PERCEPCIÓN DE PADRES Y PROFESORES SOBRE LOS EFECTOS DE LA DIETA EN EL DESARROLLO MENTAL DE LOS NIÑOS

PARENTS' AND TEACHERS' PERCEPTIONS OF THE EFFECTS OF DIET ON CHILDREN'S MENTAL PERFORMANCE

UNIVERSIDAD DE GRANADA

FACULTAD DE MEDICINA

DEPARTAMENTO DE PEDIATRÍA

Memoria presentada por

JUAN CARLOS LÓPEZ ROBLES

Para optar al título de Doctor en Pedagogía

DIRECTORAS

Prof. Cristina Campoy Folgoso

Dra. Bernadette Egan

Dra. Elena Martín Bautista

Granada, 15 de Mayo de 2017

Editorial: Universidad de Granada. Tesis Doctorales
Autor: Juan Carlos López Robbles
ISBN: 978-84-9163-304-4
URI: http://hdl.handle.net/10481/47432

UNIVERSIDAD DE GRANADA

Facultad de Medicina

Departamento de Pediatría

Dña. Cristina Campoy Folgoso, Profesora Titular del Departamento de Pediatría, de la Universidad de Granada, Dña. Bernadette Egan, Senior Research Fellow, de la Universidad de Surrey (Reino Unido) y Dña. Elena Martín Bautista, resposanble de la Oficina de Proyectos Europeos e Internacionales del Instituto de Investigacion Biomedica de Malaga (IBIMA).

HACEN CONSTAR que el presente trabajo titulado *"Percepción de padres y profesores sobre los efectos de la dieta en el desarrollo mental de los niños / Parents' and teachers' perceptions of the effects of diet On children's mental performance",* que constituye la memoria presentada por Juan Carlos López Robles para optar al Grado de Doctor por la Universidad de Granada, ha sido realizado en el Departamento de Pediatría bajo su dirección. Asimismo, considerándola concluida, autorizan su presentación, a fin de que pueda ser juzgada por el tribunal correspondiente.

Y para que conste, firman la presente en Granada, a 15 de Mayo de 2017

Prof. CRISTINA CAMPOY, MD

Dra. BERNADETTE EGAN

Dra. ELENA MARTÍN-BAUTISTA

Tesis inscrita en el programa de doctorado en **Condicionantes Genéticos, Nutricionales y Ambientales del Crecimiento y el Desarrollo**, Departamento de Pediatría, Facultad de Medicina, Universidad de Granada.

El doctorando / The *doctoral candidate* **[Juan Carlos López Robles]** y los directores de la tesis / and the thesis supervisor/s: **[Cristina Campoy Folgoso, Bernadette Egan y Elena Martín Bautista]**

Garantizamos, al firmar esta tesis doctoral, que el trabajo ha sido realizado por el doctorando bajo la dirección de los directores de la tesis y hasta donde nuestro conocimiento alcanza, en la realización del trabajo, se han respetado los derechos de otros autores a ser citados, cuando se han utilizado sus resultados o publicaciones.

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The present Doctoral Thesis has been conducted within the framework of the NUTRIMENTHE project “The effect of diet on the mental performance of children” (7th Framework Programme; FP7-KBBE-2007-2-2-01). NUTRIMENTHE was a five-year EU-funded Project that aimed to further our understanding and knowledge of the effect of nutrition on the mental development and performance of children, studying the role, mechanisms, risks and benefits of specific nutrients and food components on the mental performance of children.

This work is based on an international collaboration between four research institutions (University of Granada, Spain; Ludwig-Maximiliams University of Münich, Germany; University of Pécs, Hungary; and, University of Surrey, UK) to gain an insight into parents and teachers understanding of how nutrition influences mental performance. The Consumer Attitudes worpackage, led by the Universiy of Surrey (United Kingdom), examined parents and teachers knowledge of the effects on brain development of childhood diets, understanding how stakeholders perceive that food affects children's attention, sleep, motivation, effort and memory, and how those perceptions impact food choice.

A mis padres

LIST OF ABBREVIATIONS

EU: European Union

GHI: General Health Interest

NH: Nutrition and Health

PA: Physical Activity

SES: Socio Economic Status

SPSS: Statistical Package For Social Sciences

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ACKNOWLEDGEMENTS

This doctoral thesis has been possible thanks to the support and collaboration of a large group of people, and I would like to thank all those who have contributed in some way to make it a reality:

I would like to thank Prof. Cristina Campoy the opportunity she gave me for joining the Euristikos research group. With her and with all my colleagues, I grew beyond the limits of the different areas of knowledge. This work is a true reflection of her vision of research as a collaboration between departments.

My special thanks go to Dr. Bernadette Egan for her continued support and endless positive view. Her leading at the international collaboration in the framework of Nutrimenthe has been a great source of inspiration. Also, I would like to thank the Research Team at the Food, Consumer and Health Research Institute at the University of Surrey, UK for their hospitality in Guilford; Dr. Monique Raats and Dr. Heather Gage for their support, and theirs expert view in this topic.

Moreover, I would like to thank Elena Martín-Bautista for her advices, always direct and with a good dose of sense of humor. Furthermore, I would like to thank all parents, teachers, colleagues and school staff involved in the research.

Last but not least my thanks go to my parents for all their inconditional support, love and being there for me whatever comes. Also to my brother, my sister and their beautiful families for giving me the entire moral supports. And my deepest gratefulness goes to Xavi for his understanding and for making me laugh every day.

AGRADECIMIENTOS

Esta tesis doctoral ha sido posible gracias al apoyo y colaboración de un numeroso grupo de personas, y me gustaría agradecérselo a todos áquellos que han contribuidode alguna manera para que sea una realidad:

Quiero agradecer a la Prof. Cristina Campoy la oportunidad que me brindó al incorporarme al equipo de investigación Euristikos. Con ella y con todos mis compañeros crecí más allá de los límites de las diferentes áreas del conocimiento. Este trabajo es fiel reflejo de su visión de la investigación como colaboración entre departamentos.

Mi agradecimiento especial va dirigido a la Dr. Bernadette Egan por su constante e interminable punto de vista desde la positividad. Su liderazgo en la colaboración internacional en el grupo de trabajo de Nutrimenthe ha sido una gran fuente de inspiración. También quiero agradecer al Equipo de Investigación “Consumer and Health Research Institute” de la Universidad de Surrey, Reino Unido, por su hospitalidad; a la Dra. Monique Raats y a la Dra. Heather Gage por su ayuda y su punto de vista como expertas en la materia.

Por otra parte, quiero dar las gracias a Elena Martín-Bautista por sus consejos, siempre directos y con una buena dosis de sentido del humor. Conjuntamente, quisiera agradecer a todos los padres, maestros, colegas y personal escolar involucrados en la investigación.

Por último, pero no menos importante, gracias a mis padres por todo su apoyo incondicional, su amor y por estar allí para mí con lo que sea. También a mi hermano, a mi hermana y a sus hermosas familias por darme todo el apoyo moral. Y mi más profundo agradecimiento a Xavi por su comprensión y por hacerme reír todos los días.

CONTENTS

1. Background

1. BACKGROUND

The early years represent a critical period of growth and development for children, both physically and mentally and form the basis of future health behaviours (1). Between the ages of three and five children, should have acquired the basic skills of language, gross and fine motor skills, and be capable of independent eating, sleeping, and toileting (2). Cognitive abilities refer to the mental skills that are essential to everyday life, including learning, play, as well as daily self-care (3). These skills enable individuals to function in the world, to know, be aware, think, conceptualize, reason, criticize, and be creative, as well as acquire, interpret, organize, store, retrieve, and employ information (4–7). A wide range of factors such as age, gender, socioeconomic status, parents' education level, school setting, area of residence, birth order, nicotine exposure, and culture have been shown to affect children's cognitive abilities and their academic performance (8–10).

The development and long-term health of children are also linked to nutritional habits from early life onwards (11). Nowadays, childhood obesity is a worldwide problem and has accelerated in recent years (12,13). The reasons for this are complex and in addition to genetics and a complex web of environmental and psychosocial factors, parental influence on children's eating patterns and food intake has been identified as an an important predictor of the development of childhood obesity (14–16). Prior studies that have noted the importance of obesity during childhood emphasize that this is related to permanent neurodevelopment problems and society at large is not aware of it (17,18).

Human development involves understanding the larger world beyond one's family and home and interacting with people outside of the family environment in community venues, such as schools or the playground (2). This is true of children's

food preferences and trying new foods is influenced by the people around them (19). Young children depend on their families and others, including teachers, to support their well-being and promote positive development, including eating behaviours (20). Studies in children and adults have shown positive associations between nutrition knowledge and the likelihood of healthy food consumption, highlighting that nutrition knowledge is necessary for making healthier food choices (21–23).

Further research, involving Structural Equation Modelling (SEM), determined that children of parents with greater nutrition knowledge have a better recognition of healthy instead of unhealthy foods (24). This indicates that parents' nutrition knowledge may directly affect children's nutrition knowledge and highlights the importance of the family in teaching their children about healthy foods.

The range and complexity of the factors that influence childrens' diet have been captured and illustrated by Adamo & Brett in Figure.01. The authors highlight the different factors that influence parental perceptions of the quality of their child's diet. These factors include but are not limited to the following examples.

Biological parameters such as genetics or weight status have a role in influencing parents' perception of their childrens' body status (25); as does Socio-Economic Status (SES) (26–28), parents education level, home incomes (29), food insecurity, inadequate cooking facilities and limited time as well as long working hours. Some authors suggest that there is a bidirectional interaction between parenting and children's weight status (30). Although SES indicators have an impact on food intake, parents education level has been strongly related to family's dietary habits, especially mothers education level to children's nutritional behaviours (31–33). Moreover, culture can have an effect on children's diet quality and it has been stated that over 35% of the variance in dietetic consumption in children comes from cultural influences (34).

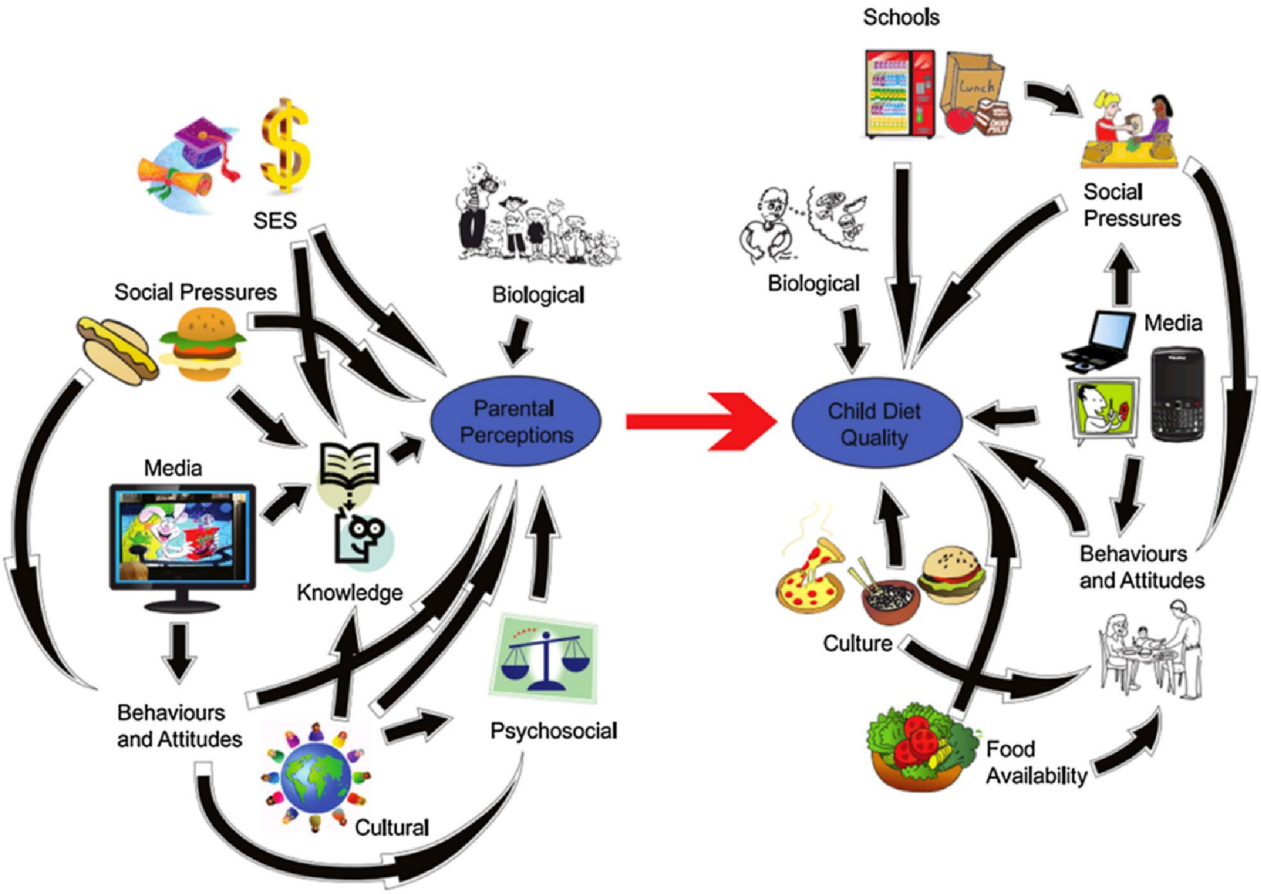

Figure.01 The interrelationships of different influences on parental perceptions and diet quality in children. (1)

In addition environmental or social pressures by way of comparison to other people and media marketing (television, magazines, newspapers, internet, retailers) are important factors that may influence parents' knowledge and consequently their perception of the quality of children's diet. Reports show that the majority of parents feel that their children are influenced by advertisements on television and commercials, given that they are designed for an audience with a remarkable ability to recall content from the advertisement (35–37).

During parenthood healthy eating samples are necessary and play significant roles in establishing longer-term eating behaviours that should be perceived as a great

responsibility (38). The model also incorporates the role of psychosocial factors, for example perception of control, parenting style, guilt or fears heavily reinforced by cultural perceptions like customs, celebrations and traditional foods. Parental control of a child's eating can have a considerable influence on the quality of their child's diet and they sometimes have to understand when cultural traditions are not in accordance with healthy eating recommendations (39).

Influences on the quality of a child's diet may alsorelate to a range ofbiological or physical factors at the individual child level (personal food preferences, cravings, neophobia). At school there can be swapping of school lunches, peer pressure on food choice, school cafeteria lunches. As children grow up a raft of other influences come into play including social pressures, convenience culture and media influence (food marketing to children through a variety of media platforms). As a consequence behaviours and attitudes develop: pestering parents to purchase junk foods, preferences for unhealthy items; sometimes opposite to food availability, parental preferences and exposure to different foods, types of food available, restrictive or lenient food control. Culture is sometimes an extra handicap in the way junk foods are normalizated, family meals become exceptional, shifts in work-home priorities or eating in front of the television.

1.1. NUTRITION AND MENTAL PERFORMANCE

The brain develops and grows throughout childhood and places greater demands on the provision of macronutrients and micronutrients than one might expect. Both groups of nutrients can affect brain and cognitive development which is reflected by outcomes such as mental performance, mood and behaviour as well as mental disorders. During periods of rapid growth nutrient deficiences can damage brain structure development (40,41) which can have long-term consequences for mental

functioning such as focusing attention and stimulation inhibition (42). Certain nutrients can affect brain structures, neurotransmission or even brain energy supply and metabolism (43).

Nutrients are not consumed singly but in the context of an individual's diet. Human diet composition, specially a child's diet and their eating behaviours, plays an important role in brain development as evidenced in several studies (44–46). Nutrients are the morphological base for brain development but are also necesary for brain neurochemistry and neurophysiology and a deficiency can disrupt brain organisation with strong repercussions on its function (47). At a more detailed level, nutrients such as fatty acids reduce cognitive deficit (48).

Cognition is defined as a complex set of abilities that can be categorized into different cognitive modalities such as intelligence, memory, reasoning, attention and psychomotor coordination (49). Nutrition and specific food components are one of the possible influencing factors on a child's cognitive functioning and mental performance (40,41). It has been shown that nutrition can affect the brain's frontal lobes development, but also microstructure and neurotransmitter systems as well as the physiological processes that are all associated with cognitive functioning.

As shown in Figure.02, cognitive functions can be divided into six areas: language, psychomotor functions, perception, attention, memory, and learning. Each area can be further divided into specific cognitive functions, which are very much interlinked, however efficient functioning of one cognitive process may depend on other cognitive processes. For instance, encoding of new information in the long-term memory cannot take place without corresponding attention and perception as well as employing executive learning strategies (43).

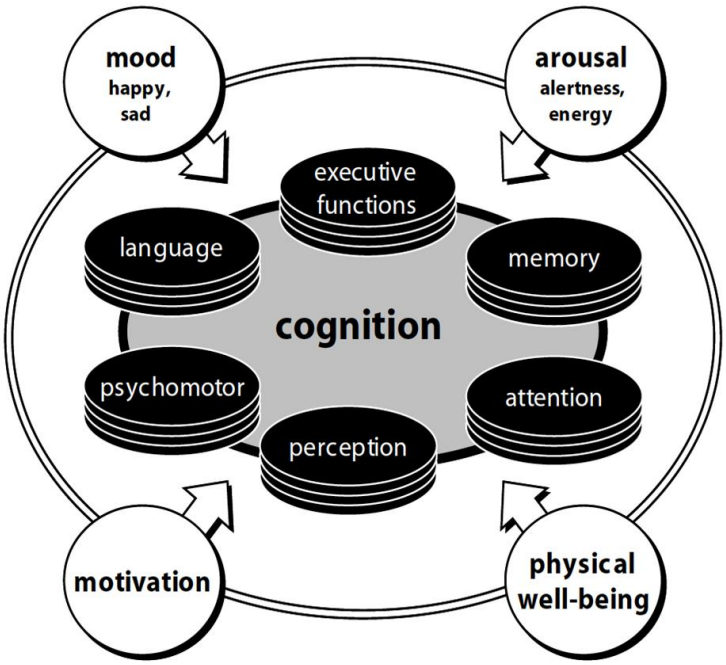

Figure.02 Schematic representation of the interaction between the cognitive functions (in black) and the factors that may modulate the efficiency of cognitive processing (in white) (43).

Memory functions include short-term and long-term memory encoding of information, storage and recovery functions as well as working memory (50). Further distinction can be made between the types of information that are being processed, for instance, involving sensory modalities, verbal vs. non-verbal and declarative vs. procedural and episodic information. Attention can be subdivided into selective attention (the ability to pay attention to those things that are considered important and to ignore those that are not), divided attention (to divide attentional processing between more than one task) and sustained attention or vigilance (51).

The executive functions involve brain regions of evolutionary younger age such as the frontal lobes. Those functions are associated with a child's ability to engage in independent and goal-directed behaviour; so they are the so called "higher order or executive functions" (42). They are defined as meta-cognitive abilities that overarch

all other cognitive functions and are of special importance. Good executive function is demonstrated for instance by mental flexibility, planning and self-monitoring behaviour, problem solving, abstract reasoning and rule learning (52). Although there are some experimental procedures for the measurement of executive function in children, one has to take into account that the full range of executive functions is thought to only develop in later childhood and even into adolescence as a maturation process which seems to be the prerequisite for good higher order cognitive performance (50).

In addition to the importance of nutrients in brain development and functioning it is important also to consider the role of meals and their timing/regularity in undertanding how nutrition can have an impact on health and wellbeing. A number of studies provide evidence for the importance of the timing of children's meals and their relationship with some foods (53,54). Meals such as breakfast have a significant impact on childrens' behaviour and performance during school day (44,55), specifically from early morning to midday, when children need a strong input of fiber and protein to meet mental and physical requirements (45). Children sharing meals with friends or family can be a determinant of their nutritional health, not only with regard to the time of eating but also in activities such as food shopping, meal preparation or conversation (56,57).

1.2. FAMILY ROLE

There are important genetic factors that influence a child throughout its life but the most significant determinant of a child's development is perhaps their familys' influence. In the process of growth and development family stands out as the strongest environmental factor (48–60) influencing both the physical and psychosocial environment in the early years and consequently on her or his

development and behaviour (61). There is a wide body of evidence in the literature that family plays a significant role in how young children aquire and develop knowledge, behaviours and beliefs (62–64). Consequently parents are highly influential in a child's eating behaviours and development of their food choices, controlling both the types and the availability of food at home (63–67).

Over the last decade an increasing number of studies have demonstrated aspects of the family food environment to have strong modifying effects on children's dietary behaviours (68–70). Parents can be strong positive or negative influencers on the quality of childrens diet given their responsibility for family food choices and meal preparation (1). This highlights the importance of parental perceptions and knowledge about child's dietary intake, and thus they must be able to recognize when and how to make any necessary changes, additionally they are acting as models through their own eating behaviours (62).

Children emulate parental behaviours and they are going to be unconcerned about nutrition when parents are disinterested in nutrition and thus compromise diet quality (71). Parents must recognize that they are their child's first and most important dietary influence and perhaps they have more control than they perceive they do. Modelling, encouragement, parental demand or family routines of eating together have been identified as environmental factors that children perceive and report (72,73).

Eating behaviours are often guided within the family context, and thus the diets of children and youth are greatly influenced by their family dynamics and routines (62,74). New strategies encourage families and schools to create and promote positive social eating environments and to provide better food choices for children, particularly at home (75,73). Parents use a variety of strategies to influence children's eating habits. The family meal represents an important moment of interaction and control (11,56).

Parents are the primary food providers for young children, as well as being important role models (76). Among the most common barriers described in the literature are family schedules, lack of money to purchase healthy food, lack of time to prepare healthy meals, the accessibility and desirability of unhealthy foods, and lack of knowledge about the nutrient content of unhealthy fast foods (77–80). Parents' perception of the importance of individual factors has been associated with their level of education. Conversely, food choices use to be determined on behalf of children by their own parents, but they may be influenced also by a multitude of factors (81), as described previously.

In order for parents to impact their children's food behaviours and attitudes, parents need knowledge about healthy foods, resources to support them in their nutritional education and the skills to purchase healthy foods and prepare them in a healthy manner (82). Studies have shown that parents prefer nutrition activities at school and promoting Physical Activity (PA) initiatives instead of theoretical lectures or nutrition counselling sessions. Parents also mentioned that those activities should be practical, fun and created for involving both parents and children. However, they also mentioned that school initiatives are influential because children spend much time at school (83).

Families are typically children's first significant models of eating behaviour nevertheless educating parents is not sufficient to promote healthy eating behaviours (80). Involving parents in school activities is challenging as parents are often not enthusiastic about participating in school interventions and they have little extra time if working (84,85). The importance of teachers and schools in educating children about healthy eating has been highlighted by parents; teachers are often seen as role models by the children and might therefore have a substantial influence on children's behaviours (86).

1.3. SCHOOLS AND TEACHERS' ROLE

Education can provide an important socio-economic influence on health-related behaviour as it may increase the use of health-related information (87). The school is recognized as an important setting for childhood health promotion interventions since children spend much time there. School performance is a complex sign of a child's development (88) and it includes factors such as biology, behaviour, accessibility to food, family food preferences and practices, socioeconomic factors and cultural beliefs that allows them, as institutions, to implement educational programmes and create a health promoting environment (89,90). Schools can be optimal settings for such activities and they have traditionally promoted healthy lifestyles among students (91,92) with nutrition education resources such as nutrition pyramid or food wheel for children focused on educating the children through their teachers during the school day (80).

Though parents are responsible for a child's genetic structure and biological predisposition, they are not the only adults influencing the development of a child's eating behaviours (73). Teachers can share examples creative lunches with variety in colour, texture, and taste to appeal to young children and help creating safe environments with enjoyable, nutritious and fun early food experiences (20). Among their many duties, school staff serve as health educators, information resources for students and parents, and as links between families and their healthcare providers (93). Teachers become models for children at mealtime and after lunch. The way teachers act in several situations has an important influence on student behaviour (94). However, there is a little research into how they perceive that some factors have an influence on children's mental performance or behaviour.

Teachers also bring their professional training and individual values to the classroom (48). They may be more likely to detect behavioural problems related to family SES, health or nutritional problems, if they know that the child in preschool or school is undergoing learning difficulties (95).

When children start school teachers and classmates become an important influence (96,97). While previous research has examined the role of the home environment in the development of children's eating behaviours and explored parental views about child feeding (98), there is little available evidence concerning the perceptions of parents or teachers of the relationship between what children eat and their mental performance. As it is represented in Figure.03, this is the fundamental evidence of programmes that show the efficiency of teachers and parents training together to promote sociable eating behaviour (99–102) to improve physical and mental development.

