills develop dramatically between the ages of 3 and 7 years. Fostering development of such skills would better equip individuals for coping with an increasingly complex and individualised world. The influence diagram for executive function, provided as Figure 3.3, shows that important nodes for intervention include the language, arts, music and drama curricula, and socio-dramatic pretend play. Metacognition and executive function skills can be learned, via pretend play, language arts, drama and music, and also via

140 Rutter (2006)

modelling (by thinking about the way in which teachers teach young children in terms of how learning is encouraged and reinforced, to foster independence[141]). Teaching these skills does not require yet more "modules" to be added to the curriculum. Rather, effective communication of metacognitive and self-regulatory skills can be achieved by the continuing professional development of teachers, and strong endorsement of the key roles of play and the mainstream arts in the early curriculum.

The two core emergent themes from this analysis of learning difficulties are thus the need for *early detection of* and *early intervention in* learning difficulties. Early detection is fundamental to intervening in the learning trajectory before learning problems become severe, enabling learning trajectories to move closer to those of typically-developing children.

Possible opportunities for early intervention in the next 1–2 decades include the exploitation and development of new technologies, new techniques for cognitive enhancement (e.g. neurocognitive activation to improve impulse control in children with ADHD[142]), and the development of cognitive neural protheses such as cochlear implants[143]. Technological interventions can be very effective when there is scientific agreement on the underlying cause of a learning difficulty, as in the case of cochlear implants for children who are born deaf[144]. In some learning difficulties, there is sufficient scientific consensus regarding the principal causal factors for the development of technological interventions aimed at remediating one causal factor. An example is "The Transporters" videos developed to enhance emotion-reading abilities in young children (typically boys) with autism spectrum disorders[145]. In other learning difficulties, such as developmental dyslexia, there is insufficient scientific consensus for technological interventions aimed at remediating early causal factors (e.g. impaired auditory processing[146]), but sufficient consensus for technological interventions aimed at remediating learning performance[147]. For example, Finnish researchers have developed a technological intervention for teaching dyslexic children to retrieve letter-sound correspondences fluently and automatically, using a video game[148].

Regarding early detection, the possibilities offered by advances in genetics and in cognitive neuroscience are illustrated by Plomin[149] and Friedrich[150]. Plomin predicts the development of "gene chips" that will genotype each child's unique sequence of three billion DNA bases, although this would give a probabilistic rather than deterministic estimate of individual risk. Friedrich outlines innovative cognitive neuroscience research in Germany that uses neural markers (biomarkers) in infancy as predictors of individual risk for later learning disorders of language. Research with the greatest potential with respect to causation in learning difficulties is *prospective longitudinal research combined with intervention studies*. For cognitive neuroscience markers of learning difficulties, such prospective longitudinal studies are already in progress in other countries[151].

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141 Whitebread et al. (2005)