1.4. INFLUENCE OF CULTURAL FACTORS AND MASS MEDIA

Community provides a context full of experiences that enrich childrens development. In this contexts, parents should became 'agents of change' about many attitudes, personal behaviours and impact in nutrition choices (103). The theories of Vygotsky described the impact of children interacting with the community and society (104,105). He stressed the role of society establishments in determining cognitive progress. Schools become a tool to promote the development of intelligence providing formal training, which likened to child's cultural context is essential to entirely estimate the child's competence at any age (106).

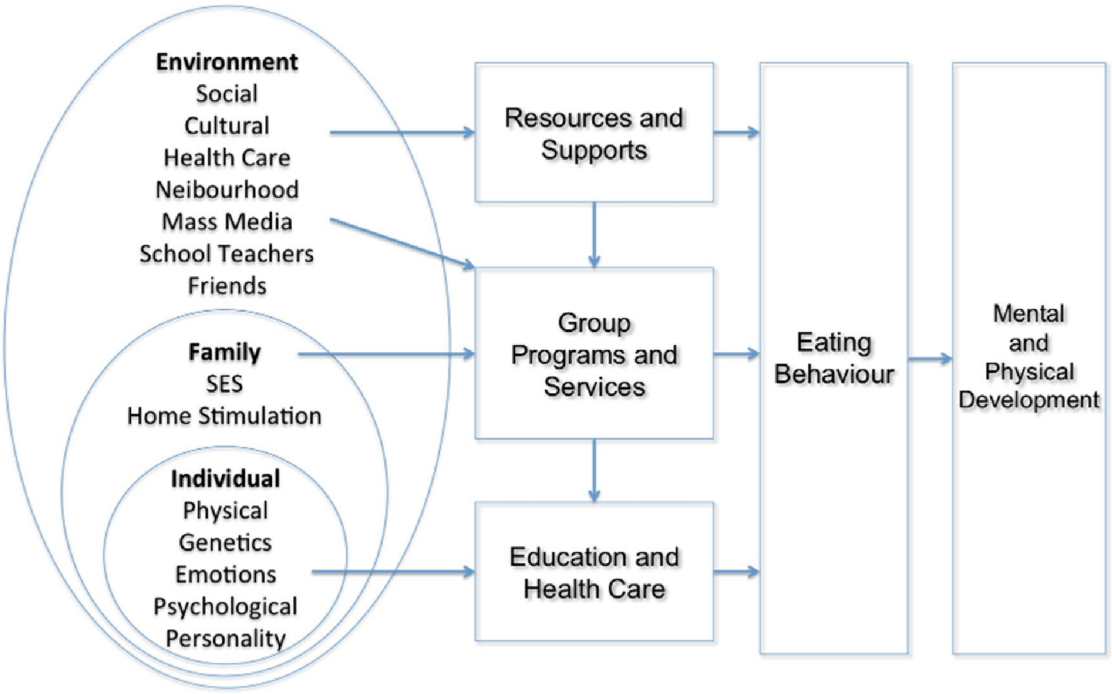

Figure.03 Interplay of individual profile (physical conditions, emotions, personality), family factors (genetic elements, SES, stimulation) and community characteristics (shool, neighbourhood, environment).

Nevertheless while children start interacting with their community and environment, peers become a large influence on their life choices and food preferences; this is particularly true for adolescent eating behaviours (107). Besides, it is possible that food consumption is affected for many indicators in different ways due to essential social and psychological processes (108,109) connected to emotional barriers that are sometimes a strong difficulty to acquire healthy eating behaviour (110).

Public Health Institutions are recommending parents to promote healthful eating behaviours and regular PA for their children, emphasizing the importance of family involvement in modelling children's dietary and activity habits (92). According to them, children's PA should be influenced by parents because of their unique position to stimulate and encourage them after school or during the weekend. Public health

strategies are grounded on both an individual and an environmental to support a healthy lifestyle (111).

Children live in a variety of social settings throughout the day, many of them around meals custom like eating with different people or the specific place where the meal is located, elements that define the eating context (75). Some studies has tryed to measure the eating context with questionaires around factors that describe the home environment (112–114). The food environment is an important determinant of dietary behaviour but so they are schools (115,116), as well as home food environment (117,118). Moreover, external influences such as television, smartphones or Internet and behaviours like eating outside instead of having lunch at home on the table may influence meals consumption (75).

Nowadays children and teenagers are exposed to advertising through a enormous selection of activities that they engage in through various media platforms which play a huge part of their lives with a continuous stream of messages about many other products and issues (119). Media are amongst the most powerful forces in people's lives and parent sometimes spend lot of time looking for further information about nutrition and physical development but sometimes they can not distinguish scientific publications from simple advertisements (120,121). They may also receive contradictory health and nutrition information from informal sources such as television, magazines, newspapers, internet, friends, relatives and retailers (122). Recently research has shown an increased interest in how children are growing up in a highly personalized era around their media experiences, and this could be affecting health with negative effects around sleep, attention or learning (123,124).

In conclusión there is ample evidence from the literature of the effects of nutrition, diet, environment, social conditions and mass media on childrens' physical development but with less attention focused on childrens' mental development. Signficantly there has been a lack of research involving parents and signficant others, such as teachers, to gain insight into their knowledge, beliefs and attitudes concerning the role of nutrtion and diet in the mental development and performance of children, despite recognition of their vital role in childrens' development.

This is the gap in knowledge that this thesis aims to address with the additional aim of examining these issues across a number of European countries.

1.5. REFERENCES

1. Adamo KB, Brett KE. Parental perceptions and childhood dietary quality. Matern Child Heal J. 2014;18:978–95.

2. Hamel S., Pelphrey A. Preschool Years. In: Carey WB, Crocker AC, Elias ER, Feldman HM, II WLC, editors. Developmental-Behavioral Pediatrics. 4th ed. Philadelphia: Saunders/Elservier. 2009;39–49.

3. Almomani F, Josman N, Al-Momani MO, Malkawi SH, Nazzal M, Almahadawi KA, et al. Factors related to cognitive function among elementary school children. Scand J Occup Ther. 2014;21:191–8.

4. Josman N, Abdallah TM, Engel-Yeger B. Using the LOTCA to measure cultural and sociodemographic effects on cognitive cultural and sociodemographic effects on cognitive skills in two groups of children. Am J Occup Ther. 2011;65:29–37.

5. Josman N, Abdallah TM, Engel-Yeger B. Cultural factors affecting the differential performance of Israeli and Palestinian children on the Loewenstein Occupational Therapy Cognitive Assessment. Res Dev Disabil. 2010;31:656–63.

6. Uyanik M, Aki E, Düger T, Bumin G, Kayihan H. Cognition in 4-11 year old children in Turkey. Pediatr Rehabil. 1999;3:119–24.

7. Katz N, Itzkovich M, Averbuch S, Elazar B. Loewenstein Occupational Therapy Cognitive Assessment (LOTCA) battery for brain-injured patients: reliability and validity. Am J Occup Ther. 1989;43:184–92.

8. Van Kempen E, Fischer P, Janssen N, Houthuijs D, van Kamp I, Stansfeld S, et al. Neurobehavioral effects of exposure to traffic-related air pollution and transportation noise in primary schoolchildren. Environ Res. 2012;115:18–25.

9. Stansfeld SA, Berglund B, Clark C, Lopez-Barrio I, Fischer P, Ohrström E, et al. Aircraft and road traffic noise and children's cognition and health: a cross-national study. Lancet. 2005;365:1942–9.

10. Díaz AL. Personal, family, and academic factors affecting low achievement in secondary school. Pers Fam Acad factors Affect low Achiev Second Sch. 2003;1:43–66.

11. Scaglioni S, Arrizza C, Vecchi F, Tedeschi S. Determinants of children' s eating behavior. Am J Clin Nutr. 2011;94:2006–11.

12. Fernández-Alvira JM, De Bourdeaudhuij I, Singh AS, Vik FN, Manios Y, Kovacs E, et al. Clustering of energy balance-related behaviors and parental education in European children: the ENERGY-project. Int J Behav Nutr Phys Act. 2013;10:5–15.

13. Spruijt-Metz D. Etiology, treatment and prevention of obesity in childhood and adolescence: a decade in review. J Res Adolesc. 2011;21:129–52.

14. Kröller K, Warschburger P. Associations between maternal feeding style and food intake of children with a higher risk for overweight. Appetite. 2008;51:166–72.

15. Benton D. Role of parents in the determination of the food preferences of children and the development of obesity. Int J Obes Relat Metab Disord. 2004;28:858–69.

16. Elder JP, Arredondo EM, Campbell N, Baquero B, Duerksen S, Ayala G, et al. Individual, family, and community environmental correlates of obesity in Latino elementary school children. J Sch Health. 2010;80:20–30.

17. Campoy C, Martín-Bautista E, García-Valdés L, Florido J, Agil A, Lorente JA, et al. Study of maternal nutrition and genetic on the foetal adiposity programming (The PREOBE study). Nutr Hosp. 2008;23:584–90.

18. De Miguel-Etayo P, Muro C, Santabárbara J, López-Antón R, Morandé G, Martín-Matillas M, et al. Behavioral predictors of attrition in adolescents participating in a multidisciplinary obesity treatment program: EVASYON study. Int J Obes. 2016;40:84–7.

19. Bellows L, Anderson J. (2006) The Food Friends: Encouraging Preschoolers to Try New Foods. Young Child. http://www.naeyc.org/files/naeyc/Food_Friends.pdf (accessed May 2017).

20. Eliassen EK. The impact of teachers and families on young children's eating behaviors. Young Child. 2011;66:84–90.

21. Worsley A. Nutrition knowledge and food consumption: can nutrition knowledge change food behaviour? Asia Pac J Clin Nutr. 2002;11:579-585.

22. Gibson EL, Wardle J, Watts CJ. Fruit and vegetable consumption, nutritional knowledge and beliefs in mothers and children. Appetite. 1998;31:205–28.

23. Wardle J, Parmenter K, Waller J. Nutrition knowledge and food intake. Appetite. 2000;34:269–75.

24. Zarnowiecki D, Sinn N, Petkov J, Dollman J. Parental nutrition knowledge and attitudes as predictors of 5–6-year-old children's healthy food knowledge. Public Health Nutrition. 2012;15: 1284–90.

25. Sylvetsky-Meni AC, Gillepsie SE, Hardy T, Welsh JA. The impact of parents' categorization of their own weight and their child's weight on healthy lifestyle promoting beliefs and practices. J Obes. Hindawi Publishing Corporation; 2015;2015:1–7.

26. Shavers VL. Measurement of socioeconomic status in health disparities research. J Natl Med Assoc. 2007;99:1013–23.

27. Braveman PA, Cubbin C, Egerter S, Chideya S, Marchi KS, Metzler M, et al. Socioeconomic status in health research: one size does not fit all. JAMA. 2005;294:2879–88.

28. Wagstaff A, Watanabe N. What difference does the choice of SES make in health inequality measurement? Health Econ. 2003;12:885–90.

29. Irala-Estévez JD, Groth M, Johansson L, Oltersdorf U, Prättälä R, Martínez-González MA. A systematic review of socio-economic differences in food habits in Europe: consumption of fruit and vegetables. Eur J Clin Nutr. 2000;54:706–14.

30. Lobstein T, Baur L, Uauy R, Baur L, Uauy R, Ogden C, et al. Obesity in children and young people: a crisis in public health. Obes Rev. BioMed Central; 2004;5:4–85.

31. Cribb VL, Jones LR, Rogers IS, Ness AR, Emmett PM. Is maternal education level associated with diet in 10-year-old children? Public Health Nutr. 2011;14:2037–48.

32. Nilsen SM, Krokstad S, Holmen TL, Westin S. Adolescents' health-related dietary patterns by parental socio-economic position, the Nord-Trøndelag Health Study (HUNT). Eur J Public Health. 2010;20:299–305.

33. Ebenegger V, Marques-Vidal P-M, Nydegger A, Laimbacher J, Niederer I, Bürgi F, et al. Independent contribution of parental migrant status and educational level to adiposity and eating habits in preschool children. Eur J Clin Nutr. 2011;65:210–8.

34. Vauthier JM, Lluch A, Lecomte E, Artur Y, Herbeth B. Family resemblance in energy and macronutrient intakes: the Stanislas Family Study. Int J Epidemiol. 1996;25:1030–7.

35. Turner JJ, Kelly J, McKenna K. Food for thought: parents' perspectives of child influence. Br Food J. 2006;108:181–91.

36. Campos D, Hernández-Torres JJ, Agil A, López-Robles JC, Comino M, Macías M, et al. Analysis of food advertising destined to children in Spanish Television , for obesity prevention : Where are we going? Arch Med Sci. 2016;4:799–807.

37. Wilcox BL, Kunkel D, Cantor J, Dowrick P, Linn S, Palmer E. (2004) Report of the APA Task Force on advertising and children. American Psychological Association. http://www.apa.org/pi/families/resources/advertising-children.pdf (accessed May 2017)

38. Birch L, Savage JS, Ventura A. Influences on the Development of Children's Eating Behaviours: From Infancy to Adolescence. Can J Diet Pract Res. 2007;68:1–56.

39. Hart LM, Damiano SR, Cornell C, Paxton SJ. What parents know and want to learn about healthy eating and body image in preschool children: a triangulated qualitative study with parents and Early Childhood Professionals. BMC Public Health. 2015;15:596–609.

40. Associate Parliamentary, F., & Health F. (2008) The influence of nutrition on mental health. http://www.foodforthebrain.org/media/229766/FHF.pdf (accessed May 2017)

41. Westenhoefer J, Bellisle F, Blundell JE, de Vries J, Edwards D, Kallus W, et al. PASSCLAIM - Mental state and performance. Eur J Nutr. 2004;43:85–117.

42. Hughes D, Bryan J. The assessment of cognitive performance in children: considerations for detecting nutritional influences. Nutr Rev. 2003;61:413–22.

43. Schmitt JAJ, Benton D, Kallus KW. General methodological considerations for the assessment of nutritional influences on human cognitive functions. Eur J Nutr. 2005;44:459–64.

44. Benton D, Jarvis M. The role of breakfast and a mid-morning snack on the ability of children to concentrate at school. Physiol Behav. 2007;90:382–5.

45. Mahoney CR, Taylor HA, Kanarek RB, Samuel P. Effect of breakfast composition on cognitive processes in elementary school children. Physiol Behav. 2005;85:635–45.

46. Taras H. Nutrition and student performance at school. J Sch Health. 2005;75:199–213.

47. Anjos T, Almaë S, Emmett P, Tiemeier H, Closa-Monasterolo R, Luque V, et al. Nutrition and neurodevelopment in children : focus on NUTRIMENTHE project. Eur J Nutr. 2013;52:1825–42.

48. Gómez-Pinilla F. Brain foods: the effects of nutrients on brain function. Nat Rev Neurosci. 2008;9:568–78.

49. Bellisle F. Effects of diet on behaviour and cognition in children. Br J Nutr. 2004;92:227-32.

50. Isaacs E, Oates J, ILSI Europe a.i.s.b.l. Nutrition and cognition: assessing cognitive abilities in children and young people. Eur J Nutr. 2008;47:4–24.

51. Matthias E, Schandry R, Duschek S, Pollatos O. On the relationship between interoceptive awareness and the attentional processing of visual stimuli. Int J Psychophysiol. 2009;72:154–9.

52. Miyake A, Friedman NP, Emerson MJ, Witzki AH, Howerter A, Wager TD. The unity and diversity of executive functions and their contributions to complex "Frontal Lobe": a latent variable analysis. Cogn Psychol. 2000;41:49–100.

53. Boutelle KN, Birnbaum AS, Lytle LA, Murray DM, Story M. Associations between perceived family meal environment and parent intake of fruit, vegetables, and fat. J Nutr Educ Behav. 2003;35:24–9.

54. Ontai LL, Sitnick SL, Shilts MK, Townsend MS. My child at mealtime: A visually enhanced self-assessment of feeding styles for low-income parents of preschoolers. Appetite. 2016;99:76–81.

55. Rampersaud GC, Pereira MA, Girard BL, Adams J, Metzl JD. Breakfast habits, nutritional status, body weight, and academic performance in children and adolescents. J Am Diet Assoc. 2005;105:743–60.

56. Melbye EL, Øgaard T, Øverby NC, Hansen H. Parental food-related behaviors and family meal frequencies: associations in Norwegian dyads of parents and preadolescent children. BMC Public Health. 2013;13:820–9.

57. Hammons AJ, Fiese BH. Is frequency of shared family meals related to the nutritional health of children and adolescents? Pediatrics. 2011;127:1565–74.

58. Bronfenbrenner U. Ecology of the family as a context for human development: Research perspectives. Dev Psychol. 1986;22:723–42.

59. Saudino KJ. Behavioral genetics and child temperament. J Dev Behav Pediatr. 2005;26:214–23.

60. Morris AS, Silk JS, Steinberg L, Myers SS, Robinson LR. The role of the family context in the development of emotion regulation. Soc Dev. 2007;16:361–88.

61. Ludwig S, Rostain A. Family function and dysfunction. In: Carey WB, Crocker AC, Elias ER, Feldman HM, II WLC, editors. Developmental-Behavioral Pediatrics. 4th ed. Philadelphia: Saunders/Elservier; 2009;103–18.

62. Birch LL, Davison KK. Family environmental factors influencing the developing behavioral controls of food intake and childhood overweight. Pediatr Clin North Am. 2001;48:893–907.

63. Golan M, Crow S. Parents are key players in the prevention and treatment of weight-related problems. Nutr Rev. 2004;62:39–50.

64. Golan M, Crow S. Targeting parents exclusively in the treatment of childhood obesity: long-term results. Obes Res. 2004;12:357–61.

65. Brown R, Ogden J. Children's eating attitudes and behaviour: a study of the modelling and control theories of parental influence. Health Educ Res. 2004;19:261–71.

66. Campbell KJ, Crawford DA, Hesketh KD. Australian parents' views on their 5-6-year-old children's food choices. Health Promot Int. 2007;22:11–8.

67. Wyse R, Campbell E, Nathan N, Wolfenden L. Associations between characteristics of the home food environment and fruit and vegetable intake in preschool children: A cross-sectional study. BMC Public Health. 2011; 11:938–48.

68. Hendrie G, Sohonpal G, Lange K, Golley R. Change in the family food environment is associated with positive dietary change in children. Int J Behav Nutr Phys Act. 2013;10:4–14.

69. Ding D, Sallis JF, Norman GJ, Saelens BE, Harris SK, Kerr J, et al. Community food environment, home food environment, and fruit and vegetable intake of children and adolescents. J Nutr Educ Behav. 2012;44:634–8.

70. Sallis JF, Glanz K. Physical activity and food environments: solutions to the obesity epidemic. Milbank Q. 2009;87:123–54.

71. Brown K, McIlveen H, Strugnell C. Nutritional awareness and food preferences of young consumers. Nutr Food Sci. 2000;30:230–5.

72. Ray C, Roos E, Brug J, Behrendt I, Ehrenblad B, Yngve A, et al. Role of free school lunch in the associations between family-environmental factors and children's fruit and vegetable intake in four European countries. Public Health Nutr. 2013;16:1109–17.

73. Savage JS, Fisher JO, Birch LL. Parental influence on eating behavior: conception to adolescence. J Law Med Ethics. 2007;35:22–34.

74. De Bourdeaudhuij I, Van Oost P. Family members' influence on decision making about food: differences in perception and relationship with healthy eating. Am J Health Promot. 1998;13:73–81.

75. Mak TN, Prynne CJ, Cole D, Fitt E, Roberts C, Bates B, et al. Assessing eating context and fruit and vegetable consumption in children: new methods using food diaries in the UK national diet and nutrition survey rolling programme. International Journal of Behavioral Nutrition and Physical Activity. Int J Behav Nutr Phys Act. 2012;9:126–41.

76. Savage JS, Fisher JO, Birch LL. Parental influence on eating behavior: conception to adolescence. J Law Med Ethics. 2007;35:22–34.

77. McCaffree J. Childhood eating patterns: the roles parents play. J Am Diet Assoc. 2003;103:1587.

78. Fisher JO, Birch LL. Eating in the absence of hunger and overweight in girls from 5 to 7 y of age. Am J Clin Nutr. 2002;76:226–31.

79. Hart KH, Herriot A, Bishop JA, Truby H. Promoting healthy diet and exercise patterns amongst primary school children: a qualitative investigation of parental perspectives. J Hum Nutr Diet. 2003;16:89–96.

80. Goh Y-Y, Bogart LM, Sipple-Asher BK, Uyeda K, Hawes-Dawson J, Olarita-Dhungana J, et al. Using community-based participatory research to identify potential interventions to overcome barriers to adolescents' healthy eating and physical activity. J Behav Med. 2009;32:491–502.

81. Slusser W, Prelip M, Kinsler J, Erausquin JT, Thai C, Neumann C. Challenges to parent nutrition education: a qualitative study of parents of urban children attending low-income schools. Public Health Nutr. 2011;14:1833–41.

82. Ohly HR, Hayter A, Pettinger C, Pikhart H, Watt RG, Rees GA. Developing a nutrition intervention in children's centres: exploring views of parents in rural/urban settings in the UK. Public Health Nutr. 2012;16:1516–21.

83. McKee MD, Maher S, Deen D, Blank AE. Counseling to prevent obesity among preschool children: acceptability of a pilot urban primary care intervention. Ann Fam Med. 2010;8:249–55.

84. Van Lippevelde W, Verloigne M, De Bourdeaudhuij I, Bjelland M, Lien N, Fernández-Alvira JM, et al. What do parents think about parental participation in school-based interventions on energy balance-related behaviours? a qualitative study in 4 countries. BMC Public Health. 2011;11:881–92.

85. Perry CL, Crockett SJ, Pirie P. Influencing parental health behavior: implications of community assessments. Health Educ. 2013;18:68–77.

86. Gentile DA, Welk G, Eisenmann JC, Reimer RA, Walsh DA, Russell DW, et al. Evaluation of a multiple ecological level child obesity prevention program: Switch what you Do, View, and Chew. BMC Med. 2009;7:49–61.

87. Golan M, Weizman A. Familial approach to the treatment of childhood obesity: conceptual mode. J Nutr Educ. 2001;33:102–7.

88. Laitinen S, Räsänen L, Viikari J, Akerblom HK. Diet of Finnish children in relation to the family's socio-economic status. Scand J Soc Med. 1995;23:88–94.

89. Wegner LM. School Achievement and Underachievement. In: Carey WB, Crocker AC, Elias ER, Feldman HM, II WLC, editors. Developmental-Behavioral Pediatrics. 4th ed. Philadelphia: Saunders/Elservier; 2009;497–505.

90. Story M, Kaphingst KM, French S. The role of schools in obesity prevention. Future Child. 2006;16:109–42.

91. Ferreira I, van der Horst K, Wendel-Vos W, Kremers S, van Lenthe FJ, Brug J. Environmental correlates of physical activity in youth - a review and update. Obes Rev. 2007;8:129–54.

92. Nihiser AJ, Lee SM, Wechsler H, McKenna M, Odom E, Reinold C, et al. BMI measurement in schools. Pediatrics. 2009;124:89-97.

93. Koplan JP, Liverman CT, Kraak VI. Preventing childhood obesity: health in the balance. Institute of Medicine, editor. Washington: The National Academies Press; 2005.

94. Schantz S. Child and adolescent obesity, BMI and the school nurses role. NASN Sch Nurse. 2007;22:22–3.

95. Dworkin PH. Schools as Milieu. In: Carey WB, Crocker AC, Elias ER, Feldman HM, II WLC, editors. Developmental-Behavioral Pediatrics. 4th ed. Philadelphia: Saunders/Elservier. 2009;164–9.

96. Giannopulu I, Escolano S, Cusin F, Citeau H, Dellatolas G. Teachers' reporting of behavioural problems and cognitive-academic performances in children aged 5-7 years. Br J Educ Psychol. 2008;78:127–47.

97. Pérez-Rodrigo C, Aranceta J. School-based nutrition education: lessons learned and new perspectives. Public Health Nutr. 2001;4:131–9.

98. Sylva K. School Influences on Children's Development. J Child Psychol Psychiatry. 1994;35:135–70.

99. Sherry B, McDivitt J, Birch LL, Cook FH, Sanders S, Prish JL, et al. Attitudes, practices, and concerns about child feeding and child weight status among socioeconomically diverse white, Hispanic, and African-American mothers. J Am Diet Assoc. 2004;104:215–21.

100. Barrera M, Biglan A, Taylor TK, Gunn BK, Smolkowski K, Black C, et al. Early elementary school intervention to reduce conduct problems: a randomized trial with Hispanic and non-Hispanic children. Prev Sci. 2002;3:83–94.

101. Grossman DC, Neckerman HJ, Koepsell TD, Liu PY, Asher KN, Beland K, et al. Effectiveness of a violence prevention curriculum among children in elementary school. A randomized controlled trial. JAMA. 1997;277:1605–11.

102. Olweus D. Bullying at school: basic facts and effects of a school based intervention program. J Child Psychol Psychiatry. 1994;35:1171–90.

103. Hetherington E, Parke R, Locke V. Child psychology: A contemporary viewpoint. Boston: McGraw-Hill. 1999.

104. DeCosta P, Møller P, Frøst MB, Olsen A. Changing children's eating behaviour - A review of experimental research. Appetite. 2017;113:327–57.

105. Kozulin A. Vygotsky's Educational Theory in Cultural Context. Cambridge: Cambridge University Press. 2003.

106. Rappley MD, Kallman JR. Middle childhood. In: Carey WB, Crocker AC, Elias ER, Feldman HM, II WLC, editors. Developmental-Behavioral Pediatrics. 4th ed. Philadelphia: Saunders/Elservier. 2009,50–61.

107. Berk LE, Winsler A. Scaffolding. Children's Learning: Vygotsky and Early Childhood Education. Washington: National Association for the Education of Young Children. 1995.

108. Salvy S-J, de la Haye K, Bowker JC, Hermans RCJ. Influence of peers and friends on children's and adolescents' eating and activity behaviors. Physiol Behav. 2012;106:369–78.

109. Turrell G, Hewitt B, Patterson C, Oldenburg B. Measuring socio-economic position in dietary research: is choice of socio-economic indicator important? Public Health Nutr. 2003;6:191–200.

110. Galobardes B, Lynch J, Smith GD. Measuring socioeconomic position in health research. Br Med Bull. 2007;81:21–37.

111. Janz NK, Becker MH. The Health Belief Model: a decade later. Health Educ Q. 1984;11:1–47.

112. De Cocker K, Ottevaere C, Sjöström M, Moreno LA, Wärnberg J, Valtueña J, et al. Self-reported physical activity in European adolescents: results from the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) study. Public Health Nutr. 2011;14:2083–91.

113. Sandvik C, De Bourdeaudhuij I, Due P, Brug J, Wind M, Bere E, et al. Personal, social and environmental factors regarding fruit and vegetable intake among schoolchildren in nine European countries. Ann Nutr Metab. 2005;49:255–66.

114. Reinaerts E, de Nooijer J, Candel M, de Vries N. Explaining school children's fruit and vegetable consumption: the contributions of availability, accessibility, exposure, parental consumption and habit in addition to psychosocial factors. Appetite. 2007;48:248–58.

115. Bauer KW, Neumark-Sztainer D, Fulkerson JA, Hannan PJ, Story M. Familial correlates of adolescent girls' physical activity, television use, dietary intake, weight, and body composition. Int J Behav Nutr Phys Act. 2011;8:25–35.

116. Briefel RR, Crepinsek MK, Cabili C, Wilson A, Gleason PM. School food environments and practices affect dietary behaviors of US public school children. J Am Diet Assoc. 2009;109:91-107.

117. Harrison F, Jennings A, Jones A, Welch A, van Sluijs E, Griffin S, et al. Food and drink consumption at school lunchtime: the impact of lunch type and contribution to overall intake in British 9-10-year-old children. Public Health Nutr. 2013;16:1132–9.

118. Vereecken C, Haerens L, De Bourdeaudhuij I, Maes L. The relationship between children's home food environment and dietary patterns in childhood and adolescence. Public Health Nutr. 2010;13:1729–35.

119. Arcan C, Neumark-Sztainer D, Hannan P, van den Berg P, Story M, Larson N. Parental eating behaviours, home food environment and adolescent intakes of fruits, vegetables and dairy foods: longitudinal findings from Project EAT. Public Health Nutr. 2007;10:1257–65.

120. Bolton RN, Parasuraman A, Hoefnagels A, Migchels N, Kabadayi S, Gruber T, et al. Understanding Generation Y and their use of social media: a review and research agenda. J Serv Manag. 2013;24:245–67.

121. Harris JL, Bargh J a., Brownell KD. Priming effect of television food advertising on eating behavior. Health Psychol. 2010;28:404–13.

122. Strasburger VC. Children, adolescents, and advertising. Pediatrics. 2006;118:2563–9.

123. Raats MM. The role of consumers. Nestle Nutr Workshop Ser Pediatr Program. 2010;66:161–71.

124. Reid Chassiakos Y, Radesky J, Christakis D, Moreno MA, Cross C. Children and Adolescents and Digital Media. Pediatrics. 2016;138:1–20.

2. Objectives / Objetivos

2.A. GENERAL OBJECTIVE AND SPECIFIC AIMS

The general objective of the present Doctoral Thesis is to examine how parents and teachers in four European countries (England Hungary, Germany and Spain) perceive that diet affects children's mental performance, helping to address the gaps in knowledge regarding their understanding of the role of nutrition in the mental and physical development of children.

The specific aims of the individual manuscripts included in this Doctoral Thesis are:

1. To examine parents and teachers beliefs about the effect of food on child's attention and learning.
2. To investigate how parents and teachers view the effect of diet on mental development in comparison with physical development.
3. To explore the factors that influence parents' food choices and how these relate to effects on their childrens' mental performance.
4. To assess qualitatively teachers' perceptions of the relationship between what children eat with their cognition and mental well being.
5. To evaluate any cross-country differences and similarities between parents and teachers from four different European countries respect to their perceptions and believe regarding the effect of diet on the mental performance of children.

2.B. OBJECTIVO GENERAL Y OBJETIVOS ESPECÍFICOS (SPANISH)

El objetivo general de esta Tesis Doctoral es examinar cómo los padres y los profesores de cuatro países europos (Alemania, España, Hungría e Inglaterra) perciben que la dieta afecta al desarrollo mental de los niños y aborda sus lagunas de conocimiento sobre la nutrición influyendo en el desarrollo físico y mental de los niños.

Los objetivos específicos de los artículos incluidos en esta Tesis Doctoral son:

1. Examinar las creencias de los padres y los maestros sobre el efecto de los alimentos sobre la atención y el aprendizaje del niño.
2. Investigar cómo padres y maestros perciben el efecto de la dieta sobre el desarrollo mental en comparación con el desarrollo físico.
3. Explorar la elección de alimentos que hacen los padres y su percepción acerca de cómo dicha elección está conectada con el desarrollo mental de sus hijos.
4. Valorar cualitativamente las percepciones de los maestros sobre la relación entre lo que comen los niños con su cognición y el bienestar mental.
5. Evaluar las diferencias y semejanzas entre padres y maestros de cuatro países europeos, respecto a sus percepciones y creencias en cuanto a los efectos de la dieta sobre el desarrollo cognitivo de los niños.

3. Material and Methods

3. MATERIALS AND METHODS

The present Doctoral Thesis is based on data from The Nutrimenthe Project. JCLR was a member of one of the research teams involved in the research on "Consumer attitudes" led by the University of Surrey.

3.1. ETHICS COMMITTEES

The study protocols were developed according to European regulations and following the ethical guidelines established by the four countries institutions. The study protocols were approved by the University Research Ethics Committee of each center in which the study was carried out. Participants, parents and teachers, provided signed informed consent to participate in each study.

3.2. METHODOLOGICAL APPROACH

The research involved two different but complementary approaches, qualitative and quantitative work.

Qualitative research has been used extensively in nursing and health care applications to evaluate diverse concepts such as quality of life" or "reflective thinking" (1,2). Using this methodology it is possible to gain a deeper understanding of issues by becoming immersed in the research, thus revealing different patterns or new themes from the specific views of participants (3). Qualitative research also provides the challenge of being mindful of and attentive to situational dynamics, using the context carefully for it possible adaptation in new settings.

Based on the findings of the qualitative study a questionnaire was developed to examine consumers' beliefs and attitudes towards the effects of nutrition on a child's

health and mental performance. It was considered that quantitative measures would usefully supplement and extend the qualitative analysis by exploring both parents and teachers' beliefs and attitudes more generally and also parents' food choices.

3.3. STUDY DESIGN

The studies were conducted with parents and teachers of children aged 4-10 years old, in mainstream education and without diagnosed pathologies such as Attention Deficit Hyperactivity Disorder (ADHD). Inclusion criteria were the ability to speak the native language of the particular country and answer all interview questions.

For the qualitative studies parents and teachers were approached through schools in the four European countries where the study was to be conducted: England, Germany, Hungary and Spain.

Because of the differences in the school systems of the four participating countries it was agreed to recruit and contact participants through state elementary schools to facilitate their participation in the qualitative studies.

Access to national samples for the quantitative research was achieved by the use of, an external market research agency in England, which had links with partner organisations in the other three countries. Parents and teachers were recruited from established online panels in each country. Data for the quantitative research were collected using a web-based survey with the questionnaire distributed to parents and teachers in each country.

The final sample from both qualitative and quantitative studies comprised 1930 parents and 463 teachers, a total of 2393 participants distributed as shown in Table.01.

The research began with a qualitative study of parents' perceptions of the effects of diet on children's mental performance and the details of this study provide the foundation for the subsequent work. The details of that study are described in the manuscript "*A qualitative interview study on effects of diet on children's mental state and performance. Evaluation of perceptions, attitudes and beliefs of parents in four European countries*" (4) This manuscript (Appendix 2.1) stresses that "understanding the relationship between nutrition and mental performance in children is important in terms of their attainment and productivity both in school and later life. Since parents are seen as nutritional gatekeepers for their children's diets, their views and beliefs are of crucial importance". From a foreground, it was important to know that "parental perceptions were important for many purposes including the targeting of dietary advice and prioritising of public health issues".

Table.01 Number of participants in quantitative and qualitative studies

Participants' distribution by country for quantitative and qualitative studies					
	Qualitative n = 184		Quantitative n = 2209		
	Parents	Teachers	Card Sorting	Questionaires	
				Parents	Teachers
England	31	12	53	401	100
Germany	35	11	45	401	100
Hungary	23	17	52	401	103
Spain	35	20	50	403	100

The follow-up research (Appendix 2.2) was conducted to investigate how important parents thought food is as an influence on mental performance, compared with other possible relevant factors, such as home background and the school environment. It also explored parents' views about the importance of four different food-related behaviours on mental performance from a quantitative approach as detailed in the manuscript "*Views of parents in four European countries about the effects of food on the mental performance of primary school children*"(5).

Subsequent to these two studies it was considered useful to supplement and extend the qualitative study with an interview study with teachers and to develop a questionnaire to quanitfy the results with national samples in the four countries.

For the articles included as results in this Doctoral Thesis, the data were obtained between the years 2009 and 2013 from both the interview study and the questionnaire study.

Chapter I and chapter II

A questionaire (Appendix 3) was developed to explore how parents and teachers percieve that diet affects the mental and physical development of children; the effect of diet on ten selected indicators of a child's physical (overall health, energy levels, weight, physical activity and sleep) and mental (attention, ability to learn, memory, mood and behaviour) performance (each scored on a five-point scale – extremely, very much, moderately, slightly, not at all – or don't know). Information was collected on the socio-demographic characteristics of respondents that might influence their views Respondents also completed the General Health Interest (GHI) scale, an eight-item instrument that measures health-related food attitudes, each scored on a seven-point scale from which an average is calculated, range 1 (least interested in healthy eating) to 7 (most interested).

Chapter III

A semi-structured interview schedule was developed, based on the aim of the study and relevant literature. The four participating countries agreed a preliminary interview format and developed a list of topics for the interview questions. This interview schedule was developed and used initially with parents in the first part of the research (Appendix 2.1) and subsequently adapted for use with teachers. Topics included questions on teachers' beliefs and perceptions of the effects of diet on children aged 4–10, such as effects on wellbeing and development, physical and mental status, effects of specific foods on their mental or physical state as well as prompting for short or long term effects of diet and foods.

In order to achieve a greater immersion in the development and implementation of the research, the author of this Doctoral Thesis undertook two research stays at the University of Surrey, in the *Food, Consumer Behaviour and Health Research Centre* where the transcriptions, translations and analysis were carried out of the data obtained in Spain.

3.4. REFERENCES

1. Taylor RM, Gibson F, Franck LS. A concept analysis of health-related quality of life in young people with chronic illness. J Clin Nurs. 2008;17:1823–33.

2. Van Vuuren M, Botes A. Concept analysis of reflective thinking. Curationis. 1999;22:25–35.

3. Campos CJG, Turato ER. Content analysis in studies using the clinical-qualitative method: application and perspectives. Rev Lat Am Enfermagem. 2009;17:259–64.

4. Brands B, Egan B, Györei E, López-Robles JC, Gage H, Campoy C, et al. A qualitative interview study on effects of diet on children's mental state and performance. Evaluation of perceptions, attitudes and beliefs of parents in four European countries. Appetite. 2012;58:739–46.

5. Gage H, Egan B, Williams P, Györei E, Brands B, López-Robles JC, et al. Views of parents in four European countries about the effect of food on the mental performance of primary school children. Eur J Clin Nutr. 2014;68:32–7.

4. Chapter I
The effect of diet on the physical and mental development of children: views of parents and teachers in four European countries

4.1. INTRODUCTION

Perceptions and understanding of the impact of diet on the physical health of children is an important public health issue, particularly in the context of growing concerns about childhood obesity [(1)], but traditionally little attention has been paid to lay views about the relationship between nutrition and a child's mental development and performance [(2)]. Food and nutrition, however, have important and pervasive impacts on brain development and cognitive functioning through effects on brain cell structure, neurotransmission, brain energy supply and metabolism [(3)]. A balanced diet is, thus, important for mental as well as physical development, with implications for school performance, achievement in adulthood and lifelong health and well-being [(4,5)]. What parents and teachers believe about the relationship between nutrition and the mental development of children may affect their attitudes and behaviours regarding food provision for young people [(6)]. We explored their views in four European countries in order to identify gaps in awareness about the importance of nutrition for brain development and cognition, as well as the need for policies to improve public understanding.

Previously, we qualitatively examined the perceptions and beliefs of parents and teachers regarding the relationship between what children eat and their health and mental performance by conducting interviews in each of the four countries: England, Germany, Hungary and Spain [(7)]. The importance of developing good eating habits emerged as a concern for parents, as they perceived these habits could have long-term implications for health. Parents also identified conflict in trying to balance the provision of a healthy nutritious diet and satisfying their children's food preferences. Participants from all the countries spoke of the effects of diet in terms of physical, mental and behavioural outcomes, with attention and concentration being the aspects of mental performance most often mentioned by parents. They defined

foods as ‘good’ and ‘bad’ with good foods having positive effects and bad foods having negative effects, especially as manifested by changes in mood and behaviour [7]. However, they ranked food-related factors (such as regularity of meals and what a child eats) significantly lower than physical (activity, sleep) and psychological (mood, behaviour) factors and school environment as influences on cognitive development and mental performance [8]. The objective of the present study was to examine these attitudes and beliefs on a wider scale, to compare them across four different European countries and to distil messages for public health policy.

4.2. METHODS

The study design and details were agreed upon between the international research teams through several face-to-face meetings and intervening email exchanges. Ethical approval was obtained in all the countries according to local procedures.

The questionnaire was developed by the members of the research team. Relevant theoretical and empirical literature on the relationship between nutrition and mental performance was accessed to identify key factors. In addition, the findings from the qualitative interviews that had been completed with parents and teachers in each country [7] were consulted. A meeting involving researchers and four invited nutrition experts and psychologists was held in England, and a list of topics for the questionnaire was agreed upon. This was circulated to the other participating countries for comment. A preliminary questionnaire was then developed in English and translated into local languages. It was piloted in all four countries with a small number of local volunteer parents and teachers to ensure that the type, flow and number of questions were appropriate to the aims of the study, and to pre-test for clarity and comprehension. Results from the pilot study were evaluated and

compared, and the content of the final questionnaire (comprising twenty-five items) was decided. Changes following the pilot study involved refinement of the wording to ensure consistency in meaning across the four countries.

In this study, we report results from the analysis of three items that explored respon-dents' views on the following: the extent to which diet affects the mental development and physical development of children; and the effect of diet on ten selected indicators of a child's physical (overall health, energy levels, weight, physical activity and sleep) and mental (attention, ability to learn, memory, mood and behaviour) performance (each scored on a five-point scale – extremely, very much, moderately, slightly, not at all – or don't know). Findings from other items, including those examining factors affecting parental food choice, will be reported elsewhere. Information was collected on the socio-demographic characteristics of respondents that might influence their views: age, sex, ethnicity, whether born in the country, highest level of education attained, occupation of the main earner, number of children living at home, if respondent had ever gained a qualification relating to health or nutrition, smoking status and (for teachers only) number of years teaching. Respondents also completed the General Health Interest (GHI) scale, an eight-item instrument that measures health-related food attitudes, each scored on a seven-point scale from which an average is calculated, range 1 (least interested in healthy eating) to 7 (most interested) [(9)].

Recruitment of participants

In order to access national samples, data collection was managed by a market research agency in England, which had links with partner organisations in the other three countries. Parents and teachers were recruited from established online panels in each country. Panel members were selected according to the inclusion criteria for individual studies, and were paid in the form of points for timely and full completion

of instruments. Inclusion criteria were as follows: for parents, that they had a child aged 4–10 years old and, for teachers, that they were in mainstream (not private or special) education. Teachers had to teach the same age group. We focused on 4- to 10-year-old children because at that age parents are still likely to be having a significant influence over their diet and nutrition. We excluded parents and teachers of children with diagnosed pathologies, such as attention deficit hyperactivity disorder, because we reasoned that they may have researched dietary influences on development more thoroughly than the general population. The target was to recruit 400 parents and 100 teachers in each country, enabling the detection, using a two-sided test, with size of 5 % and power of 80 %, of an underlying difference in prevalence of 10 % for parents (20 % for teachers) with regard to any dichotomous outcome. The questionnaire was completed online and controls in the questionnaire prevented non-response to any item, and thus all the returns were complete.

Analysis

Data were transferred to SPSS (version 16; SPSS Inc.) for analysis. Summary statistics (numbers, percentages, means, standard deviations, medians and ranges) were calculated for all background variables and were broken down by respondent group (parent/teacher) and country (England/Germany/Hungary/Spain). Comparisons were performed using the appropriate statistical tests: χ^2 for categorical variables; the Mann–Whitney *U* test (parents *v*. teachers) or the Kruskal–Wallis test (countries) for ordinal variables; and unpaired *t* test (parents *v*. teachers) or one-way ANOVA (countries) for continuous variables.

The proportions of parents and teachers thinking that diet influences physical or mental development of a child extremely or very much (*v*. moderately, slightly, not at all) were compared; the four countries were also compared within the parent and teacher groups separately. Views of parents and teachers of the effect of diet on

specific indicators of a child's physical and mental performance were compared using χ^2 tests (extremely, very much *v*. moderately, slightly, not at all) and Mann–Whitney *U* tests (for a five-point ordinal scale 1=not at all to 5=extremely); comparisons across countries were analysed using Kruskal–Wallis tests. Associations were explored between GHI score and the importance (five-point ordinal scale) attributed to diet as an influence on mental or physical development (independent variables) and participant characteristics (including country) using step-wise linear regression modelling. Statistical significance was reported at the 5 % level.

4.3. RESULTS

Sample characteristics

The questionnaires were returned by 1606 parents (401 in England, Germany and Hungary; 403 in Spain) and 403 teachers (100 in England, Germany and Spain; 103 in Hungary). Characteristics of the respondents are detailed in Table.1. Respondents were predominantly of white ethnicity. Higher proportions of teachers than parents were over the age of 45 years (35.3% *v*. 18.3%; $P<0.001$), and teachers were also less likely to smoke than parents (15.9% *v*. 26.3%, $P<0.001$). About one-half of the teachers reported having no children under the age of 18 years living at home. Parent responders differed significantly across countries for all the variables except for smoking rates; teachers did not differ internationally with respect to having a qualification related to health or nutrition and whether born in the home country. The GHI mean scores were significantly higher for teachers than parents (4.83 *v*. 4.67; $P=0.006$), and differences existed in GHI among countries for both parents and teachers (C.I – Table.1 A-B-C). The step-wise regression modelling showed that parent GHI scores increased with age and were significantly higher for women (than men),

non-smokers and those educated up to the college/university level. The teacher GHI was also higher for older respondents and women, and for those without a qualification in health or nutrition. In both the parent and teacher models, respondents in Spain and Germany recorded higher GHI compared with those in England; parent scores in Hungary were significantly lower than in England (C.I – Table.2).

C.I – Table.1 (A)

Characteristics of respondents: comparison of parents (A) and teachers (B), including by country (C)

A		PARENTS								
		England N=401		Germany N=401		Hungary N=401		Spain N=403		p-value*
		n	%	n	%	n	%	n	%	EGHS
Age(years)	>=45	93	23.2	77	19.2	48	12.0	75	18.6	.001
Sex	Male	129	32.2	176	43.9	130	32.4	185	45.9	<.001
Born home country	Yes	358	89.3	377	94.0	389	97.0	382	94.8	<.001
Qualification health/nutrition	Yes	37	9.2	58	14.5	57	14.2	47	11.7	.082
Current smoker	Yes	89	22.2	117	29.2	108	26.9	109	27.0	.145
Ethnicity	White	360	89.8	379	94.5	398	99.3	385	95.5	<.001
Higher education[1]	Yes	266	66.3	212	52.9	158	39.4	226	56.1	<.001
Main earner occupation	Manag, Prof[2]	130	32.4	148	36.9	122	30.4	158	39.2	.035
Parent(s) who teach	Yes	15	3.7	33	8.2	35	8.7	39	9.7	.008
Teacher in state school[3]	Yes									
Teacher is a parent	Yes									
Children <18 living with respondent	None	4	1.0	12	3.0	3	0.7	13	3.2	.015
Continuous variables		M	SD	M	SD	M	SD	M	SD	
No. of children <18 living with respondent		1.82	.88	1.81	1.15	1.90	.80	2.10	1.17	<.001
Years in teaching										
GHI: range 1-7 (most interested in healthy eating)[4]		4.65	.93	4.71	1.04	4.37	1.14	4.95	1.00	<.001

M (mean), SD (standard deviation), P (Parents), T (Teachers), E (England), G(Germany), H(Hungary), S (Spain)
[1] Highest level of education is college or university; [2] Managerial or professional (rather than clerical, administrative, manual, homemaker, retired, student, seeking work); [3] Rather than independent school; [4] General Health Interest Scale $\chi 2$ test.

C.I – Table.1 (B)

Characteristics of respondents: comparison of parents (A) and teachers (B), including by country (C)

B		TEACHERS								
		England N=100		Germany N=100		Hungary N=103		Spain N=100		p-value*
		n	%	n	%	n	%	n	%	EGHS
Age(years)	>=45	29	29.0	26	26.0	57	55.3	31	31.0	<.001
Sex	Male	35	35.0	50	50.0	16	15.5	47	47.0	<.001
Born home country	Yes	92	92.0	94	94.0	100	97.1	92	92.0	.386
Qualification health/nutrition	Yes	15	15.0	18	18.0	24	23.3	17	17.0	.464
Current smoker	Yes	9.0	9.0	27	27.0	14	13.6	14	14.0	.004
Ethnicity	White	84	84.0	96	96.0	101	98.1	100	100	<.001
Higher education[1]	Yes									
Main earner occupation	Manag, Prof[2]									
Parent(s) who teach	Yes									
Teacher in state school[3]	Yes	81	81.0	76	76.0	92	89.3	37	37.0	<.001
Teacher is a parent	Yes	69	69.0	69	69.0	85	82.5	70	70.0	.080
Children <18 living with respondent	None	44	44.0	44	44.0	65	63.1	44	44.0	.011
Continuous variables		M	SD	M	SD	M	SD	M	SD	
No. of children <18 living with respondent		.99	1.10	.99	1.17	.62	.99	1.16	1.35	.008
Years in teaching		11.4	11.1	11.1	11.2	23.2	10.7	10.4	10.3	<.001
GHI: range 1-7 (most interested in healthy eating)[4]		4.71	1.06	4.83	1.13	4.73	0.95	5.06	0.97	0.071

M (mean), SD (standard deviation), P (Parents), T (Teachers), E (England), G(Germany), H(Hungary), S (Spain)
[1] Highest level of education is college or university; [2] Managerial or professional (rather than clerical, administrative, manual, homemaker, retired, student, seeking work); [3] Rather than independent school; [4] General Health Interest Scale $\chi 2$ test.