142 Foster (SR-E29) – see Appendix B

143 Ibid

144 Woll (SR-D5) – see Appendix B

145 Baron-Cohen (SR-D10) – see Appendix B

146 Lyytinen (SR-D12) – see Appendix B

147 Ibid

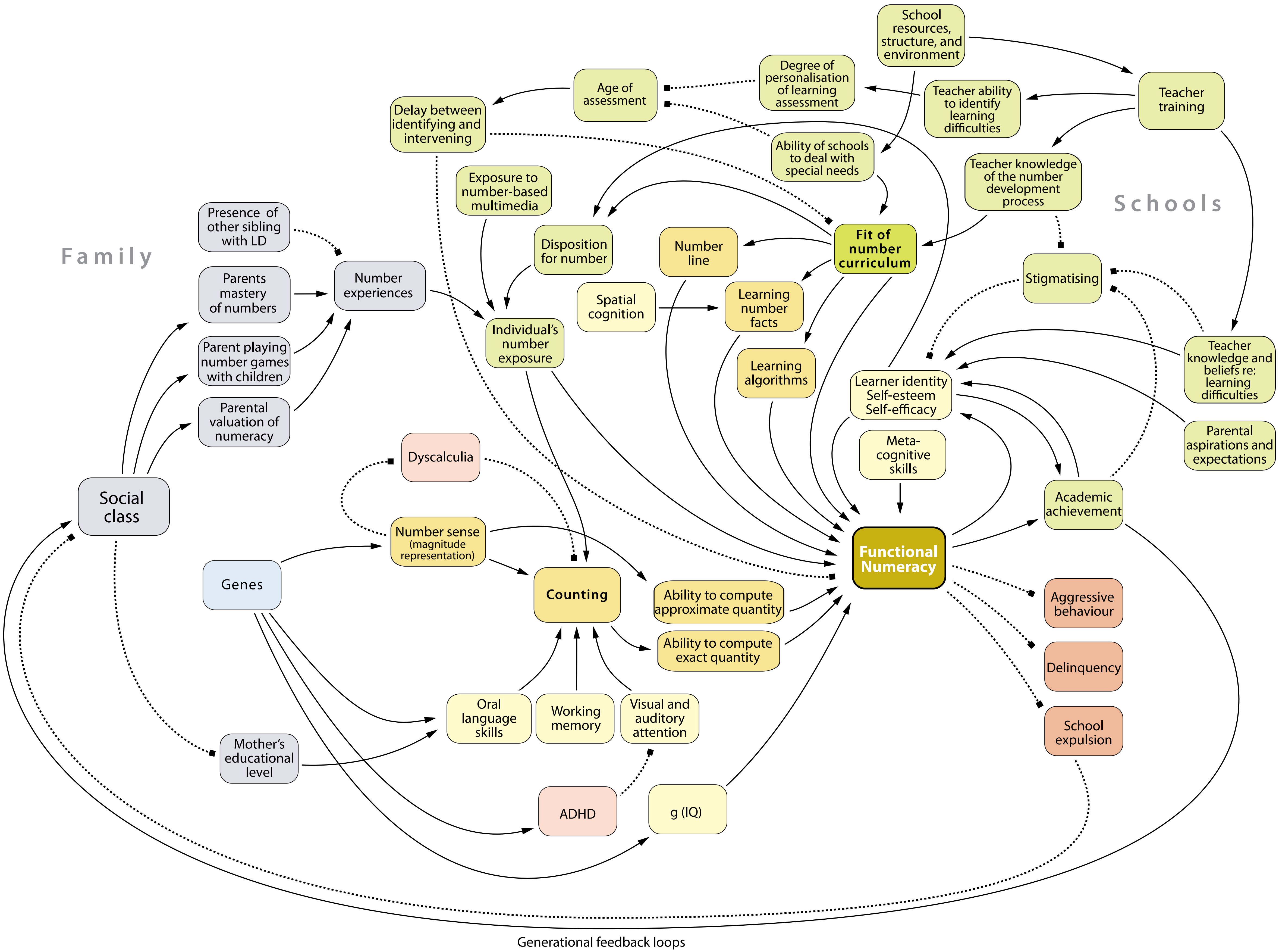
148 Ibid

149 Plomin (SR-D7) – see Appendix B

150 Friedrich (SR-D14) – see Appendix B

151 e.g. Germany for SLI, Finland for dyslexia; see Friedrich (SR-D14); Lyytinen (SR-D12) – see Appendix B

Figure 3.2 Influence diagram for functional numeracy



Social/behavioural interventions are also likely to be effective interventions for learning difficulties, because children can improve their own learning through self-reflection and self-regulation. They can also be effective because children find them enjoyable. Technological interventions must be very intrinsically motivating if children are to persevere with them (surprisingly, many deaf children turn off their cochlear implants for large parts of the day).

In this review, interventions based on improving language and executive function were identified as likely to be of benefit to children with many different kinds of learning difficulties. In fact, such interventions are likely to benefit all children, even those without learning difficulties. Such interventions could begin in nursery, and could be delivered initially through play and the arts (music, drama, story-telling, socio-dramatic pretend play).

With regard to research, a key gap is research on how individual differences in basic sensory processing mechanisms contribute to cognitive outcomes. More sensory research is needed to identify targets for intervention in infancy. The author's personal scientific view is that coordinated research into sensory processing in typical and atypical development, studying all sensory systems across different learning difficulties, would yield significantly improved understanding of developmental mechanisms with consequent benefits for early intervention.

Figure 3.3: Influence diagram for executive function