C.I – Table.1 (C)

Characteristics of respondents: comparison of parents (A) and teachers (B), including by country (C)

C		ALL COUNTRIES				
		Parents N=1606		Teachers N=403		p-value* P vsT
		n	%	n	%	
Age(years)	>=45	293	18.3	143	35.3	<.001
Sex	Male	620	38.6	148	36.7	-.478
Born home country	Yes	1506	93.8	378	93.8	.986
Qualification health/nutrition	Yes	199	12.4	74	18.4	.002
Current smoker	Yes	423	26.3	64	15.9	<.001
Ethnicity	White	1522	94.8	381	94.5	.854
Higher education[1]	Yes	862	53.7			
Main earner occupation	Manag, Prof[2]	558	34.7			
Parent(s) who teach	Yes	122	7.6			
Teacher in state school[3]	Yes			286	71.0	
Teacher is a parent	Yes			293	72.7	
Children <18 living with respondent	None	32	2.0	197	48.9	<.001
Continuous variables		M	SD	M	SD	
No. of children <18 living with respondent		1.91	1.02	.94	1.17	<.001
Years in teaching						
GHI: range 1-7 (most interested in healthy eating)[4]		4.67	1.05	4.83	1.03	.006

M (mean), SD (standard deviation), P (Parents), T (Teachers), E (England), G(Germany), H(Hungary), S (Spain)
[1] Highest level of education is college or university; [2] Managerial or professional (rather than clerical, administrative, manual, homemaker, retired, student, seeking work); [3] Rather than independent school; [4] General Health Interest Scale $\chi 2$ test.

C. I – Table.2
Modelling of factors associated with General Health Interest (GHI) score (*B* coefficient and their standard errors; 95 % confidence intervals)

					95% CI	
	Factors*	B	SE	Significance	Lower bound	Upper bound
Parents†	Constant	3.371	0.149	0.001	3.080	3.662
	Sex (1, male; 2, female)	0.482	0.053	0.001	0.378	0.586
	Age (in 10 year bands)	0.160	0.029	0.001	0.104	0.216
	Spain	0.396	0.071	0.001	0.256	0.535
	Germany	0.164	0.071	0.022	0.024	0.304
	Hungary	–0.233	0.072	0.001	–0.374	–0.092
	Current smoker (yes)	–0.207	0.057	0.001	–0.319	–0.095
	University education (yes)	0.102	0.052	0.048	0.001	0.203
Teachers†	Constant	3.254	0.241	0.001	2.779	3.728
	Sex (1, male; 2, female)	0.635	0.104	0.001	0.431	0.839
	Age (in 10 year bands)	0.124	0.041	0.003	0.044	0.205
	Spain	0.492	0.121	0.001	0.253	0.730
	Germany	0.313	0.123	0.011	0.072	0.554
	Qualification in health or nutrition (yes)	–0.249	0.125	0.047	–0.495	–0.003

* Dependent variable: GHI score, range 1 (least interest in healthy eating) – 7 (most interest).
† Independent variables: country (England as reference); age; sex; born in home country; qualification in health or nutrition; higher (college/university) education; current smoker; and ethnicity (white or other).

Views about the influence of diet on the physical and mental development of a child

Overall, 80 % of the parents and teachers felt that a child's physical development depends very much or extremely (*v.*moderately, slightly, not at all) on diet; the equivalent proportion for mental development was lower (67 %). Except for Germany, higher proportions of teachers than parents thought that diet was a very/extremely important influence on both physical and mental development (parents *v*. teachers overall difference (all countries together) not significant). However, significant differences existed between countries in the views of parents and teachers on the importance of diet for both physical and mental development (C.I – Table.3 A-B).

C. I – Table.3 (A)

Views about the influence of diet on physical and mental development of a child: comparison of parents and teachers, including by country

A		p-value*	p-value**	Number and % responding extremely or very much vs. moderately, slightly, not at all			
To what extent do you think a child's:		Between countries	Parents vs. Teachers; (All countries)	All countries			
				N	n	%	P+T %
Physical development depends on diet	Parents	<.001	0.187	1593	1264	79.3	79.8
	Teachers	<.001		403	329	81.6	
Mental development depends on diet	Parents	<.001	0.265	1586	1061	66.9	67.4
	Teachers	<.001		401	278	69.3	

***** Kruskal-Wallis test, utilising raw ordinal values (extremely to not at all)
** Mann-Whitney U test, utilising raw ordinal values (extremely to not at all)

C. I – Table.3 (B)

Views about the influence of diet on physical and mental development of a child: comparison of parents and teachers, including by country

B		Number and % responding extremely or very much vs. moderately, slightly, not at all											
To what extent do you think a child's:		England			Germany			Hungary			Spain		
		N	n	%	N	n	%	N	n	%	N	n	%
Physical development depends on diet	Parents	398	281	70.6	395	289	73.2	401	375	93.5	399	319	79.9
	Teachers	100	74	74.0	100	70	70.0	103	102	99.0	100	83	83.0
Mental development depends on diet	Parents	399	239	59.9	393	244	62.1	400	329	82.2	394	249	63.2
	Teachers	99	63	63.6	100	60	60.0	102	91	89.2	100	64	64.0

***** Kruskal-Wallis test, utilising raw ordinal values (extremely to not at all)
** Mann-Whitney U test, utilising raw ordinal values (extremely to not at all)

In all four regression models (parents and teachers, physical and mental development), living in Hungary and scoring higher on the GHI (more interest in healthy eating) were associated with believing that diet had a larger influence on physical and mental development. Parents with higher education also viewed diet as more important for both types of development (than those with less education); parents without a qualification in health and nutrition (compared with those with) and parents with fewer children were more likely to think that diet strongly influenced physical development (C.I – Table.4).

Views about the influence of diet on specific indicators of a child's physical and mental performance

When asked about the effect of diet on specific indicators, the importance attributed to physical indicators of performance (especially overall health, energy levels, weight and physical activity) was generally greater than that for mental indicators, by both parents and teachers. In addition, there were no significant differences between teachers and parents in the proportions who felt that those physical indicators, and ability to learn, were influenced very much/extremely by diet. However, the proportions of parents and teachers differed significantly regarding their views on the impact of diet on other indications of mental performance (attention, mood, behaviour and (marginally) memory) and sleep. For each of these aspects, the proportion of teachers who felt that diet was a strong influence was higher compared with the proportion of parents. Differences existed between countries regarding the importance of all indicators for mental performance, except for teachers regarding memory and (marginally) mood (C.I – Table.5 A-B-C).

C. I – Table.4

Modelling of factors associated with views on the importance of diet in the physical and mental development of a child (*B* coefficient and their standard errors 95 % confidence intervals)

					95% Confidence Intervals	
*PHYSICAL DEVELOPMENT	Factor **	B coefficient	Standard error	Significance	Lower bound	Upper bound
	Constant	2.575	0.176	0.001	2.229	2.921
Parents	Hungary	0.555	0.049	0.001	0.459	0.652
N=1593	General Health Interest Scale (1-7 high)	0.161	0.020	0.001	0.122	0.200
(13, incomplete data)	Highest level of education completed (5 point scale)	0.094	0.019	0.001	0.057	0.132
R^2 = 0.107	Qualification in health or nutrition (1=yes; 2=no)	0.159	0.064	0.013	0.034	0.283
	Total number of boys + girls living with respondent	-0.041	0.021	0.049	-0.081	0.000
Teachers	Constant	2.950	0.179	0.001	2.598	3.303
N= 403	Hungary	0.614	0.085	0.001	0.447	0.781
R^2 = 0.169	General Health Interest Scale (1-7 high)	0.207	0.036	0.001	0.136	0.277
*MENTAL DEVELOPMENT						
	Constant	2.488	0.125	0.001	2.244	2.733
Parents	Hungary	0.513	0.052	0.001	0.411	0.614
N=1586	General Health Interest Scale (1-7 high)	0.185	0.021	0.001	0.143	0.226
(20, incomplete data)	Highest level of education completed (5 point scale)	0.077	0.020	0.001	0.038	0.117
R^2 = 0.092						
Teachers	Constant	3.126	0.251	0.001	2.634	3.619
N= 401	Hungary	0.548	0.093	0.001	0.365	0.730
(2, incomplete data)	General Health Interest Scale (1-7 high)	0.197	0.039	0.001	0.120	0.273
R^2 = 0.130	Ethnicity (white)	-0.408	0.178	0.022	-0.758	-0.059

*Dependent variable: Diet affects the physical/ mental development of a child (5 point scale: 1 not at all – 5 extremely; don't know excluded)

**Independent variables: country (with England as the reference); age; sex; highest level of education attained by parents / years in teaching for teachers; total number of children under 18 living with respondent; GHI score; qualification in health or nutrition; ethnicity. Current smoker excluded from analysis because of high correlation with GHI.

C. I – Table.5 (A)

Views about the effect of diet on indicators of a childs physical and mental performance (Numbers and percentages)

A		Number and % responding extremely or very much vs. moderately, slightly, not at all Parents				
				Inter country difference		
	Indicators+ of physical and mental performance:	**n**	**%**		Rank*	Sig diffs*
To what extent do you think diet will influence a child's:	Energy levels	1431	89.5	<0.001	HESG	H>ESG HE>G
	Overall health	1409	88.1	<0.001	HSEG	H>G
	Weight	1384	87.0	0.010	EHSG	EH>G
	Amount of physical activity	1291	81.0	<0.001	HEGS	H>EGS HE>S
	Ability to learn	1140	71.8	<0.001	GHES	GH>ES
	Attention	1107	69.8	<0.001	GHES	GHE>S
	Sleep	1066	67.2	0.0018	HEGS	H>EGS
	Mood	1042	65.5	0.001	EHGS	EH>S
	Memory	968	62.1	0.041	GHES	G>S
	Behaviour	887	56.2	<0.001	EHGS	E>GS

E=England; G=Germany; H=Hungary; S=Spain; MWU= Mann Whitney U test; Chi Sq. = $\chi 2$ square test
+Tthe order in which indicators were presented to respondents was rotated.
* Significant differences between countries shown by > MWU tests based on the 5 point ordinal scale (1= not at all to 5= extremely); $\chi 2$ test based on comparing: extremely or very much vs. moderately, slightly, not at all.

C. I – Table.5 (B)

Views about the effect of diet on indicators of a childs physical and mental performance (Numbers and percentages)

B	Indicators+ of physical and mental performance:	Number and % responding extremely or very much vs. moderately, slightly, not at all Teachers				
					Inter country difference	
		n	**%**		Rank*	Sig diffs*
To what extent do you think diet will influence a child's:	Energy levels	366	90.8	0.004	HESG	H>G
	Overall health	358	89.1	0.035	HESG	H>SG
	Weight	359	89.1	0.211	-	-
	Amount of physical activity	329	81.6	0.002	HESG	H>SG
	Ability to learn	290	72.1	<0.001	EHGS	EH>S
	Attention	314	78.3	0.009	HEGS	H>S
	Sleep	288	72.4	0.017	HESG	H>G
	Mood	298	74.1	0.093	-	-
	Memory	268	67.2	0.644	-	-
	Behaviour	261	65.1	<0.001	EHGS	E>GS

E=England; G=Germany; H=Hungary; S=Spain; MWU= Mann Whitney U test; Chi Sq. = $\chi 2$ square test
+Tthe order in which indicators were presented to respondents was rotated.
* Significant differences between countries shown by > MWU tests based on the 5 point ordinal scale (1= not at all to 5= extremely); $\chi 2$ test based on comparing: extremely or very much vs. moderately, slightly, not at all.

C. I – Table.5 (C)

Views about the effect of diet on indicators of a childs physical and mental performance (Numbers and percentages)

C		Difference in proportions: Parents *vs.* Teachers	
	Indicators+ of physical and mental performance:	MWU p-value	Chi Sq. p-value
To what extent do you think diet will influence a child's:	Energy levels	0.105	0.433
	Overall health	0.159	0.601
	Weight	0.445	0.270
	Amount of physical activity	0.966	0.767
	Ability to learn	0.311	0.903
	Attention	<0.001	0.001
	Sleep	0.030	0.047
	Mood	0.001	0.001
	Memory	0.071	0.059
	Behaviour	<0.001	0.001

E=England; G=Germany; H=Hungary; S=Spain; MWU= Mann Whitney U test; Chi Sq. = $\chi 2$ square test
+Tthe order in which indicators were presented to respondents was rotated.
* Significant differences between countries shown by > MWU tests based on the 5 point ordinal scale (1= not at all to 5= extremely); $\chi 2$ test based on comparing: extremely or very much vs. moderately, slightly, not at all.

4.4. DISCUSSION

Across all countries, larger propor-tions of parents and teachers regarded diet to be an important determinant of physical development than of mental development. When asked about specific indicators, responses from both groups continued to show that they thought that diet had a bigger influence on aspects of physical performance (especially overall health, energy levels, weight and physical activity) than on dimensions of mental performance (especially mood, memory and behaviour).

One reason why parents and teachers attributed less importance to the influence of diet on mental development of children than to their physical development may be due to the lack of attention paid to mental performance relative to concerns

about obesity [2]. This in turn may have resulted from uncertainties in the scientific evidence about the relationship between dietary intake and mental performance, impeding the design and delivery of clear messages for consumers. Multiple factors affect mental functioning, and identifying the independent impact of nutrition is challenging [10]. Cognitive processes are complex and experimental designs are confounded by a range of factors (such as the time of day the measurement is made or composition of the foods used in interventions) [11–14]. Socio-economic factors (such as parenting, access to education and resources at home) influence background cognitive competence. Moreover, mood, motivation and arousal (themselves affected by nutrition) can additionally influence mental performance in various ways [10,14].

Another explanation for less recognition of the role of diet in mental performance may lie in the difficulties lay members of the public experience with understanding the processes of brain development and cognition. Our previous interviews with parents of primary-school children in the four countries confirmed that they believed that diet affects mental functioning of a child as well as his/her physical health and well-being, but that they encountered problems with articulating what the concept of 'mental performance' meant to them. Cognitive processes encompass a range of complex functions (perception, psychomotor, attention, memory, language and executive functions) [3], the details of which may be hard to comprehend. Parents tended to relate most to 'attention' and 'concentration', and many expressed the view that food affected these dimensions indirectly through its impact on mood and behaviour. Consistent with findings from other studies [15,16], parents also related to 'learning' as an element of mental performance [3]. The selection of indicators of mental performance for the questionnaire in this study reflected these pragmatic considerations and the need to ensure that meaningful terminology was used. However, respondents (and

parents in particular) still may have found the link between diet and mental performance less clear than that between diet and physical outcomes for children.

The lower level of awareness of the importance of diet for brain development and cognition (compared with awareness of physical outcomes) indicates potential for educating consumers. Information can be provided through a number of routes, including public health messages, health professionals and the food industry. Although the influences of nutrition on mental performance are complex, sufficient evidence has been established to allow the design of reliable information for consumers on the role of dietary factors. General messages about the need for a varied diet with good nutritional content and regular intake should highlight the advantages for cognitive functioning as well as for physical health [3,17,18]. In addition, specific ways in which diet and nutrition affect children's mental development and performance can be promoted. Beyond long-term deficiencies [19], it appears that brain function is sensitive to short-term variations in the availability of nutrients, with stronger findings for 'at-risk' groups [20]. Eating behaviours such as skipping breakfast may contribute to poor mental performance [19–21]. The lack of energy leads to decreased glucose and insulin levels in the body, which may be associated with impaired cognitive functioning[22]. Along with alleviating hunger, breakfast provides essential nutrients to the brain [23]. Potential links have also been identified between children's behaviour and food intolerance, sucrose intake and additives in foods [12,24], which might be incorporated in the information that is designed.

Understanding the differences in views between subgroups of the population is important to appropriately target public health messages. Respondents having a high interest in healthy eating and higher educational attainment (including teachers) were already more likely to regard diet as an important influence on mental development of their children, implying the need to address other groups in society.

In this respect, the survey findings are consistent with other studies that have found socio-economic differences in parental knowledge about food, and specifically that higher income parents tend to discuss food in terms of health and medical issues, whereas lower income parents tend to consider the impact of food on their child's outward appearance and functional capacity [25]. Diet was regarded as more important for the physical and mental development of children in Hungary than in the other countries. Possible reasons for greater awareness in Hungary may include cultural differences or greater availability of relevant information for consumers. Exploring these reasons in greater detail may help design policies that will improve understanding in the other countries.

Although care was taken in translating and piloting the questionnaire to ensure uniformity between countries, the findings need to be interpreted in the light of a number of limitations. The study was based on four countries that provided geographical spread across Europe, but may not have been socially and politically representative of the entire European population. In order to recruit large national samples, respondents were drawn from market research panels. Members of the panels are volunteers and are typically re-imbursed for the time they spend completing online surveys. Hence, the people attracted to this role may not be representative of the general population in each country – for example, the samples recruited to this study from Germany included a higher proportion of current smokers than indicated by national data [26].

Data analysis revealed significant differences between countries in some characteristics of the respondents (especially among parents) regarding views. Inclusion of individual countries in the regression modelling identified key areas of international differences – for example, respondents in Hungary attributed greater importance to diet in physical and mental development of their children than

respondents in the other countries. Comparisons revealed significant differences among countries in most aspects, but it should be noted that absolute differences in some cases were not big, yet the large sample size meant that even small differences become statistically significant.

Brain development and cognition are important for learning, memory, information processing, reasoning, behaviour and many other functions that affect an individual's life achievements and well-being. However, physical outcomes for children were viewed as important by more parents and teachers in our sample of countries than children's mental development and performance. Benefit may arise from increasing awareness of the potential role of diet and nutrition in both brain development and cognitive functioning of children through increasing the quantity and clarity of consumer information [(27)], particularly targeting groups with the responsibility of caring for and educating children. Parents in particular are important gatekeepers to a child's diet and central to the environment in which most children's eating habits are developed [(28)]. As such, they constitute an important target group for communication about the nutritional properties and health effects of foods. Complex household, community and social factors interact to determine parental choice of food for their children [(29)], and timely, consistent and evidence-based information, tailored to different groups, and delivered in a variety of formats, is needed to form a basis for rational decision making [(30)].

Effective nutritional communication requires the recipient to have a certain level of nutritional knowledge; where this is lacking, the target audience cannot be reached effectively and information may be misinterpreted, as highlighted in the context of EU regulation on nutrition and health claims [(31)]. Understanding parents' and teachers' views of the importance of diet in the mental development of children is essential before developing meaningful messages and dietary change

interventions, but further research is needed to identify which dissemination strategies are most effective in reaching parents and teachers in different cultural settings and social, economic and ethnic groups.

4.5. REFERENCES

1. Lopez-Dicastillo O., Grande, G. & Cakkery, P. (2010) Parents' contrasting views on diet versus activity of children: Implications for health promotion and obesity prevention. Patient Educ Couns 78, 117–123.

2. Florence, MD, Asbridge, M & Veugelers, PJ (2008) Diet quality and academic performance. J Sch Health 78, 209–215.

3. Schmitt, JA, Benton, D & Kallus, KW (2005) General methodological considerations for the assessment of nutritional influences on human cognitive functions. Eur J Nutr 44, 459–464.

4. Alderman, H, Behrman, JR, Lavy, V, et al. (1997) Child nutrition, child health, and school enrollment: a longitudinal analysis. World Bank Policy Research Working Paper (1700).

5. Associate Parliamentary Food and Health Forum (2008) The links between diet and behaviour. The influence of nutrition on mental health.

6. European Food Information Council. The determinants of food choice. EUFIC Review 04/2005, European Food Information Council. Accessed June 2014.

7. Brands, B, Egan, B, Gyorei, E, et al. (2012) A qualitative interview study on effects of diet on children's mental state and performance. Evaluation of perceptions, attitudes and beliefs of parents in four European countries. Appetite 58, 739–746.

8. Gage, H, Egan, B, Williams, P, et al. (2014) Views of parents in four European countries about the effect of food on the mental performance of primary school children. Eur J Clin Nutr 68, 32–37.

9. Roininen, K, Lahteenmaki, L & Tuorila, H (1999) Quantification of consumer attitudes to health and hedonic characteristics of foods. Appetite 33, 71–88.

10. Isaac, E & Oates, J (2008) Nutrition and cognition: assessing cognitive abilities in children and young people. Eur J Nutr 47, Suppl. 3, 4–24.

11. Bellisle, F, Blundell, J, Dye, L, et al. (1998) Functional food science and behaviour and psychological functions. Br J Nutr 80, S173–S193.

12. Benton, D (2008) The influence of children's diet on their cognition and behavior. Eur J Nutr 47, 25–37.

13. Dye, L & Blundell, J (2002) Functional foods. Psychological and behavioural functions. Br J Nutr 88, S187–S211.

14. Gibson, EL & Green, MW (2002) Nutritional influences on cognitive function. Mechanisms of susceptibility. Nutr Res Rev 15, 169–206.

15. Russell, CG., Flight, I., Leppard, P., et al. (2004) A comparison of paper-and-pencil and computerised method of 'hard' laddering. Food Qual Prefer 15, 279–291.

16. Russell, CG, Busson, A, Flight, I, et al. (2004) A comparison of three laddering techniques applied to an example of a complex food choice. Food Qual Prefer 15, 569–583.

17. Bellisle, F (2004) Effects of diet on behaviour and cognition in children. Br J Nutr 92, 227–232.

18. Tomlinson, D, Wilkinson, H & Wilkinson, P (2009) Diet and mental health in children. Child Adolesc Mental Health14, 148–155.

19. Rausch, R (2013) Nutrition and academic performance in school age children: the relation to obesity and food insufficiency. J Nutr Food Sci 3, 2–4.

20. Pollitt, E (1995) Does breakfast make a difference in school? J Am Diet Assoc 95, 1134–1139.

21. Levy, L (2013) Breakfast and cognition, review of the literature, Public Health England https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/256398/Breakfast_and_cognition_review_FINAL_publication_formatted.pdf (accessed 25 May 2014).

22. Pollitt, E & Mathews, R (1998) Breakfast and cognition. An integrative summary. Am J Clin Nutr 67, 804–813.

23. Hoyland, A, Dye, L & Lawton, CL (2009) A systematic review of the effect of breakfast on the cognitive performance of children and adolescents. NutrRes Rev 22, 220–243.

24. Benton, D (2010) The influence of dietary status on the cognitive performance of children. Mol Nutr Food Res 54, 457–470.

25. Coveney, J (2004) A qualitative study exploring socio-economic differences in parental lay knowledge of food and health: implications for public health nutri-tion. Public Health Nutr 8, 290–297.

26. OECD Health Data (2012) Eurostat Statistics Database. http://www.oecd-ilibrary.org/sites/9789264183896-en/02/05/index.html?itemId=/content/chapter/9789264183896-24-en (accessed 25 May 2014)

27. Gage, H., von Rosen-von Howwell, J., Laitinen, K., et al. (2012) Health effects of infant feeding for parents in leaflets and magazines in five European countries. Public Underst Sci 22, 365–379.

28. Birch, LL & Davison, KK (2001) Family en-vironmental factors influencing the developing behavioral controls of food intake and childhood overweight. Pediatr Clin North Am 48, 893–907.

29. Raats, M (2010) The role of consumers. In Drivers of Innovation in Pediatric Nutrition, pp. 161–171 [Koletzko B, Koletzko S and Rummele F, (editors)]. Basel, Switzerland: Nestle Nutrition Institute Workshop Series, Pediatric Program. Karger.

31. Jackson, C, Cheater, F & Reid, L (2008) A systematic review of decision support needs of parents making child health decisions. Health Expect 11, 232–251.

32. Van Trijp, HCM (2009) Consumer unders-tanding and nutritional communication: key issues in the context of the new EU legislation. Eur J Nutr 48, S41–S48.

5. Chapter II
Importance of mental performance in parental choice of food for children aged 4–10 years: a study in four European countries

5.1. INTRODUCTION

Parents are the main gatekeepers of the diet of children under the age of 10 years, exerting significant control over what they eat through selection of the range of foods that are offered[1] and methods such as restriction and rewards[2]. In making food choices for their children, research has shown that parents are aware of the importance of developing good eating habits for long-term health and are concerned with balancing a healthy diet with their child's food preferences[3]. Even though parents associate some foods (such as sugary drinks) with effects on mood and behaviour[4], most perceive that diet has a stronger impact on the physical development of their child than on his/her mental performance[5]. Food and nutrition, however, have important and pervasive impacts on brain development and cognitive functioning through effects on cell structure, neurotransmission, energy supply to the brain and metabolism[6,7]. Beyond the role of specific nutrients, eating patterns such as skipping breakfast are considered to contribute to poor mental performance[8] and consumption of foods containing certain additives to result in behaviour changes(9). Hence a balanced diet is important for mental as well as physical development with implications for school performance, attainment and well-being in adulthood[10,11].

The present work reports the findings from a questionnaire study involving the parents of children aged 4–10 years in a convenience sample of four European countries (England, Germany, Hungary and Spain). The countries included were those participating in a larger European programme of work on the role that diet plays in the mental performance of children (NUTRIMENTHE project). Since traditionally most attention has been paid to how nutrition affects physical health, the questionnaire particularly probed the extent to which parents took account of the impact of their food choices on the mental performance of their children. The findings reported herein relate to: (i) the relative importance of perceived healthiness, impact on

elements of mental performance, attributes of food such as taste, and cost and convenience of preparation in parental food choices; (ii) the awareness and beliefs of parents about the effect of food on their child's ability to learn and attention; (iii) the characteristics of parents associated with the prioritisation of mental performance when choosing food for their children; and (iv) the main influences on parental decision making, including roles of family, friends, health professionals and the media. The inclusion of four different countries enables cultural differences to be explored.

5.2. METHODS

Questionnaire development

The questionnaire was developed by members of the international research teams through several face-to-face meetings and intervening email exchanges. A preliminary questionnaire was developed in English and translated into local languages. It was piloted in all four countries with a small number of local volunteer parents to ensure that the type, flow and number of questions were appropriate to the aims of the study and to pre-test for clarity and comprehension. Results from the pilots were evaluated and compared and the content of the final questionnaire (comprising twenty-five items) agreed. Changes following the pilot involved refinement of the wording to ensure consistency in meaning across the four countries.

The first of three items on food choice asked parents to what extent (not at all/slightly/moderately/very much/extremely/don't know) they took account of eleven different factors when preparing food for their child. They were also asked to rank their top three factors. The order in which the factors were presented to

respondents was rotated. The factors were selected with reference to the relevant theoretical and empirical literature and in discussion with four nutrition and psychology experts. They were divided into four groups: (i) the effect of food on physical functioning (healthiness of food, child's energy levels); (ii) the effect of food on four elements of their child's mental performance (ability to learn, attention, mood, behaviour); (iii) food-related factors (flavour, providing variety, child's food preferences); and (iv) pragmatic factors (cost, ease of preparation).

The findings from qualitative interviews with parents in each country were consulted to guide the selection of elements of mental performance[3]. Parents encountered problems with articulating what the concept of 'mental performance' meant to them. Cognitive processes encompass a range of complex functions (perception, psycho-motor, attention, memory, language, executive functions)[6], the details of which may be hard for lay people to comprehend. Parents tended to relate most to 'attention' and 'concentration', and many expressed the view that food affected these dimensions indirectly through its impact on mood and behaviour. Consistent with findings from other research[12,13], parents also related to 'learning' as an element of mental performance[6]. The selection of indicators of mental performance for the questionnaire in the present study reflected these considerations and the need to ensure that the terminology used was meaningful to parents.

Second, to gain more understanding of the importance parents attribute to the effect of food on mental performance, respondents were asked the extent to which they agreed or disagreed (5-point Likert scale) with two statements: one relating to their awareness of foods that improve their child's attention and ability to learn; the other to their belief that food improves their child's attention and ability to learn. The final item related to the extent (not at all/slightly/moderately/very much/extremely/don't know) to which parents' decisions about how to feed their

child were influenced by eleven different sources (including self, partner, other family, friends, health professionals and various media sources).

In addition, information was collected on the socio-demographic characteristics of respondents that might influence their views and behaviours: age, sex, ethnicity, whether born in the country, highest level of education attained, occupation of main earner, number of children living at home, if respondent had ever gained a qualification relating to health or nutrition, and smoking status. Respondents also completed the General Health Interest (GHI) scale, an eight-item instrument that measures health-related food attitudes, each scored on a 7-point scale from which an average is calculated, range 1 (least interested in healthy eating) to 7 (most interested)[14].

Recruitment of participants

In order to access national samples, data collection was managed by a market research agency in England that had links with partner organisations in the other three countries. Parents were recruited from established panels in each country. Panel members are selected according to the inclusion criteria for individual studies, which, in the present study, were that parents had a child aged 4–10 years old, in mainstream (not private or special) education. The focus on 4–10-year-old children was because, at that age, parents are still likely to be having a significant influence over their diet and nutrition. Parents of children with diagnosed pathologies, such as attention-deficit hyperactivity disorder, were excluded because it was reasoned that they may have researched dietary influences on development more thoroughly than the general population. The questionnaire was distributed and completed online. Controls in the questionnaire prevented non-response to any item so all returns were complete. Ethical approval was gained from the University of Surrey research ethics committee.

Sample size

The target was to recruit 400 parents in each country, enabling the detection, using a two-sided test, with size of 5% and power of 80%, of an underlying difference in prevalence of 10% with regard to any dichotomous outcome.

Analysis

Data were transferred to the statistical software package SPSS version 16 for analysis. Summary statistics (numbers, percentages, means, standard deviations, medians, ranges) were calculated for all background variables and broken down by country. Comparisons between countries were performed using the appropriate statistical tests.

Factors in food choice were ranked according to the proportions of parents responding that they took account of the factor extremely, very much or moderately (v. slightly or not at all). Factors were also ranked for the proportion of respondents placing the factor among one of the top three. Rankings were compared between countries, and between parents with different sex mixes of children, because boys are generally regarded as needing more energy (at a given age) than girls[15].

The proportions of parents agreeing or strongly agreeing that they were not aware of which foods contribute to attention and ability to learn, and did not believe foods impact on attention and ability to learn, were analysed descriptively and compared between countries.

Backwards stepwise logistic regression modelling was undertaken to explore associations between parents' background characteristics and stating that they take account of each of the four mental performance factors slightly or not at all (v. moderately, very much or extremely) in making food choices for their child.

The importance of different sources of information used by parents in food choice decisions were re-coded on a 5-point scale (1 =not at all to 5 =extremely; don't know treated as missing). The eleven sources were combined into four groups for analysis: self (i.e. own common sense), family and friends, doctor and health professionals, and media (comprising seven items: radio, television, websites, social networks, advertisements, books, magazines). A mean score was calculated for each parent for each group. Country-level means were then compared.

5.3. RESULTS

Sample characteristics

Questionnaires were returned by 1606 parents with children aged between 4 and 10 years (n 401 in England, Germany, Hungary; n 403 in Spain), but the children were not co-resident with some of the respondents. Since the questions specifically referred to food choice for 'their child', those parents with no children living with them were excluded from the analysis. This left a total sample of 1574 respondents. Respondents were predominantly of white ethnicity. Parent responders differed significantly across countries in all characteristics except for smoking rates (overall, 25,9% were current smokers) and having a qualification in health and nutrition (55,3%; C.II – Table.1 A-B).

Factors affecting food choices

Across all countries, the proportions of parents stating they took account of a factor extremely, very much or moderately (v. slightly or not at all) when making food choices for their child were lowest for the pragmatic factors of cost (79,8%) and convenience (76,8%) and highest for healthiness of food, making food appealing to their child and the perceived effect of food on energy levels (over 90%). Between 80 and 85% of

parents considered the impact of food on the four elements of mental performance to be moderately, very much or extremely important. Differences existed between countries in the importance that parents said they attached to cost, flavour of food, child's preferences, providing variety and the effect of food on child's mood and attention (but not with respect to the effect of food on the child's energy levels, ability to learn, behaviour, ease of preparation or the healthiness of food; C.II – Table.2).

C. II – Table.1 (A)

Characteristics of respondents and comparison across countries: convenience sample of parents of children aged 4–10 years from four European countries

A Characteristic		Parents N=1574 **n**	**%**	Sig Diff between countries
Age (years	18 - 24	96	6.1	
	25 - 34	514	32.7	0.044
	35 - 44	678	43.1	
	>= 45	286	18.2	<0.001^
Gender	Male	598	38.0	<0.000^
Born in home country	Yes	1475	93.7	<0.000^
Qualification health/nutrition	Yes	186	11.8	0.097^
Ever smoked	Yes	870	55.3	0.555^
Current smoker	Yes	408	25.9	0.142^
Ethnicity	White	1491	94.7	<0.001^
Higher education[1]	Yes	847	53.8	<0.001^
Main earner occupation	Man,Prof[2]	545	34.6	0.046^
Continuous variables (Mean, Standard Deviation)		M	SD	
No. of children <18 living with respondent		1.95	0.99	<0.001'
GHI: range 1-7 (most interested in healthy eating)[3]		4.67	1.05	<0.001'

[1] Highest level of education is college or university; [2] Managerial or professional (rather than clerical, administrative, manual, homemaker, retired, student, seeking work); [3] General Health Interest Scale
M (mean), SD (standard deviation); # Krushcal Wallis test; ^ Chi Square test; ~ T test; ' Anova

C. II – Table.1 (B)

Characteristics of respondents and comparison across countries: convenience sample of parents of children aged 4–10 years from four European countries

B		England N=397		Germany N=389		Hungary N=398		Spain N=390	
Characteristic		n	%	n	%	n	%	n	**%**
Age (years	18 - 24	20	5.0	48	12.3	4	1.0	24	6.2
	25 - 34	141	35.5	127	32.6	137	34.4	109	27.9
	35 - 44	144	36.3	141	36.2	210	52.8	183	46.9
	>= 45	92	23.2	73	18.8	47	11.8	74	19.0
Gender	Male	127	32.0	166	42.7	128	32.2	177	45.4
Born in home country	Yes	354	89.2	366	94.1	386	97.0	369	94.6
Qualification health/nutrition	Yes	36	9.1	51	13.1	57	14.3	42	10.8
Ever smoked	Yes	209	52.6	217	55.8	219	55.0	225	57.7
Current smoker	Yes	86	21.7	111	28.5	107	26.9	104	26.7
Ethnicity	White	356	89.7	367	94.3	395	99.2	373	95.9
Higher education[1]	Yes	263	66.2	207	53.2	158	39.7	219	56.2
Main earner occupation	Man,Prof[2]	130	32.7	144	37.0	120	30.2	151	38.7
Continuous variables (Mean, Standard Deviation)		M	SD	M	SD	M	SD	M	SD
No. of children <18 living with respondent		1.83	.860	1.86	1.12	1.92	.784	2.17	1.13
GHI: range 1-7 (most interested in healthy eating)[3]		4.65	.930	4.70	1.03	4.37	1.15	4.95	1.00

[1] Highest level of education is college or university; [2] Managerial or professional (rather than clerical, administrative, manual, homemaker, retired, student, seeking work); [3] General Health Interest Scale
M (mean), SD (standard deviation); # Krushcal Wallis test; ^ Chi Square test; ~ T test; ‘ Anova

These rankings altered somewhat when the proportions of parents listing a factor in the top three most important were examined. Healthiness (80,3%), offering variety (57,1%) and the child’s food preferences (41,9%) were the most important to parents. A middle group of factors comprised the effect of food on the child’s energy (28,0%), flavour of food (27,3%) and cost (20,0%). Ease of preparation and the four factors relating to the child’s mental performance were all ranked in the top three factors by less than 10% of respondents (C.II – Table.2 A-B).

Differences existed between countries in the proportions ranking factors in the top three for all factors except healthiness, where there was close agree-ment. Compared with the other countries, respondents in Hungary were less likely to rate

C. II – Table 2 (A)

Factors affecting food provision for children among a convenience sample of Q6 parents of children aged 4–10 years from four European countries

A	When providing food for your child, to what extent do you take account of the following?					
	Don't know	Number, % responding extremely, very much, moderately *vs*. slightly, not at all)				
		Overall ranking				
				Inter country differences		
Factors influencing food provision, RANKED~	n	n	%	p (1 way ANOVA#)	Rank	Sig diff
Healthiness of food	21	1505	96.9	0.123	-	-
Offering a variety of food	24	1429	94.8	<0.001	HESG	HES>G
Flavour of food	23	1475	95.1	<0.001	HEGS	H>EGS
Child's food preferences	21	1474	94.9	<0.001	HEGS	H>EG>S
Effect of food on child's energy levels	25	1440	93.0	0.985	-	-
Effect of food on child's behaviour	39	1306	85.1	0.098	-	-
Effect of food on child's attention	46	1291	84.5	0.013	GESH	G>H
Effect of food on child's mood	48	1283	84.1	0.017	GEHS	G>S
Effect of food on child's ability to learn	49	1277	83.7	0.097	-	-
Cost of foods	23	1237	79.8	<0.001	HESG	HE>GS
Ease of preparation	24	1190	76.8	0.040	-	-

~ Note order of presentation of factors to respondents was rotated

1 way ANOVA based on the 5 point linear scale (1= not at all to 5 = extremely).

C. II – Table 2 (B)

Factors affecting food provision for children among a convenience sample of Q6 parents of children aged 4–10 years from four European countries

B Factors in top 3 most important influences on food provision, RANKED	When providing food for your child, to what extent do you take account of the following? Number, % ranking factor in top three most important										
	All countries		England N=397		Germany N=389		Hungary N=398		Spain N=390		Difference between countries, p (chi sq)
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	
Healthiness of food	1264	80.3	321	80.9	302	77.6	330	82.9	331	79.7	0.305
Offering a variety of food	899	57.1	212	53.4	162	41.6	221	55.5	304	77.9	<0.001
Child's food preferences	659	41.9	138	34.8	177	45.5	249	62.6	95	24.1	<0.001
Effect of food on child's energy levels	440	28.0	97	24.4	84	21.6	90	22.6	169	43.3	<0.001
Flavour of food	429	27.3	101	25.4	121	31.1	114	28.6	93	23.8	<0.001
Cost of foods	328	20.8	117	29.5	58	14.9	120	30.2	33	8.5	<0.001
Effect of food on child's ability to learn	152	9.7	39	9.8	56	14.4	15	3.8	42	10.8	<0.001
Effect of food on child's attention	147	9.3	32	8.1	74	19.0	13	3.3	28	7.2	<0.001
Ease of preparation	146	9.3	46	11.6	5	13.1	10	2.5	39	10.0	<0.001
Effect of food on child's behaviour	141	9.0	55	13.9	31	8.0	21	5.3	34	8.7	<0.001
Effect of food on child's mood	117	7.4	33	8.3	51	13.1	11	2.8	22	5.6	<0.001

~ Note order of presentation of factors to respondents was rotated

1 way ANOVA based on the 5 point linear scale (1= not at all to 5 = extremely).

the four elements of mental performance among the top three factors influencing their food choices, while those in Germany were more likely to do so (other than behaviour). The child's food preferences were important in Hungary, and less so in Spain, where variety and providing energy were relatively important considerations (C.II – Table.2 A-B). In Germany, low proportions of parents considered variety of food, and flavour was important. Cost was relatively unimportant in both Germany and Spain. Ease of preparation was unimportant in all countries but particularly so in Hungary.

Comparing parents with different sex mixes of children

Of the 1574 parents with children living at home, (34,1%) had only boys; (24,5%) had only girls; (41,5%) had both boys and girls. Within each country separately, there was no significant difference between parents with only girls, only boys or both in the extent to which parents said they took account of any of the eleven factors or in the proportions that ranked any factor among the top three (data not shown).

Combining all four countries, the sex mix of children had a significant effect on the extent to which parents said they took account of the child's food preferences (P=0,003) and marginally the flavour of food (P=0,077). Both these factors were more important to parents who had only girls, than to those who had only boys, or both. There was no significant difference between parents with only girls, only boys or both in the extent to which parents said they took account of any of the other nine factors or in the proportions that ranked any factor in the top three (data not shown).

Awareness and beliefs of parents about the effect of food on their child's ability to learn and attention

Across all countries, some 60% of parents stated that they believed that food affected ability to learn (57,4%) or attention (60,5%). Similar proportions stated they were not aware which foods affected the ability to learn (34,8%) or attention (37,8%) of their child (C.II – Table.3). There was a highly statistically significant positive association between stating awareness and belief; for ability to learn, of those aware, 85,9% also believed, 89,3% for attention (χ^2 test, P<0,0005 for both). Also, parents stating they were not aware or did not believe were significantly more likely to state they only slightly or not at all (v. moderately, very much or extremely) took account of the effect of foods on their child's ability to learn or attention (χ^2 test, P<0.0005 for each association).

Characteristics of parents prioritising different factors when choosing foods for their children

Regression modelling identified that parents having a higher GHI mean score were more likely to consider the effect of all four elements of mental performance as being moderately, very or extremely important when making food choices for their child; hence, putting low priority on mental performance factors was associatedwith less interest in healthy eating. Parents in Germany (compared with those in England) were more likely to consider a child's ability to learn, attention and mood to be moderately, very or extremely important when making food choices for their child. Similarly, parents in Hungary prioritised ability to learn. White ethnicity was associated with increased likelihood of considering a child's behaviour as important in food choices. Having more children in the family made parents less likely to consider the effect of the food on their child's mood to be moderately, very or extremely important in their food choices (C.II – Table.4 A-B).

C. II – Table.3

Awareness and beliefs of parents about the effect of food on their child's ability to learn and attention, and comparisons between countries, among a convenience sample of parents of children aged 4–10 years from four European countries

To what extent do you agree or disagree with each of the following statements? Number and % agreeing or strongly agreeing vs. neither agreeing nor disagreeing, disagreeing, strongly disagreeing, don't know

	ABILITY TO LEARN										
	All countries		England		Germany		Hungary		Spain		P#
	n	%	n	%	n	%	n	%	n	%	X^2
I AM AWARE which foods contribute to my child's……	548	34.8	136	34.3	152	39.1	117	30.0	143	35.9	0.061
I BELIEVE food has an impact on my child's	904	57.4	256	64.5	204	52.4	195	50.0	249	62.6	<0.001
	ATTENTION										
	All countries		England		Germany		Hungary		Spain		P#
	n	%	n	%	n	%	n	%	n	%	X^2
I AM AWARE which foods contribute to my child's……	595	37.8	162	40.8	164	42.4	115	29.5	154	38.7	0.001
I BELIEVE food has an impact on my child's	952	60.5	260	65.5	226	58.1	219	56.2	247	62.1	0.036

Inter country difference, using the $\chi 2$ test.
Negative statement have been reversed for clarity

Influences on parents' food choice decisions

Parents reported that their own common sense and experience was the most important influence on decisions about how to feed their child; media sources had little influence in all countries. Differences existed between countries. In contrast to England where parents reported above-average reliance on self and less reliance on family/friends and health professionals, parents in Spain attributed more importance to family/friends and health professionals and less to their own common sense (C.II – Table.5 A-B).

C. II – Table.4 (A)

Characteristics and country* of parents considering mental performance factor is moderately, very much or extremely (v.notatallor slightly) important when making food choices for their child among a convenience sample of parents of children aged 4–10 years from four European countries

A

Factor in food choice/ Dependent variable	Number stating factor is important		Significant characteristics	Exp B†
	Slightly/ Not at all	Moderately, very much/ extremely		
Effect of food on child's ability to learn	248	1277	GHI mean	1.671
			Current smoker	1.586
			Germany	1.477
			Hungary	1.494
Effect of food on child's attention	237	1291	GHI mean	1.703
			Current smoker	1.415
			Germany	1.510
Effect of food on child's behaviour	229	1306	GHI mean	1.702
			White ethnicity	1.932
Effect of food on child's mood	243	1283	Number of children	0.873
			GHI mean	1.549
			Germany	1.456

*Independent variables/characteristics of parents included in the modelling: total number of children living at home; General Health Interest (GHI) mean score (1=low to 7 =high interest/healthy eater); ethnicity white (yes v. no); age (in six categories); sex; born in country (yes v. no); qualification related to health or nutrition (yes v. no); university or college education (v. educated to age 18 years at most); country (with England as the reference). Current smoker was omitted due to correlation with GHI: mean (SD) GHI of 1166 non-smokers was 4·73 (1·04) v. 4·51 (1·08) for current smokers (P<0·0005, unpaired t test).

†Adjusted odds ratio for considering the effect of food on element of mental performance to be moderately, very or extremely (v. slightly, not at all) important.

C. II – Table.4 (B)

Characteristics and country* of parents considering mental performance factor is moderately, very much or extremely (v.notatallor slightly) important when making food choices for their child among a convenience sample of parents of children aged 4–10 years from four European countries

B

Factor in food choice/ Dependent variable	P (signif)	95% Confidence Intervals		Notes / interpretation MORE LIKELY prioritise factor (rank factor amongst top three of 11 factors) if
		Lower	Upper	
Effect of food on child's ability to learn	<0.0005 0.008 0.033 0.024	1.451 1.128 1.033 1.055	1.925 2.729 2.111 2.116	1 point higher GHI mean / being a current smoker / living in Germany / living in Hungary increases the likelihood of considering the effect of food on child's ability to learn as moderately, very or extremely (vs. slightly or not at all) important by 1.671 / 1.586 / 1.477 / 1.494 times
Effect of food on child's attention	<0.00050.045 0.025	1.280 1.007 1.054	1.959 1.987 2.165	1 point higher GHI mean / being a current smoker / living in Germany increases the likelihood of considering he effect of food on child's attention as moderately, very or extremely (vs. slightly or not at all) important by 1.703 / 1.415 / 1.501 times
Effect of food on child's behaviour	<0.00050.019	1.477 1.115	1.961 3.345	1 point higher GHI mean / white ethnicity increases the likelihood of considering the effect of food on child's behaviour as moderately, very or extremely (vs. slightly or not at all) important by 1.702 / 1.932 times
Effect of food on child's mood	0.050 <0.00050.037	0.762 1.353 1.024	1.000 1.774 2.070	1 point higher GHI mean / living in Germany increases the likelihood of considering the effect of food on child's mood as moderately, very or extremely (vs. slightly or not at all) important by 1.549 / 1.456 times. Having one more child reduces the likelihood by 0.873 times.

*Independent variables/characteristics of parents included in the modelling: total number of children living at home; General Health Interest (GHI) mean score (1=low to 7 =high interest/healthy eater); ethnicity white (yes v. no); age (in six categories); sex; born in country (yes v. no); qualification related to health or nutrition (yes v. no); university or college education (v. educated to age 18 years at most); country (with England as the reference). Current smoker was omitted due to correlation with GHI: mean (SD) GHI of 1166 non-smokers was 4·73 (1·04) v. 4·51 (1·08) for current smokers (P<0·0005, unpaired t test).

†Adjusted odds ratio for considering the effect of food on element of mental performance to be moderately, very or extremely (v. slightly, not at all) important

C. II – Table.5 (A)

Influences on parents' decisions about how to feed their child, and comparisons between countries, among a convenience sample of parents of children aged European countries

A	Mean score based on: Not at all =1 to Extremely =5; Don't know treated as missing.			
How much is your decision about how to feed your child influenced by:	All countries			Differences between countries, P*
	N	Mean	SD	ANOVA
Self (common sense/ experience)	1553	4.08	.851	0.001
Family and friends (partner, other family and friends)	1557	3.02	.947	<0.0005
Doctor and health professionals	1550	3.27	1.20	<0..0005
Media (Radio, TV, Advertisements, books, magazines, websites, social networks)	1556	2.31	.910	0.095

*Using one-way ANOVA based on the 5-point linear scale (1=not at all to 5=extremely

C. II – Table.5 (B)

Influences on parents' decisions about how to feed their child, and comparisons between countries, among a convenience sample of parents of children aged European countries

B	Mean score based on: Not at all =1 to Extremely =5; Don't know treated as missing.											
How much is your decision about how to feed your child influenced by:	England			Germany			Hungary			Spain		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
Self (common sense/ experience)	388	4.15	.869	381	4.04	.949	396	4.17	.741	388	3.96	.822
Family and friends (partner, other family and friends)	390	2.78	1.03	382	3.14	.995	397	3.04	.862	388	3.15	.850
Doctor and health professionals	387	2.76	1.27	380	3.01	1.27	397	3.51	1.03	386	3.79	.975
Media (Radio, TV, Advertisements, books, magazines, websites, social networks)	390	2.12	.990	381	2.32	.984	397	2.34	.731	388	2.37	.909

*Using one-way ANOVA based on the 5-point linear scale (1=not at all to 5=extremely

5.4. DISCUSSION

Dietary choices are influenced by a complex web of factors, including palatability (taste, smell, texture), nutritional content, calorific value, cost, convenience and the social context[16]. Almost all parents in each of the four European countries included in the present study rated healthiness of food to be important when choosing food for their child. Lower proportions (80–85%) considered the impact of food on their child's attention, ability to learn, mood and behaviour to be important, and even lower proportions (about 60%) stated they believed that food impacted their child's ability to learn and attention. Cost considerations, food variety, flavour and effect of food on energy levels were all more likely to be rated in the top three factors considered by parents in making food choices than the four elements of mental performance. These findings differ somewhat from those of other European[17] and US[18] food and nutrition surveys which found cost and taste to be more important than healthiness, possibly reflecting a reordering of priorities when selecting foods for children. Neither of these major surveys offered mental performance as factors in food choice, indicating the general focus on food as a determinant of physical rather than cognitive functioning.

Across all countries parents with only girls were more likely to state that their child's food preferences were important in their choice of food for the child than parents who had only boys or a mix of boys and girls. Consistent with other evidence that shows similarities in parents' feeding styles for boys and girls[19], no other factor in food choice differed according to the sex of the child. It has been shown that parents are likely to modulate their feeding strategies to match each individual child's eating behaviours and that the relationship is complex and interactive[20].

Geographical location can affect access to certain foods, cultural traditions can account for dietary differences, and knowledge and beliefs about the risks and benefits of alternative nutritional decisions influence ability to choose healthy options[21–24]. In this regard, differences were found between countries in their rankings of the factors influencing food choices. For example, providing variety was significantly less important to parents in Germany and most important in Spain. Parents in Hungary generally prioritised elements of mental performance less than parents in England; parents in Germany considered them more important (except for the effect of food on behaviour). Cultural differences in attitudes to foods are well recognised[25,26], but accounting for differences between countries in our results is to some extent speculative as this was not explicitly explored by the questionnaire. It may, however, reflect national differences in policies and public health messages[27].

Lower prioritisation of the effect of food on mental performance indicates the potential for educating parents and building public awareness. Recently, public health concerns have focused heavily on childhood obesity[28] and scope exists to redress this imbalance. Uncertainties exist, however, in the scientific evidence about the relationship between dietary intake and mental performance, resulting in a lack of clear messages for consumers[29–32]. Poor knowledge and understanding were indicated by parental responses to the survey, with less than 40% reporting they were aware which foods contributed to ability to learn and attention. Multiple factors affect mental functioning, however, and identifying the independent effect of nutrition, from social, economic, genetic and parenting factors, is challenging[7,29]. Further research in this area is required, along with robust dissemination strategies to ensure that key messages about the role of nutrients and eating behaviours, such as skipping breakfast, reach the target audiences[9,33–35]. Respondents in each country stated that decisions about food choices for their children were less influenced by

media sources than by health professionals, and that they relied on their own experience and common sense the most, so innovative methods of getting messages over may need to be identified. Understanding subgroups of populations is important for effective public policy; for example, parents with lower general interest in healthy eating were less likely to prioritise all mental performance issues, so may warrant special targeting.

Although care was taken in translating and piloting the questionnaire to ensure uniformity between countries, the findings need to be interpreted in the light of a number of limitations. The study was based on a convenience sample of four countries that provided geographical spread across Europe but may not have been socially and politically representative of the whole European population. In order to recruit large national samples, respondents were drawn from market research panels and significant differences existed between countries in some characteristics. Members of panels are volunteers and are typically reimbursed for the time they spend completing online surveys, so the people attracted to this role are self-selected and may not be representative of the general population in each country[36,37]. The weakness of such approaches are well documented[38] and further research on the representativeness of online samples has been recommended[37]. Some 38% of respondents were men and fathers have been shown to have different attitudes to feeding children to those of mothers[39]. At individual and country level, differences were not found between reported awareness and beliefs of men and women about the effect of food. Taking all countries together, however, female respondents were more aware than men of which foods affected their child's attention and ability to learn. Women were also more likely to believe that food affected their child's ability to learn, but there were no differences between men and

women in beliefs about the impact of food on their child's attention. The study did not test the nutrition knowledge and understanding of respondents.

Brain development and cognition are important for learning, memory, information processing, reasoning, behaviour and many other functions that affect an individual's life achievements and well-being. Benefit may arise from increasing awareness of the potential role of diet and nutrition in both the brain development and cognitive functioning of children through increasing the quantity and clarity of consumer information[40]. Parents in particular are important gatekeepers to a child's diet and central to the environment in which most children's eating habits are developed[41]. As such they constitute an important target group for communication on the nutritional properties and health effects of foods. Timely, consistent and evidence-based information, tailored to different groups, and delivered in a variety of formats, is needed to form a basis for rational decision making around food choices[42].

5.5. REFERENCES

1. Koivisto H (1999) Factors influencing children's food choice. Ann Med 31, Suppl. 1, 26–32.

2. Brown R & Ogden J (2004) Children's eating attitudes and behaviour: a study of the modelling and control theories of parental influence. Health Educ Res 19, 261–271.

3. Brands B, Egan B, Györei E et al. (2012) A qualitative interview study on effects of diet on children's mental state and performance. Evaluation of perceptions, attitudes and beliefs of parents in four European countries. Appetite 58, 739–746.

4. Hart K, Herriott A, Bishop J et al. (2003) Promoting healthy diet and exercise patterns amongst primary school children; a qualitative investigation of parents' perspectives. J Hum Nutr Diet 16, 18–96.

5. Egan B, Gage H, Williams P et al. (2016) The effect of diet on the physical and mental development of children: views of parents and teachers in four European countries. Br J Nutr (Epublication ahead of print version).
6. Schmitt JA, Benton D & Kallus KW (2005) General methodological considerations for the assessment of nutritional influences on human cognitive functions. Eur J Nutr 44, 459–464.
7. Isaacs E & Oates J (2008) Nutrition and cognition: assessing cognitive abilities in children and young people. Eur J Nutrn 47, Suppl. 3, 4–24.
8. Bellisle F (2004) Effect of diet on behaviour and cognition in children. Br J Nutr 92, Suppl. 2, S229–S232.
9. Benton D (2008) The influence of children's diet on their cognition and behaviour. Eur J Nutr 47, 25–37.
10. Alderman H, Behrman JR, Lavy V et al. (1997) Child Nutrition, Child Health, and School Enrollment. A Longitudinal Analysis.
11. Associate Parliamentary Food and Health Forum (2008) The links between diet and behaviour. The influence of nutrition on mental health.
12. Russell CG, Flight I, Leppard P et al. (2004) A comparison of paper-and-pencil and computerised method of 'hard' laddering. Food Qual Prefer 15, 279–291.
13. Russell CG, Busson A, Flight I et al. (2004) A comparison of three laddering techniques applied to an example of a complex food choice. Food Qual Prefer 15, 569–583.
14. Roininen K, Lahteenmaki L & Tuorila H (1999) Quantification of consumer attitudes to health and hedonic characteristics of foods. Appetite 33, 71–88.
15. Zelman K (2005) Estimated calorie requirements. http://www.webmd.com/diet/features/estimated-calorie-requirement (accessed December 2015).
16. Raats M (2010) The role of consumers. Nestle Nutr Workshop Ser Pediatr Program 66, 161–171.
17. Lappalainen R, Kearney J & Gibney M (1998) A pan EU survey of consumer attitudes to food, nutrition and health: an overview. Food Qual Prefer 9, 467–478.
18. International Food Information Council Foundation (2011) Food and Health Survey: Consumer Attitudes Toward FoodSafety, Nutrition and Health.

http://www.foodinsight.org/Content/3840/2011%20IFIC%20FDTN%20Food%20and%20Health%20Survey.pdf (accessed May 2015).

19. Webber L, Cooke L, Hill C et al. (2010) Associations between children's appetite traits and maternal feeding practices. J Am Diet Assoc 110, 1718–1722.
20. Webber L, Cooke L & Wardle J (2010) Maternal perceptions of causes and consequences of sibling differences in eating behaviour. Eur J Clin Nutr 64, 1316–1322.
21. Pheasant H (2008) Social, behavioural and other determinants of choice of diet. http://www.healthknowledge.org.uk/public-health-textbook/disease-causation-diagnostic/2e-health-social-behaviour/social-behavioural-determinants#1 (accessed January 2015).
22. Shepherd R (1999) Social determinants of food choice. Proc Nutr Soc 58, 807–812.
23. Gibney M, Margetts B, Kearney J et al. (Editors) Public Health Nutrition. The Nutrition Society 2004.
24. European Food Information Council (2006) The determinants of food choice. EUFIC Review 04/2005. http://www.eufic.org/article/en/expid/review-food-choice/ (accessed January 2015).
25. Trichopoulou A & Naska A, on behalf of the DAFNE III Group, et al. (2002) Disparities in food habits across Europe. Proc Nutr Soc 61, 553–558.
26. Musher-Eizenman D, de Lauzon-Guillain B, Holub S et al. (2009) Child and parent characteristics related to parental feeding practices. A cross-cultural examination in the US and France. Appetite 52, 89–95.
27. Capacci S, Mazzocchi M, Shankar B et al. (2002) Policies to promote healthy eating in Europe: a structured review of policies and their effectiveness. Nutr Rev 70, 188–200.
28. Florence MD, Asbridge M & Veugelers PJ (2008) Diet quality and academic performance. J Sch Health 78, 209–215.
29. Gorbey HE, Brownawell AM & Falk MC (2010) Do scientific dietary constituents and supplements affect mental energy? Review of the evidence. Nutr Rev 68, 697–671.
30. Weichselbaum E & Buttriss J (2011) Nutrition, health and school children. Nutr Bull 36, 295–355.

31. Attuquayefio T & Stevenson RJ (2015) A systematic review of longer-term dietary interventions on human cognitive function: emerging patterns and future directions. Appetite 95, 554–570.
32. Haapala EA, Eloranta A-M, Venalainen T et al. (2015) Associations of diet quality with cognition in children – the Physical Activity and Nutrition in Children Study. Br J Nutr 114, 1080–1087.
33. Benton D (2010) The influence of dietary status on the cognitive performance of children. Mol Nutr Food Res 54, 457–470.
34. Hoyland A, Dye L & Lawton CL (2009) A systematic review of the effect of breakfast on the cognitive performance of children and adolescents. Nutr Res Rev 22, 220–243.
35. Levy L (2013) Breakfast and cognition, review of the literature. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/256398/Breakfast_and_cognition_review_FINAL_publication_formatted.pdf (accessed May 2014).
36. Craig B, Hays R, Pickard S et al. (2013) Comparison of US panel vendors for online surveys. J Med Internet Res 15, e260.
37. Khazaal Y, van Singer M, Chatton A et al. (2014) Does self-selection affect samples' representativeness in online surveys? An investigation in online video game research. J Med Internet Res 16, e164.
38. Evans JR & Mathur A (2005) The value of online surveys. Internet Res 15, 195–219.
39. Blissett J, Meyer C & Haycraft E (2006) Maternal and paternal controlling feeding practices with male and female children. Appetite 47, 2112–2219.
40. Gage H, von Rosen-von Hoewel J, Laiteinen K et al. (2012) Health effects of infant feeding for parents in leaflets and magazines in five European countries. Public Underst Sci 22, 365–379.
41. Birch LL & Davison KK (2001) Family environmental factors influencing the developing behavioral controls of food intake and childhood overweight. Pediatr Clin North Am 48, 893–907.
42. Jackson C, Cheater F & Reid L (2008) A systematic review of decision support needs of parents making child health decisions. Health Expect 11, 232–251.

6. Chapter III
Teacher's Perceptions of Dietary Influences on European Children's Mental Performance

6.1. INTRODUCTION

Childhood is a very important period of life when children develop both physically and mentally and also learn eating habits, influenced by both parents and their environment[1].

Diet, exercise and sleep are all factors that can affect brain health and mental function[2-3] so adequate nutrition is necessary for brain development, which in turn may influence the optimal development of cognitive skills. In general, a balanced diet is important for mental health and wellness, with implications for school performance[4]. Children should have a varied diet with correct nutritional content, ensuring a regular intake for optimal cognitive development[5]

Mental performance can be described as a complex concept encompassing cognitive functions such as language, memory and attention[6]. Learning, working memory and executive function are also processes involved in cognition[7] A number of authors have identified some of the key dietary components required to maintain optimal brain function[8-9]; these include proteins, glucose, vitamins, fats and minerals, all of which are important for brain development and function. Proteins help children to avoid being lethargic, withdrawn and passive, all of which affect social and emotional development and glucose is essential in providing energy for the brain[10]. The relationship between glucose and memory has been examined and it was found that students who fasted but drank a glucose drink performed as well as those who ate breakfast[11-12].

It has also been demonstrated that fluctuating levels of carbohydrates may cause dizziness and mental confusion, both of which can affect cognitive performance and affect learning and behaviour[13]. Such research confirms findings from previous studies that showed diet influencing cognition and behaviour in many different ways, including a lack of sufficient nutrition or a deficiency in certain nutrients[5].

Teachers, although external to the family, are the people who spend considerable time with children and, therefore, are in a position to observe carefully and repeatedly children's behaviour[14-15]. Consequently, school staff are in an excellent position to observe the effects of nutrition on the mental performance of children. Furthermore teachers are amongst the most influential players at this stage of a child's development. In a qualitative study with teachers and other school staff[16] participants were asked for their opinions regarding current healthy eating recommendations, and they emphasized that their role in prevention programmes in schools should be supportive, rather than a substitute for the role of parents. There is also evidence that teachers who engage their students in nutrition can have a significant positive effect on the health and wellbeing of an individual for years to come[17].

The environment can exert a strong influence on people's food decisions and to facilitate children making more healthy food choices and developing healthy eating habits, it is important that the school food environment is healthy[18]. Nutrition in school may have a role in influencing the proper intake of nutrients and vitamins for children's' growth and development.

Furthermore it has been recognised that providing nutritional education at school can have a positive influence on the knowledge, skills and behaviours of young people[17-18]; particularly, it can be useful to use this environment to improve children's understanding of the principles of healthy eating. The development of skills for healthy eating behaviour should be an important goal for teachers, at the same level as physical activity or other educational activities[19]. The World Health Organization in Europe had promoted an Action Plan for Food and Nutrition Policy[20-21] placing a strong emphasis on the role of schools in this effort, with a particular focus on nutrition and physical activity education.

Insight into teacher understanding of the relationship between nutrition and mental performance is therefore important but to date very few studies on children's development have considered teachers knowledge as a possible influence on children's food choices.

Other factors may influence teacher's perceptions of the role of diet in children's physical and mental development, including the fact that teachers may also be parents. Results from a recent study indicate that parents perceive that mental performance is related to what children eat, affecting attention and concentration, often mediated by effects on mood and behaviour[22]. In a further study, by the same authors, of parents and teachers views of the effect of diet on children's mental development lower proportions of both groups regarded diet as important in mental development, compared to physical development[23]. Teacher's perceptions may also be influenced by their professional experience, in terms of the number of years they have been teaching and the age of the children they have taught[24].

With this study we aimed to assess teacher's perceptions of the relationship between what children eat and their cognition and mental well-being, understanding the ways teachers describe such effects; and further to explore any cross-country similarities and differences between teachers from four different European countries.

6.2. METHODS

The study was conducted in four European countries (Germany, Hungary, Spain and the United Kingdom) as part of the EU funded Nutrimenthe project Because of the differences in the school systems of the four participating countries and to facilitate recruitment in all countries, it was agreed to recruit teachers of children aged 4-10 years through state elementary schools. Semi-structured interviews were conducted with teachers by members of the research teams in each country

Participants

Participants were recruited through state schools in the cities and urban areas of Granada (Spain), Guildford (UK), Munich (Germany) and Pécs (Hungary). Letters of invitation were sent to the head teachers of state elementary schools in socioeconomically different districts of each of the participating cities; and those who responded with an expression of interest were involved in the study. Teachers participating represented a range of ages and years working, but all were teaching children aged 4 to 10 years old.

In Spain, six state schools in Granada were contacted but did not agree to participate; a further two semi-private schools agreed to take part in the study. In Hungary, four schools confirmed their participation in Pecs from the eighteen state schools contacted. In England, twenty-two primary schools in the Guildford area were approached and four agreed to participate; subsequently two schools dropped out. In Germany, thirty-two schools in Munich were contacted and five schools from different districts agreed to participate. The aim was to conduct a minimum of 15 interviews in each country.

Procedure

Teachers were invited to participate by returning a brief screening questionnaire, which collected contact details and socio-demographic background information.

Based on the socio-demographic data provided, teachers across age groups and of different levels of experience were invited for interview. Background data collected included age, gender, years working as teacher and which level; also if they were parents and ages and gender of their children.

Based on the aim of the study and relevant literature, a semi-structured interview schedule was developed. The research teams in the four participating countries agreed a list of topics and developed a preliminary interview format. Topics included questions

on teachers' beliefs and perceptions of the effects of diet on children aged 4-10, such as effects on wellbeing and development, physical and mental status, effects of specific foods as well as prompting for short or long-term effects of diet and foods (C.III – Table.1). To ensure that the number, type and flow of questions were appropriate to the aims of the study, the preliminary schedule was translated and piloted in all countries. Transcripts of the pilot interviews were evaluated and compared to get a final agreed version of the interview schedule. The schedule also included prompts based on experiences with pilot interviews, to ensure that crucial points were covered and to aid interview progress when teachers' answers were too brief.

C. III – Table.1
Interview structure

Questions	**Prompts**
Thinking about children in general (aged 4-10) do you think that food has an effect on children's wellbeing and development?	• In what ways does it affect children? • Can you give me some examples?
Do you think that what children eat affects them physically?	• In what way does it affect them physically- weight, sleep, energy levels?
Do you think what children eat affects their mood/behaviour? If so, how and in what ways- positive and negative?	• How would you recognise these effects? (Alertness, restlessness, calm/excited, arousal, anger, fatigue, lethargy, confusion and irritability)
Do you think that food might affect children's mental performance? If so, how and in what ways?	• Academic performance, concentration, attention, memory
Do you think that what children eat affects them now or could it affect them in the future?	• In what ways might food affect them?
Thinking about foods, are there any specific foods that you think affect children, either positively or negatively?	• Can you give me some examples of foods that affect children- good and/or bad effects? • How do you think these foods might have these effects?

Interviews were conducted with teachers on school premises at a convenient time and lasted approximately 30 minutes. . All interviews were audio-taped with the interviewee's permission and transcribed verbatim.

All data were recorded in an SPSS database. [SPSS 16.0 Command Syntax Reference, Copyright © 2007 by SPSS Inc.] Prior to conducting the interviews approval for the study was obtained from the relevant Ethics Committees in all four countries.

Data Analysis

Recorded interviews were transcribed verbatim and analysed thematically using NVivo 8.0 software [QSR NVivo Version 8.0.335.0 SP4, Copyrightn © QSR International Pty Ltd. 1999-2009.] The aim of the thematic approach was to identify and analyse patterns and regularities in the data and progressively build up an interpretation of interviews[25-26].

In order to minimise the risk of losing participants' meanings, each partner in the study analysed data primarily in the national language. Using this technique partners could present a comprehensive overview of the content of each data set at national level. Afterwards, a cross-national coding tree was developed, including definitions for each code to guarantee standardised coding[27]. Subsequently, detailed national reports in English were prepared for each country with supporting quotations. Based on these national reports, key themes and relations were identified across the four countries for comparison in a final step resulting in a cross-national report. This report was systematically cross-checked in each country for appropriateness of interpretation.

6.3. RESULTS

Between October 2008 and May 2009 a total of 60 face-to-face interviews were conducted with teachers in the four countries. The majority of teachers were women (88.3%) and 73.3% of those teachers were also parents. Almost half of the participants (41.7%) were older than 40 and 27.6% were under 30 years old, and their teaching experience ranged from one to thirty-six years.

Summaries of the main findings from the interviews, reflecting the views of the majority of teachers are presented and supported by relevant quotations from participants which best describe the findings.

Interviews started with a general question about diet having an effect on a child's wellbeing and development and if so in what way. Most teachers in all countries agreed that what children eat affects their development and growth and that their eating habits may determine their health in adult life.

> *"It will definitely affect them in the future. The usual health problems I mean if they're not eating healthily now then as a result they could end up with diabetes and heart disease. If they don't take on board a healthy diet now then they are going to suffer in the future"* (England.03)
>
> *"Sure. Sure. So I would say very long-term… In some cases unfortunately even all life long, so that they are simply developing. With the age it is anyway more complicated to maintain the weight or it is more difficult to lose the weight..."* (Germany.04)

Teachers referred to a range of physical effects of diet that may affect children's health, with obesity, overweight, cardiovascular diseases and caries seen as the most negative effects with the potential to, influence children's health in the long-term.

> *"I think nutrition can influence in future life. If you have an unbalanced diet and you get too much saturated fat, you're going to suffer obesity and other health problems."* (Spain.08)
>
> *"If they eat carbohydrate rich diet, they can put on weight, and from the obesity high blood pressure, diabetes, obesity can occur."* (Hungary.16)

Teachers in Germany mentioned some gender differences, expressing the opinion that boys are usually more physically active than girls. Nevertheless, girls were seen as more conscious about their diet than boys.

> *"So I can imagine now, that the majority of boys may lose a little bit of weight by football playing, or rather by any motor activity. There are many girls who are very-very inactive I must say, in this case they put on also when moving, all in all. And there are of course some girls, just the opposite, who begin suddenly with these eating disorders..."* (Germany.04)

In the other countries teachers did not refer to gender as a relevant factor in terms of the effects of diet in young children, explaining that changes do occur in puberty, with effects relating more to girl's concern with appearance and boys being more sporty.

> "*Well only having girls myself I haven't got any experience of that, but I suppose with boys you could say they need more energy, their running around more, their more sporty well maybe not all the time but in some areas.*" (England.07)

Teachers spoke of the effects of diet in terms of effects on energy levels, explaining that there is a direct relationship between energy levels and concentration. Children with a lack of energy were perceived as taking more time to engage in learning

"Well, I think so. At the level of concentration and attention, of course, a child who has no force, no energy, he will be distracted." (Spain.15)

"However lots of fruit and vegetables and a healthy diet will bring about lots of energy and improve concentration in school." (England.04)

The effect of diet on energy levels, and hence performance, was related to the nature of what children eat, with teacher's explaining that a balanced diet contributes to a better performance in terms of concentration, whereas eating too much sugary food or *fast food* is associated with hyperactivity, directly affecting learning. In this sense some specific foods (those with high amounts of sugar or caffeine) could have an effect on children's behaviour

"Talking about sugary foods and candies… its get children over-excited, maybe in conduct... they are overflowing with lot of energy, if they eat more things like this you can see the influence." (Spain.08)

"…if they're eating what is classed as junk food they can become very hyperactive and also very tired quickly." (England.07)

Furthermore the timing of when children eat was perceived as important by teachers. Missing out on a meal (especially breakfast) was seen as a barrier to concentrating and learning because children become less receptive to assimilating information and they become distracted more easily. Teachers perceived that some children get tired quite quickly in the morning and others become irritable when midday approaches.

"If they come to school without breakfast, they are useless at the first lesson. Then, as elevenses pass, then they are cheered up and can work well. The day-time colleagues, they know that after lunch, how sleepy they are." (Hungary.17)

In this respect teachers mentioned also that hunger could be a distraction for the children, affecting their concentration in the morning or at midday.

> *"If they're hungry, in any event, they cannot listen. Immediately after lunch, do not perform well, they have to do some outside activity."* (Hungary.15)

Most teachers, in all countries, pointed out that effects on mood and behaviour were some of the short term and more immediate effects of diet on children.

> *"Emotionally, physically and mentally, if a child eats full breakfast, for example, he'll be in a good mood, have energy, will be able to interact with his friends and will be able to focus in class and perform well and develop well and, if not breakfast or poor one, he will be sad, angry, and that creates many more problems, than everything."* (Spain.20)

Many of the teachers established a clear difference between food that they considered to have positive effects and food with negative effects on children's health. Examples of positive foods were vegetables and fruit, because of their high level of vitamins and minerals.

> *"I mean some children are used to a diet rich in vitamins, varied, just once dark bread with a carrot, and they have cute little tomatoes and an apple, really colourfully mixed, in all colours, as you say, much fruit and vegetables and carbohydrates, at the same time not so much white bread, then also full-grain bread […]."* (Germany.05)

Foods that were considered to be negative for children include sugar, soft drinks, crisps, junk foods and fast food in general. As mentioned previously this kind of food is usually associated with physical and mental effects such as obesity and hyperactivity.

"It's probably easier to say the negative ones, things like coco cola, chocolates and the sweets with colours in them; they would definitely have a negative effect on children" (England.06)

In general most teachers across all countries shared the opinion that an ideal diet should contain all the necessary nutrients for children, precluding the need for additional supplements. Nevertheless, they recognized some situations in which supplements are advisable such as compensating for a lack of nutrients or in the case of allergies or colds.

"It depends on if the parent does not give them vegetables, fruits, then at least give him vitamins. But I think that if the parent provides adequate varied diet, they will not be needed." (Hungary.17)

Meals and the regularity with which children eat was deemed important by teachers. Breakfast was identified as a very important meal that has an influence on children's behaviour and performance. Nevertheless, some teachers highlighted the importance of eating, at least, five times a day and paying attention to the time children spend eating and sleeping as well.

"The breakfast is the most important, but the lunch is so important, too, I think the regularity, and that in the evening, or in the afternoon don't let them eat too much, already, and not with fulfilled stomach go to the bed. And eat five times per a day." (Hungary.03)

Most teachers pointed out the responsibility that parents have concerning children's eating habits. According to some teachers, parents must control when and how much children eat, advising that children do not eat too late or too much (especially before going to bed).

"[…]We always ask the parents` association about what should be offered the children […]and the range of sweets, there was something once offered,

was really reduced. I think there is now almost nothing from the sweets left on offer. So full-grain rolls, things like that. Whereupon I must say it a cost aspect, but children can also bring that from home. Yes? I mean I do not have to pay €1.50 for a roll. If parents pay attention to it, then they can also give children something healthy to take with them." (Germany.04)

It was apparent from the interviews that many teachers were speaking from their own personal experience as parents, rather than their professional experience as teachers. Teachers often referred to their observations of the effects of diet on their own children. In many cases these views were based on their experience of the long term effects of diet on children' growth and development, both physical and mental.

"*I think probably from a parent's point of view, I know my son, when he was younger, he wasn't allowed fizzy drinks because it would make him quite hyperactive. And now he's 14, he's okay with that. He still doesn't have a lot, but occasionally he will have fizzy drinks and he's okay with it. So I think as he's got bigger and taller…"* (England.16)

In summary, teachers of children aged 4-10 years in all four countries spoke of the effects of diet in terms of effects on energy levels and how a lack of energy affects both attention and concentration. Effects on mood and behaviour were perceived to be some of the short-term mental effects of diet on children. Negative effects were generally associated with what teachers categorised as unhealthy foods (junk food, sweets, fizzy drinks, etc.) or with missing a meal. In contrast vegetables and fruits were categorised as healthy foods and teachers perceived that having a balanced diet (eating a range of foods, in correct proportion to age) is positive and will avoid the intake of supplements.

Hence teachers highlighted the importance of children having proper eating habits, which will determine their health in adult life. In terms of performance teachers consider breakfast as the most important meal of the day, affecting children's energy levels and consequently their ability to concentrate.

6.4. DISCUSSION

There are a considerable number of studies on the effects of nutrition-related programmes in improving the cognitive function of children, mostly supported by national governments[28-30]; but very few include reports on the beliefs or understanding of teachers on this topic.

Schools represent a unique opportunity to educate children about nutrition and its relationship to life-long health. Children can spend anywhere from six to ten hours per day in the school environment, so teachers are in a unique position to observe the effects of school health programs through diet[18] as well as to influence children's knowledge and understanding of the relationship between nutrition and development.

To our knowledge this is the first study to examine qualitatively teacher's beliefs and perceptions of the effects of diet on mental performance, in four European countries. This provides a unique opportunity to understand teacher's attitudes to nutrition, which in turn may highlight areas requiring further professional development and training.

In all four countries most teachers viewed nutrition as an important factor for children's physical growth and development, with implications for children's future health. Teachers did not refer specifically to the role of nutrition in brain development but did associate diet with both school performance and behaviour. This is in keeping with evidence from other studies undertaken with school-aged

children that pointed to a direct correlation between poor nutrition and lowered school performance[8, 31].

In speaking of the effects of diet on performance teachers referred to the effects on levels of mental energy, with teachers highlighting that students need adequate nutrition to concentrate during the school day. The scientific community in terms of physical work or energy output[32] has defined mental energy traditionally and the general public recognise mental energy as being essential for accomplishing daily activities and for the quality of life and health[33]. Participants perceived that children who arrived at school fasting, were negatively affected in their ability to concentrate and consequently to learn. Teachers tended to identify differences between some children in attention, memory, comprehension and learning. Evidence shows that maintaining optimal levels of glucose in the bloodstream, or more specifically, increasing a low level of glucose, increases the chances of cognitive engagement[5]. There is strong evidence that nutrition, specifically adequate levels of glucose in the body, is directly related to attention and working memory tasks[34-35]. Other research[36-37] has compared the performance of adequately nourished children to malnourished children and confirmed that one's academic performance can be affected by nutritional intake i.e. nutrition has a role affecting human cognitive function[13].

It was clear that teachers have knowledge and understanding of the effects of diet on mental performance and they recognise the effects of children being hungry or lacking mental energy.

Teachers in all countries identified the need for children to have a balanced diet, which includes food from several food groups. They related healthy nutritional intake with having a variety of fruits, vegetable, meats and fish and avoiding excessive amounts of sweets, crisps and processed foods[38]. They frequently expressed their

concern about children's need for healthy lifestyles and good eating habits and referred to the negative impact of skipping a meal, particularly breakfast. They perceived that an inadequate daily intake of nutrients from food has an adverse effect on learning highlighting that it is one of the main reasons for children being distracted and lacking in concentration. This is evidenced in the literature where skipping a meal negatively affected children's psychological functions like speed and accuracy of information retrieval in working memory tasks[39].

Teachers also observe that those children who skip breakfast have attention problems, particularly in performing tasks in late-morning. Children get tired more quickly and teachers notice that they are slow in solving problems and even in undertaking easy tasks. This relates directly to the idea of breakfast consumption as a positive eating habit that has an impact on children's cognitive function[37-38, 40-41].

In many of the interviews it became apparent that teachers' views were influenced by their observations and experiences as parents, rather than their professional training or experience. The development of a professional identity is considered an important element in teacher education[42] and it may be useful to consider identity in understanding teachers' attitudes to nutrition in general and more specifically to the role of diet in mental performance.

The present study has certain limitations in its methodological approach because it relies on interpreting the differences between the opinions of participants in multiple social contexts, in terms of socio-demographics, knowledge, awareness or other values. Participants volunteered for the study, thus the sample may not be representative of the wider community of teachers. Their responses could be subject to social desirability that may influence the extent to which teachers accurately report attitudes and beliefs. In addition teachers have little control over what children eat and to some extent can only speculate on the content of children's diet.

Systems of school food provision vary across Europe but evidence from this study indicates that teachers in all four countries recognised the importance of what children eat in terms of their mental performance. It is important that schools give due consideration to the food they provide for children and work closely with parents to achieve a healthful food environment in school. Consideration of the impact on mental performance and consequently educational attainment is equally important and this study highlights the significant contribution teachers can make to this debate.

6.5. REFERENCES

1. Tomlinson D, Wilkinson H, Wilkinson P. Diet and Mental Health in Children. Child Adolesc Ment Health. 2009; 14(3):148–155.
2. Benton D. The influence of children's diet on their cognition and behaviour. European Journal of Nutrition. 2008; 47(3):25–37.
3. Haapala EA, Eloranta AM, Venalainen T, et al. Associations of diet quality with cognition in children – the Physical Activity and Nutrition in Children Study. British Journal of Nutrition. 2015; 114:1080-1087.
4. Associate Parliamentary Food and Health Forum. The Links between Diet and Behaviour: The influence of nutrition on mental health (on-line). Available at:
5. http://www.foodforthebrain.org/media/229766/FHF.pdf/ . Accessed December 23, 2015.
6. Bellisle F. Effects of diet on behaviour and cognition in children. British Journal of Nutrition. 2004; 92(2):S227-S232.
7. Schmitt JA, Benton D, Kallus KW. General methodological considerations for the assessment of nutritional influences on human cognitive functions. European Journal of Nutrition. 2005; 44(8):459–464.
8. Valdez P, Reilly T, Waterhouse J. Rhythms of Mental Performance. Mind, Brain, and Education. 2008; 2(1):7-16.
9. Florence MD, Asbridge M, Veugelers PJ. Diet Quality and Academic Performance. Journal of School Health. 2008; 78(4):209–215.

10. Warthon-Medina M, Moran VH, Stammers A-L, et al. Zinc intake, status and indices of cognitive function in adults and children: a systematic review and meta-analysis. European Journal of Clinical Nutrition. 2015; 69:649-661.
11. Drummond CE. Using nutrition education and cooking classes in primary schools to encourage healthy eating. Journal of Student Wellbeing. 2010; 4(2):43-54.
12. Benton D, Parker PY. Breakfast, blood glucose, and cognition. American Journal of Clinical Nutrition. 1998; 67(4):772-778.
13. Littlecott HJ, Moore GF, Moore L, et al. Association between breakfast consumption and educational outcomes in 9–11-year-old children. Public Health Nutrition. 2015; 13(1):1-8.
14. Benton D. The influence of dietary status on the cognitive performance of children. Molecular Nutrition & Food Research. 2010; 54(4):457-470.
15. Morgan PJ, Hansen V. Physical education in primary schools: Classroom teachers' perceptions of benefits and outcomes. Health Education Journal. 2008 67: 196-207.
16. Sancho-Garnier H, Pereira B, Césarini P. A Cluster Randomized Trial to Evaluate a Health Education Programme “Living with Sun at School”. International Journal of Environ-mental Research and Public Health. 2012; 9(7):2345-2361.
17. Bucher Della Torre S, Arké C, Suris JC. Obesity Prevention Opinions of School Stakeholders: A Qualitative Study. Journal of School Health. 2010; 80(5):233-239.
18. Fisher C, Nicholas P, Marshall W. Cooking in schools: rewarding teachers for inspiring adolescents to make healthy choices. Nutrition Bulleting. 2011; 36:120-123.
19. Mensink F, Schwinghammer SA, Smeets A. The Healthy School Canteen programme: a promising intervention to make the school food environment healthier. Journal of Environmental and Public Health. 2012; 2012:415746.
20. Rosario R, Oliverira B, Araujo A, et al. The Impact of an Intervention Taught by Trained Teachers on Childhood Overweight. International Journal of Environmental Research and Public Health. 2012; 9(4):1355-1367.
21. Who European Action Plan for Food and Nutrition Policy 2007-2012 (on-line). Available at: http://www.euro.who.int/__data/assets/pdf_file/0017/74402/E91153.pdf/. Accessed January 11, 2016.

22. Who European Food and Nutrition Action Plan 2015–2020 (on-line). Available at: http://www.euro.who.int/__data/assets/pdf_file/0008/253727/64wd14e_FoodNutAP_140426.pdf . Accessed January 11, 2016.
23. Brands B, Egan B, Györei E, et al. A qualitative interview study on effects of diet on children's mental state and performance. Evaluation of perceptions, attitudes and beliefs of parents in four European countries. Appetite. 2012; 58(2):739-746.
24. Egan B, Gage H, Williams P, Brands B, Gyorei E, Lopez-Robles J-C, Campoy C, Desci T, Koletzko B & Raats, M. The effect of diet on the physical and mental development of children: views of parents and teachers in four European countries. British Journal of Nutrition. 2016
25. Leite CT, Machado Mde F, Vieira RP, et al. The school health program: teachers' perceptions. Nursing Research and Education. 2015; 33(2):280-287.
26. Braun V, Clarke V. Using thematic analysis in psychology. Qualitative Research in Psychology. 2006; 3(2):77-101.
27. Patton MQ. Enhancing the quality and credibility of qualitative analysis. Health Services Research Journal. 1999; 34(5):1189-1208.
28. Graneheim UH, Lundman B. Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. Nurse Education Today. 2004; 24(2):105-112.
29. Bundy D, Shaeffer S, Jukes M, et al. School-based Health and Nutrition Programs. In Jamison, D.T., Breman, J.G., Measham, A.R., et al., eds. Disease Control Priorities in Developing Countries. Washington (DC): World Bank; 2006:1091-1108.
30. Cullen KW, Hartstein J, Reynolds KD, et al. Improving the School Food Environment: Results from a Pilot Study in Middle Schools, Journal of the American Dietetic Association. 2007; 107(3):484-489.
31. Moore L, Moore GF, Tapper K, et al. Free breakfasts in schools: design and conduct of a cluster randomised controlled trial of the Primary School Free Breakfast Initiative in Wales. BMC Public Health. 2007; 7:258.

32. Hughes D, Bryan J. The assessment of cognitive performance in children: considerations for detecting nutritional influences. Nutrition Reviews. 2003; 61(12):413-422.
33. Wesnes KA, Barrett ML, Udani JK. An evaluation of the cognitive and mood effects of an energy shot over a 6h period in volunteers: a randomized, double-blind, placebo controlled, cross-over study. Appetite. 2013; 67:105-113.
34. Cook DB, Davis JM. Mental energy. Defining the science. Nutrition Reviews. 2006; 64(7Pt2):S1.
35. Smith AP, Clark R, Gallagher J. Breakfast cereal and caffeinated coffee: effects on working memory, attention, mood, and cardiovascular function. Physiology & Behavior. 1999; 67(1):9-17.
36. McLaughlin M, McGrath DJ, Burian-Fitzgerald MA, et al. *Student Content Engagement as a Construct for the Measurement of Effective Classroom Instruction and Teacher Knowledge*. Washington (DC): American Institutes for Research; 2005:1-45.
37. Kar B, Rao S, Chandramouli B. Cognitive development in children with chronic protein energy malnutrition. Behavior Brain Functions. 2008; 4:31.
38. Din NU, Moore GF, Murphy S, Wilkinson C, Williams NH. Health professionals' perspectives on exercise referral and physical activity promotion in primary care: Findings from a process evaluation of the National Exercise Referral Scheme in Wales. Health Educ J. 2015 Nov;74(6):743-757.
39. Pérez-Rodrigo C, Aranceta J. School-based nutrition education: lessons learned and new perspectives. Public Health Nutrition. 2001; 4(1A):131-139.
40. Pollitt E. Does breakfast make a difference in school? Journal of the American Dietetic Association. 1995; 95(10):1134-1139.
41. O'Sullivan TA, Robinson M, Kendall GE, et al. A good-quality breakfast is associated with better mental health in adolescence. Public Health Nutrition. 2008; 12(2):249-58.
42. Hoyland, A., Dye, L. and Lawton, C.L. A systematic review of the effect of breakfast on the cognitive performance of children and adolescents. Nutrition Research Reviews. 2009; 22, 220–243.

43. Friesen, M.D. and Besley, S.C. (2013) Teacher identity development in the first year of teacher education: A developmental and social psychological perspective. Teaching and Teacher Education. 2013; 36, 23-32.

7. Summary / Resumen

7.A. SUMMARY

The present work aims to qualitatively and quantitatively examine the current consumers' perceptions and beliefs of the relationship between what children eat and their mental development, state and performance. The research was divided into three studies, carried out in four European countries and funded within the framework of the NUTRIMENTHE project which aims to further our understanding and knowledge of the effect of nutrition on the mental development and performance in children.

Understanding the relationship between nutrition and mental performance in children is important in terms of their attainment and productivity both in school and later life. Since parents are seen as nutritional gatekeepers with responsibility for their children's diets, their views and beliefs are of crucial importance.

In this study, parents and teachers of primary school children perceive that diet is a less important determinant of mental than physical development. Furthermore diet is seen as a less important influence on mental performance than factors such as sleep and the quality of teaching. In our studies in four European countries this is true for a higher proportion of parents than teachers. Parents rely largely on their own experience when choosing food for their children and rate the healthiness of food as the most important influence on those choices. Also some country differences emerged from our results, particularly for parents, but these must be interpreted with caution given the large sample size whereby small differences become statistically significant.

These findings have public health policy implications. Promoting the importance of diet for mental performance is important to address those consumers who are less health conscious. But there is a need for a broad deep evidence base before

messages and interventions can be developed to reduce the level of scientific uncertainty in this domain. Furthermore, before making decisions about developing interactions and strategy as for messages to be effective there is a need to know how parents and teachers relate food consumption to the mental performance.

This Doctoral Thesis represents a number of significant findings from one of the first multicentre studies of parents' and teachers' perceptions of how nutrition may have an influence on childrens' mental performance. With this work we have addressed a number of gaps in the research to date of consumers' knowledge about the role of nutrition in childrens' development and the associated health implications. Our findings highlight the importance of understanding the differences in views between different groups of parents and other groups of the population such as teachers to appropriately target public health messages. People's perceptions of children's physical or mental development tends to focus on genetics and biological factors but it is also necessary to think of factors influencing general human growth such as the environment and the social context (6).

The first significant result which emerges from our data is that having an interest in healthy eating and higher educational attainment was related to regarding diet as an important influence on children' mental development. Parents need to be aware of the critical central role that they play in childhood development in terms of nutrition because they shape child-feeding behaviours, , which in combination with genetic and environmental factors help to establish food preferences (7). In this sense, socio-economic status (SES) is an important factor to be taken into account by researchers when screening childhood dietary quality in so much as it impacts on individual's social position and can be connected through diverse indicators such as educational achievement, future occupation or income (8).

Socio-economic differences exist in parental lay knowledge about food and SES studies reflect that higher income parents talk about food in relation to health and medical issues (9,10). Parents from higher socio-economic areas had better nutrition knowledge than those from areas with lower socio-economic level (11). Nutrition and dietary behaviours were considered by parents in our study less important factors than sleep, exercise and the school environment for attention and learning. Parents' nutrition knowledge is likely a reflection of the importance they place on these topics and their interest in health and nutrition (12). They tend to discuss the effects of diet in terms of long term health and medical outcomes rather than the link between diet and mental performance (4).

A comparison between our findings and those from other studies with consumers reveals that understanding parents' and teachers' views of the importance of diet in the mental development of children is essential before developing meaningful messages and dietary change interventions because they have a basic knowledge about what foods are healthy and they expressed an interest and concern about nutrition related to health (13). On the one hand, the effects of diet during childhood were related primarily to physical development, with positive effects in the long term, rather than cognitive processes like attention or concentration allied to mood and behaviour. On the other hand, negative effects were perceived to be more immediate and short term, and associated with specific foods and nutrients. A possible explanation for this might be that information on food labels and nutrition is an important source typically underutilized by consumers (14) and they need further knowledge on long and short term effects of foods on human development, from childhood to adolescence.

Other studies have found parents not to be receptive to interventions aimed at specifically changing dietary behaviour, but are more motivated to engage in healthy

behaviours and positive health beliefs within the family setting (15,16). This could reflect the need to educate parents to be aware of the effects of foods on mental performace through building public awareness strategies, of nutrition and the health qualities of foods and their effects. These findings of the current study are ancillary with those that reflect the degree of worry that parents can feel about children's body weight that may sometimes influence them to take steps and, for example, try to prevent obesity in their child. Identifying what factors parents think that may influence childrens' health is necessary in order to design health care system interventions that will engage parents and motivate them to take action (17). Effective communication on these topics related to health, and specifically on nutrition, require a basic level of knowledge that the intended audience may be misundertanding.

On the question of parents' food choices for their children, with this study we have found that participants' decisions about this topic were less influenced by media sources than by health professionals. These results are in contrast with recent studies about the influence of advertising on childrens' cravings and parents food choices (18,19) that underline the effects of many factors, including media sources, affecting their relationship with food consumption and their childrens meals demands. In our study parents reported relying mainly on their own experience and common sense so innovative methods of getting messages over may need to be identified. Parental influences on children's food choices and intake have an effect on individual and family practices, and operate among other mechanisms via availability and accessibility of foods or parental eating behaviour as food modelling (20,21). Parents should offer a variety of foods exposing them to healthy food options or serve as role models for healthy eating and active lifestyles (22).

The results in the qualitative work reveal that teachers did not refer directly to the role of nutrition in brain development but they associated diet with both school performance and behaviour. This can be linked to the results in the same research with parents where they spoke in terms of *attention* and *concentration* when they were asked about the effects of diet (4). Teachers in our study perceived that an inadequate daily intake of nutrients from food has an adverse effect on learning, highlighting that it is one of the main reasons for children being distracted and lacking concentration. School staff have been involved in nutritional behaviour studies as assistants, helping medical doctors and psychologists to measure and report some data (23) but they are often in a passive position and do not have an active role in the research. In many of the interviews it became apparent that teachers' view were influenced by their observations and experiences as parents, rather than their professional training or experience. In educating children about healthy eating teachers strive to promote an ideal optimal nutritional balance, which ensures that children can perform well, both in terms of development and performance. Of the many factors that can influence eating behaviours, a lack of nutrition knowledge is one of the most amenable to change (24).

Comparisons among the four countries in the questionaire revealed significant differences in some characteristics of the respondents' views, especially among parents. They perceive many factors having an influence on healthy or unhealthy food choices (25). From our results, the reason for this is not clear but it may have something to do with socio-cultural factors: for example, in Germany *providing variety* was significantly less important to parents but the most important factor in parents food choice in Spain. It was also shown that, in contrast with results from England or Germany, parents in Hungary generally prioritised elements of mental performance. A comparison with the results from the card sorting study (5) reveals

that parents in Hungary attributed greater importance to diet in physical and mental development of their children than respondents in the other countries. This rather contradictory result from the same Project may be due to the kind of methodology applyed for each intervention, emphasising the need of making consumers aware of the positive effects of promoting a healthy lifestyle.

7.B. RESUMEN (SPANISH)

El objetivo del presente trabajo es examinar cualitativa y cuantitativamente las percepciones y creencias actuales de los consumidores sobre la relación entre lo que comen los niños y su desarrollo mental. La investigación se dividió en tres estudios realizados en cuatro países europeos y financiados en el marco del proyecto NUTRIMENTHE, cuyo objetivo es profundizar en la comprensión y conocimiento del efecto de la nutrición sobre el desarrollo mental y el rendimiento en los niños.

Comprender la relación entre la nutrición y el rendimiento mental en los niños es importante en términos de los logros y la productividad del niño, tanto en la escuela como en la vida posterior. Dado que los padres son vistos como *guardianes nutricionales* siendo responsables de las dietas de sus hijos, sus opiniones y creencias son de crucial importancia.

En este estudio, los padres y los maestros de niños de educación primaria perciben que la dieta es un factor menos importante del desarrollo mental en contraposición a nivel físico. Además, la dieta se considera una influencia menos importante en el rendimiento mental que otros factores como el sueño y la calidad de la enseñanza. En nuestros estudios en cuatro países europeos esto es cierto para una mayor proporción de padres que de maestros. Los padres dependen en gran medida de su propia experiencia al elegir la comida para sus hijos y establecen los alimentos saludables como lo más determinante. También surgieron algunas diferencias entre países, especialmente si nos fijamos en los padres, aunque éstas deben ser interpretadas con precaución por el tamaño muestral, por lo que las pequeñas diferencias se vuelven estadísticamente significativas.

Estos hallazgos tienen implicaciones en las políticas de salud pública. Promover la importancia de la dieta para el rendimiento mental es crucial para atender a los consumidores que son menos conscientes de la salud. Pero, para reducir el nivel de incertidumbre en éste ámbito, es necesario ampliar profundamente la base de evidencias científicas antes de desarrollar mensajes e intervenciones concretas. Además, es necesario saber cómo padres y profesores relacionan el consumo de los alimentos con el rendimiento mental, antes de tomar decisiones sobre el desarrollo de las interacciones y la estrategia en cuanto a los mensajes para que éstos sean eficaces.

Esta tesis doctoral representa una serie de hallazgos significativos de uno de los primeros estudios multicéntricos sobre la percepción de padres y profesores acerca de cómo la nutrición puede influir en el rendimiento mental de los niños. Con este trabajo hemos abordado una serie de lagunas en investigación sobre el conocimiento de los consumidores acerca del papel de la nutrición en el desarrollo de los niños y las consecuencias sanitarias asociadas. Los resultados ponen de relieve la importancia de comprender las opiniones entre los diferentes grupos de padres y otros grupos de la población, como los profesores, para dirigir adecuadamente los mensajes de salud pública. La percepción de las personas sobre el desarrollo físico o mental de los niños tiende a centrarse en factores genéticos y biológicos, pero también es necesario pensar en factores que influyen en el crecimiento humano general, como el medio ambiente y el contexto social.

El primer resultado significativo que se desprende de nuestros datos es que el interés en una alimentación sana y un mayor nivel educativo está relacionado con la dieta como un factor que influencia en el desarrollo mental de los niños. Los padres deben ser conscientes del papel crítico central que desempeñan en el desarrollo infantil en términos de nutrición, ya que dan forma a los comportamientos de

alimentación infantil, que en combinación con factores genéticos y ambientales, ayudan a establecer las preferencias alimentarias de los niños (7). En este sentido, el estatus socioeconómico (SES) es un factor importante que los investigadores deben tener en cuenta al evaluar la calidad dietética de la infancia, ya que afecta la posición social del individuo y puede ligarse a otros indicadores como los logros educativos, la ocupación o los ingresos futuros (8).

Existen diferencias socioeconómicas en el conocimiento acerca de los alimentos que tienen los padres y estudios sobre los SES reflejan que los padres con mayores ingresos hablan de los alimentos en relación con problemas médicos y de salud (9, 10). Los padres de zonas socioeconómicas superiores tenían mejores conocimientos nutricionales que los de las zonas de menor nivel socioeconómico (11). La nutrición y el comportamiento dietético fueron considerados por los padres en nuestro estudio como factores menos importantes para la atención y el aprendizaje en comparación con el sueño, el ejercicio y el entorno escolar. El conocimiento de los padres sobre nutrición es probablemente un reflejo de la importancia que atribuyen a este tema y su consecuente interés por la salud y la nutrición (12). Estos padres tienden a discutir los efectos de la dieta en términos de salud a largo plazo y los resultados médicos en lugar de la relación entre la dieta y el rendimiento mental (4).

Comparado estos hallazgos y los de otros estudios con consumidores se revela que la comprensión de los padres y maestros sobre la importancia de la dieta en el desarrollo mental de los niños es esencial antes de dar mensajes significativos e intervenciones para fomentar un cambio de dieta, ya que tienen conocimientos básicos sobre alimentos saludables y, de alguna forma, expresaron interés y preocupación por la nutrición como factor de salud (13). Por un lado, los efectos de la dieta durante la infancia se relacionaron principalmente con el desarrollo físico, con efectos positivos a largo plazo, en lugar de procesos cognitivos como atención o

concentración ligada al estado de ánimo y comportamiento. Por otro lado, los efectos negativos fueron percibidos como más inmediatos y a corto plazo, asociados a alimentos y nutrientes específicos. Una posible explicación a esto podría ser que la información sobre las etiquetas de los alimentos y la nutrición es una fuente importante que suele ser ignorada por los consumidores (14) y éstos necesitan más conocimientos sobre los efectos a corto y largo plazo de los alimentos en el desarrollo humano.

Otros estudios han encontrado que los padres no son receptivos a intervenciones dirigidas específicamente a cambiar el comportamiento alimenticio, pero están más motivados para participar en actividades sobre comportamientos saludables y creencias positivas de salud dentro de la familia (15,16). Esto podría reflejar la necesidad de educar a los padres para que sean conscientes de los efectos de los alimentos sobre el desarrollo mental, a través de la construcción de estrategias de concienciación pública, sobre nutrición, las cualidades sanitarias de los alimentos y sus efectos. Los hallazgos del presente estudio son complementarios con aquellos que reflejan el grado de preocupación que los padres pueden sentir sobre el peso de los niños, ya que a veces puede influir en ellos para tomar medidas como, por ejemplo, al tratar de prevenir la obesidad en un hijo. Identificar los factores que los padres piensan que pueden influir en la salud de los niños es necesario para diseñar intervenciones en el sistema sanitario que involucren a los padres y los motiven a tomar medidas (17). La comunicación efectiva sobre estos temas de salud, y específicamente sobre la nutrición, requiere que su público objetivo tenga un nivel básico de conocimiento del para evitar malinterpretaciones.

Con respecto a la elección de los alimentos que hacen los padres para sus hijos, con este estudio hemos encontrado que las decisiones de los participantes sobre este tema estaban menos influenciadas por los medios de comunicación que por los

profesionales de la salud. Estos resultados contrastan con estudios recientes sobre la influencia de la publicidad en los antojos de los niños y las opciones alimentarias de los padres (18,19) que subrayan la influencia de muchos otros factores, incluyendo los medios, afectando en su relación con el consumo de alimentos y las peticiones de sus hijos. En nuestro estudio, los padres informaron que confiaban principalmente en su propia experiencia y sentido común, por lo que es necesario identificar nuevos métodos innovadores para transmitir mensajes sobre este tema. La influencia de los padres en las elecciones de alimentos y la ingesta que hacen los niños tienen un efecto sobre las prácticas individuales y familiares, y operan entre otros mecanismos a través de la disponibilidad y accesibilidad a los alimentos o del comportamiento de los padres como modelo de alimentación (20,21). Los padres deben ofrecer una variedad de alimentos saludables o servir como modelos de una alimentación saludable y estilos de vida activos (22).

Los resultados del trabajo cualitativo revelan que los maestros no se referían directamente al papel de la nutrición en el desarrollo del cerebro, sino que asociaban la dieta con el rendimiento escolar y el comportamiento. Esto se puede vincular a los resultados vistos en el mismo proyecto con respecto a la visión de los padres, donde éstos hablaron en términos de *atención* y *concentración* cuando se les preguntó acerca de los efectos de la dieta (4). Los maestros en nuestro estudio percibieron que una ingesta diaria inadecuada de nutrientes tiene un efecto adverso en el aprendizaje, destacando que es una de las principales razones para que los niños se distraigan y pierdan la concentración. En otros estudios, el personal de la escuela ha participado como ayudantes, asistiendo a médicos y psicólogos en las mediciones e informando sobre algunos datos (23), pero a menudo están en una posición pasiva y no tienen un papel activo en la investigación. En muchas de las entrevistas se hizo evidente que la opinión de los maestros estaba influenciada por sus observaciones y

experiencias como padres, más que por su formación o experiencia profesional. Al educar a los niños sobre la alimentación saludable, los maestros se esfuerzan en promover un equilibrio nutricional óptimo, lo que garantiza que los niños puedan desarrollarse bien, tanto a nivel físico como intelectual. De los muchos factores que pueden influir en los comportamientos alimentarios, la falta de conocimiento nutricional es uno de los más susceptibles de cambio (24).

Comparando entre los cuatro países participantes, en el cuestionario se revelaron diferencias significativas en algunas características de las opiniones de los encuestados, especialmente entre los padres. Se perciben muchos factores que influyen en las opciones de alimentos saludables o no saludables (25). A partir de nuestros resultados, la razón de esto no está clara, pero puede tener algo que ver con los factores socioculturales: por ejemplo, en Alemania la variedad de alimentos era de menor significación para los padres, pero éste era el factor más importante en la elección de alimentos según los padres en España. También se demostró que, en contraste con los resultados de Inglaterra o Alemania, los padres en Hungría, por lo general, priorizan aquellos elementos que influyen en el rendimiento mental. Comparando estos resultados con los del estudio de clasificación por cartas del mismo proyecto (5) se revela que los padres en Hungría atribuyeron mayor importancia a la dieta en el desarrollo físico y mental de sus hijos que los encuestados en los otros países. Este resultado contradictorio dentro del mismo Proyecto puede deberse al tipo de metodología aplicada para cada intervención, haciendo hincapié en la necesidad de sensibilizar a los consumidores sobre los efectos positivos de la promoción de un estilo de vida saludable.

7.1. REFERENCES

1. Taylor RM, Gibson F, Franck LS. A concept analysis of health-related quality of life in young people with chronic illness. J Clin Nurs. 2008;17:1823–33.

2. Van Vuuren M, Botes A. Concept analysis of reflective thinking. Curationis. 1999;22:25–35.

3. Campos CJG, Turato ER. Content analysis in studies using the clinical-qualitative method: application and perspectives. Rev Lat Am Enfermagem. 2009;17:259–64.

4. Brands B, Egan B, Györei E, López-Robles JC, Gage H, Campoy C, et al. A qualitative interview study on effects of diet on children's mental state and performance. Evaluation of perceptions, attitudes and beliefs of parents in four European countries. Appetite. 2012;58:739–46.

5. Gage H, Egan B, Williams P, Györei E, Brands B, López-Robles JC, et al. Views of parents in four European countries about the effect of food on the mental performance of primary school children. Eur J Clin Nutr. 2014;68:32–7.

6. Giannopulu I, Escolano S, Cusin F, Citeau H, Dellatolas G. Teachers' reporting of behavioural problems and cognitive-academic performances in children aged 5-7 years. Br J Educ Psychol. 2008;78:127–47.

7. Nyaradi A, Li J, Hickling S, Foster J, Oddy WH. The role of nutrition in children's neurocognitive development, from pregnancy through childhood. Front Hum Neurosci. 2013;7:97-113.

8. Fernández-Alvira JM, Mouratidou T, Bammann K, Hebestreit A, Barba G, Sieri S, et al. Parental education and frequency of food consumption in European children: the IDEFICS study. Public Health Nutr. 2013;16:487–98.

9. Coveney J. A qualitative study exploring socio-economic differences in parental lay knowledge of food and health: implications for public health nutrition. Public Health Nutr. 2015;8:290-7.

10. Delormier T, Frohlich KL, Potvin L. Food and eating as social practice - understanding eating patterns as social phenomena and implications for public health. Sociol Health Illn. 2009;31:215–28.

11. Zarnowiecki D, Sinn N, Petkov J, Dollman J. Parental nutrition knowledge and attitudes as predictors of 5–6-year-old children's healthy food knowledge. Public Health Nutr. 2012;15:1284–90.

12. Society R, Health P. Training and supporting adults who influence nutrition of children under five. Perspect Public Health. 2017;137:148–9.

13. Slusser W, Prelip M, Kinsler J, Erausquin JT, Thai C, Neumann C. Challenges to parent nutrition education: a qualitative study of parents of urban children attending low-income schools. Public Health Nutr. 2011;14:1833–41.

14. Miller LMS, Cassady DL. The effects of nutrition knowledge on food label use. A review of the literature. Appetite. 2015;92:207–16.

15. Hart KH, Herriot A, Bishop JA, Truby H. Promoting healthy diet and exercise patterns amongst primary school children: a qualitative investigation of parental perspectives. J Hum Nutr Diet. 2003;16:89–96.

16. McKee MD, Maher S, Deen D, Blank AE. Counseling to prevent obesity among preschool children: acceptability of a pilot urban primary care intervention. Ann Fam Med. 2010;8:249–55.

17. Moore LC, Harris C V, Bradlyn AS. Exploring the relationship between parental concern and the management of childhood obesity. Matern Child Health J. 2012;16:902–8.

18. Castronuovo L, Gutkowski P, Tiscornia V, Allemandi L. Las madres y la publicidad de alimentos dirigida a niños y niñas: percepciones y experiencias. Mothers food Advert Dir Child perceptions Exp. Salud Colectiva. 2016;12:537–50.

19. Lwin MO, Shin W, Yee AZH, Wardoyo RJ. A Parental Health Education Model of Children's Food Consumption: Influence on Children's Attitudes, Intention, and Consumption of Healthy and Unhealthy Foods. J Health Commun. 2017;22:403–12.

20. Vereecken CA, Keukelier E, Maes L. Influence of mother's educational level on food parenting practices and food habits of young children. Appetite. 2004;43:93–103.

21. Hebestreit A, Keimer KM, Hassel H, Nappo A, Eiben G, Fernández JM, et al. What do children understand? Communicating health behavior in a European multicenter study. J Public Health. 2010;18:391–401.

22. Hagan JF, Shaw JS, Duncan PM. Bright Futures: Guidelines for Health Supervision of Infants, Children, and Adolescents. 3rd ed. Elk Grove Village: American Academy of Pediatrics. 2008.

23. Grosso G, Mistretta A, Turconi G, Cena H, Roggi C, Galvano F. Nutrition knowledge and other determinants of food intake and lifestyle habits in children and young adolescents living in a rural area of Sicily, South Italy. Public Health Nutr. 2013;16:1827–36.

24. Campbell KJ, Hesketh KD. Strategies which aim to positively impact on weight, physical activity, diet and sedentary behaviours in children from zero to five years. A systematic review of the literature. Obes Rev. 2007;8:327–38.

25. Bau A, Krull S, Ernert A, Babitsch B. Eating behaviour and its association with social living conditions and weight status among adolescent girls : results of the cross-sectional Berlin School Children ' s Cohort study. Public Health Nutr. 2011;14:1759–67.

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8. Social impact and future research

8. SOCIAL IMPACT AND FUTURE RESEARCH

Early childhood has become a focal point for many government health promotion programmes (1). Development of good eating habits are crucial in children to avoid both short-term and long-term negative effects on health and well- being, including elements of mental performance such as attention and working memory (2).

A reasonable approach to tackle this issue could be developping actions at different levels: from family to high school and universities, but also involving social environment with easy and simple messages. One example of this type of intervention is the German health initiative “Trinken im Unterricht” that promotes good hydration of children in order to be able to concentrate well. Promoting both physical and mental performance through several public health initiatives and providing small changes in childrens’ environment can easily improve healthy habits. These kinds of interventions suggest several courses of action for improving mental function that has a huge economic potential. Small improvements in cognitive skills can have very large impacts on a nations’ future well-being (3).

School food policy is potentially an important element of the public health agenda in the European area. In the UK, school food standards have been compulsory since September 2013 in all primary and secondary schools (4,5). In Spain, the National Government adheres to the NAOS Global Strategy, providing recommendations to schools on foods standards but schools meals are not regulated. In Hungary all schools offer canteens for the children but parents can choose to give their children homemade meals. In Germany the Federal Ministry of Food, Agriculture and Consumers Protection is promoting the ‘In Form’ national initiative to improve healthy diets and physical activity (6,7). The positive environment created in schools has the potential to influence attitudes, beliefs and behaviours (8).

Advances in school food have been shown to have an impact both within and beyond the school domain (9) but require evaluation beyond that of nutritional status alone. Consideration of the impact on mental performance and consequently educational attainment is equally important and this study highlights the significant contribution teachers can make to this debate.

Another important level to think about is how food packaging and brands are influencing consumers' decisions during food shopping. It has been demonstrated that advertising and food branding have a strong influence on children when they are choosing what to eat (10), so parents are constantly faced with their childrens' cravings and pressures. Consumers are nowadays accustomed to identifying invasive marketing campains but they cannot always control their children's environment to prevent them being exposed to adverts. In this sense, it is difficult for parents to offset the constant media blitz about some unhealthy foods, so they give up a few times and integrate those foods as a reward for their children (11,12).

The use of Nutrition and Health (NH) claims is becoming widespread since they are operating as influential tools for consumer interaction providing information about food characteristics or benefits (13). As consumers, parents preference for NH claims may be an influence, given their responsibility for food shopping at home, and facilitate well-informed food choices. Systematic comparisons of consumer perceptions across different health benefits and claim types have received limited academic attention (14). Relating to this point, the role of the consumer has become a much more prominent feature in the EU legislation to ensure that NH claims are truthful, relevant and understood by consumers and the WHO proposes in it last Global Plan (15) the restriction of food and non-alcoholic beverages advertising directed to children and adolescents.

Findings in this Doctoral Thesis need to be interpreted in light of some methodological limitations starting with the geographical spread across Europe. Although the number of participants was hight, it may not be representative of the general population in each country; however, participants recruited reflected socio-economically diverse catchment areas. Since participants volunteered for the study, the sample may not be representative of the community of consumers in terms of socio-demographics, knowledge and awareness or other values. The results do not claim to reflect an exhaustive census, but they are useful for revealing meaningful patterns. Further research is needed to identify which dissemination strategies are most effective in reaching parents and teachers in different cultural settings and social, economic and ethnic groups and investigators should also consider the eating contexts when designing future programmes and interventions that target dietary behaviours and food consumption (16).

Parents spoke predominantly of the effects of food on ‘‘attention’’ and ‘‘concentration’’, but often described these effects as being mediated by effects on mood and behaviour (17). They spoke about the characteristics and quantity of food and drinks such as positive effects, associated with children having healthy balanced diet (fruits, vegetables and wholegrain products) or negative effects from many unhealthy foods (sugar, fat chips, sweets, fast food, fizzy drinks and pizza), but they have difficulties conceptualising what is meant by mental performance. Mental performance has received increased attention from an educational and public health perspective and an interest in developing appropriate health strategies. With the emphasis on evidence-based policy, it is important that robust data regarding consumer views forms the starting point for exploring how, where needed, behaviour changes can be achieved.

A number of possible future studies using the same experimental setup are apparent to continue studying other factors influencing childrens' mental performance. The whole context of childrens' development could continue analysing how parents and teachers perceive that Physical Activity (PA) affects childrens' behavior in comparison with dietary intake. Targeting consumers to improve children's behaviours is necessary for prevention and treatment of children with overweight problems and is considered a feasible strategy (18,19). They should be proactively incorporate into PA each day and helping institutions and schools to promote healthy habits for life.

8.1. REFERENCES

1. Jomaa LH, McDonnell E, Probart C. School feeding programs in developing countries: impacts on children's health and educational outcomes. Nutr Rev. 2011;69:83–98.

2. Condon EM, Crepinsek MK, Fox MK. School Meals: Types of Foods Offered to and Consumed by Children at Lunch and Breakfast. J Am Diet Assoc. 2009;109:67–78.

3. Straub N, Grunert P, von Kries R, Koletzko B. Health economic potential of early nutrition programming: a model calculation of long-term reduction in blood pressure and related morbidity costs by use of long-chain polyunsaturated fatty acid-supplemented formula. Am J Clin Nutr. 2011;94:2030–35.

4. Regional Committee for Europe 64th Session. (2015) European Food Nutrition Action Plan. http://www.euro.who.int/__data/assets/pdf_file/0008/253727/64wd14e_FoodNutAP_140426.pdf?ua=1 (accessed May 2017)

5. Department for Education – Government of th United Kingdom (2017) Standards for school food in England https://www.gov.uk/government/publications/standards-for-school-food-in-england (accessed May 2017)

6. Adamson A, Spence S, Reed L, Conway R, Palmer A, Stewart E, et al. School food standards in the UK: implementation and evaluation. Public Health Nutr. 2013;16:968–81.

7. O'Dea JA, Wagstaff S. Increased breakfast frequency and nutritional quality among schoolchildren after a national breakfast promotion campaign in Australia between 2000 and 2006. Health Educ Res. 2011;26:1086–96.

8. Attuquayefio T, Stevenson RJ. A systematic review of longer-term dietary interventions on human cognitive function: Emerging patterns and future directions. Appetite. 2015;95:554–70.

9. Macnab A, Kasangaki A. 'Many voices, one song': a model for an oral health programme as a first step in establishing a health promoting school. Health Promot Int. 2012;27:63–73.

10. McGale LS, Halford JCG, Harrold JA, Boyland EJ. The Influence of Brand Equity Characters on Children's Food Preferences and Choices. J Pediatr. Elsevier Inc.; 2016;177:33–8.

11. Lwin MO, Shin W, Yee AZH, Wardoyo RJ. A Parental Health Education Model of Children's Food Consumption: Influence on Children's Attitudes, Intention, and Consumption of Healthy and Unhealthy Foods. J Health Commun. 2017;22:403–12.

12. Yee AZH, Lwin MO, Ho SS. The influence of parental practices on child promotive and preventive food consumption behaviors: A systematic review and meta-analysis. Int J Behav Nutr Phys Act. Intl J Behav Nutr Phys Act; 2017;14:47.

13. Leathwood PD, Richardson DP, Sträter P, Todd PM, van Trijp HCM. Consumer understanding of nutrition and health claims: sources of evidence. Br J Nutr. 2007;98:474–84.

14. Williams P. Consumer Understanding and Use of Health Claims for Foods. Nutr Rev. 2005;63:256–64.

15. Organización Mundial de la Salud. (2013) Plan de acción mundial para la prevención y el control de las enfermedades no transmisibles 2013-2020. http://www2.paho.org/hq/index.php?option=com_docman&task=doc_view&Itemid=270&gid=31439&lang=es (accessed May 2017)

16. Mak TN, Prynne CJ, Cole D, Fitt E, Roberts C, Bates B, et al. Assessing eating context and fruit and vegetable consumption in children: new methods using food diaries in the UK national diet and nutrition survey rolling programme. Int J Behav Nutr. Phys Act; 2012;9:126–41.

17. Brands B, Egan B, Györei E, López-Robles JC, Gage H, Campoy C, et al. A qualitative interview study on effects of diet on children's mental state and performance. Evaluation of perceptions, attitudes and beliefs of parents in four European countries. Appetite. 2012;58:739–46.

18. Demory-Luce D, Morales M, Nicklas T, Baranowski T, Zakeri I, Berenson G. Changes in food group consumption patterns from childhood to young adulthood: the Bogalusa Heart Study. J Am Diet Assoc. 2004;104:1684–91.

19. Raj M, Kumar RK. Obesity in children & adolescents. Indian J Med Res. Medknow Publications; 2010;132:598–607.

9. Conclusions / Conclusiones

9.A. CONCLUSIONS

Based on this set of studies, the following conclusions could be drawn. However, given the limitations of the recruitment performed in this study, these findings are not generally representative for all European countries.

1. Parents and teachers perceive diet as a more important factor in children's physical development rather than their mental performance. They both represent important target groups to communicate with and improve their awareness of the role of diet. This requires the provision of specific knowledge driven by public health strategies, with clear messages about the effects of nutrition on childrens' mental development.

2. Parents primarily rate the healthiness of diet to be important when choosing food for their children. They rate cost considerations, food variety, flavour and effects of food on energy levels ahead of effects on specific elements of mental performance.

3. Parents sometimes rely on health profesionals in order to make decisions about food choices for their children rather than information from media sources, but more often they still pay more attention to their own experience and common sense.

4. Teachers perceive that there is an important relationship between what children eat and their cognition during the school day. They recognise the effects of diet when children skip a meal, especially breakfast, given that food provides the physical and mental energy necessary for children to concentrate and pay attention in class.

5. Some cross-country differences were found related to geographical location, which may pertain mainly to cultural traditions, accounting for parents and teachers' dietary knowledge or beliefs.

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9.B. CONCLUSIONES (SPANISH)

Basándonos en este estudio, se pueden extraer las siguientes conclusiones. Sin embargo, dadas las limitaciones del reclutamiento en este estudio, estos hallazgos no son generalmente representativos para todos los países europeos:

1. Los padres y los profesores perciben la dieta como un factor importante en el desarrollo físico de los niños más que en el desarrollo mental. Ambos constituyen grupos importantes para comunicar y mejorar la concienciación sobre el papel de la dieta. Esto requiere de conocimientos específicos de impulsados por estrategias de públicas, con mensajes claros sobre los efectos de la nutrición en el desarrollo mental de los niños.

2. Los padres consideran principalmente una dieta saludable al elegir la comida para sus hijos. Tienen en cuenta el coste, la variedad, el sabor y los efectos de los alimentos sobre los niveles de energía antes que los efectos sobre elementos específicos del rendimiento mental.

3. Los padres a veces confían en los profesionales de la salud para decidir sobre la compra de alimentos para sus hijos en lugar de en los mensajes de los medios de comunicación, pero más a menudo prestan atención a su propia experiencia y sentido común.

4. Los maestros perciben que hay una relación importante entre lo que los niños comen y su cognición durante la jornada escolar. Reconocen los efectos de la dieta cuando los niños se saltan una comida, especialmente el desayuno, dado que proporciona la energía física y mental necesaria para concentrarse y prestar atención en clase.

5. Se han encontrado algunas diferencias entre países relacionadas con la ubicación geográfica, que pueden referirse principalmente a tradiciones culturales, teniendo en cuental los conocimientos o creencias alimentarias de padres y maestros.

10. Appendices

10.1. APPENDIX 1

PUBLICATIONS INCLUDED IN THE PRESENT THESIS

British Journal of Nutrition, page 1 of 9
doi:10.1017/S000711451500032X

The effect of diet on the physical and mental development of children: views of parents and teachers in four European countries

Bernadette Egan[1]*, Heather Gage[1], Peter Williams[2], Brigitte Brands[3], Eszter Györei[4], Juan-Carlos López-Robles[5], Cristina Campoy[5], Tamas Decsi[4], Berthold Koletzko[3] and Monique Raats[1]

[1]*Food, Consumer Behaviour and Health Research Centre, University of Surrey, UK*
[2]*Department of Mathematics, University of Surrey, Guildford, Surrey, UK*
[3]*Dr. von Hauner Children's Hospital, Ludwig-Maximilians University, Germany*
[4]*Department of Paediatrics, University of Pécs, Hungary*
[5]*Department of Paediatrics, University of Granada, Spain*

(Submitted 12 August 2014 – Final revision received 6 January 2015 – Accepted 12 January 2015)

Abstract

Although the impact of diet on physical health is an important public health issue, less attention has been devoted to the relationship between nutrition and children's mental development. The views of parents and teachers about the extent to which diet affects physical and mental development of children were compared in four European countries. An online questionnaire (developed in English and translated) was circulated through a market research agency. Participants were parents or teachers of children aged 4–10 years without learning or behavioural issues. Questionnaires were returned by 1606 parents (401 in England, Germany and Hungary; 403 in Spain) and 403 teachers (100 in each country, except for 103 in Hungary). Teachers were older than parents (35·3 % *v.* 18·3 % over 45 years; $P < 0·001$) and less likely to smoke (15·9 % *v.* 26·3 %, $P < 0·001$). There was no difference between the proportions of parents and teachers who felt that a child's physical development depended very much/extremely (*v.* moderately/slightly/not at all) on diet (overall 79·8 %). Lower proportions of both groups thought that mental development was very much/extremely influenced by diet (67·4 %). In the regression modelling, believing that physical and mental performance was greatly influenced by diet was significantly and positively associated with living in Hungary, scoring higher on a measure of General Health Interest and (parents only) level of education attained. Differences existed among countries in most views. Lower levels of awareness of the importance of diet for brain development and cognition (compared with physical health outcomes) indicate the potential for educating consumers, especially parents with lower educational attainment.

Key words: Diet: Development: Children

Perceptions and understanding of the impact of diet on the physical health of children is an important public health issue, particularly in the context of growing concerns about childhood obesity[1], but traditionally little attention has been paid to lay views about the relationship between nutrition and a child's mental development and performance[2]. Food and nutrition, however, have important and pervasive impacts on brain development and cognitive functioning through effects on brain cell structure, neurotransmission, brain energy supply and metabolism[3]. A balanced diet is, thus, important for mental as well as physical development, with implications for school performance, achievement in adulthood and lifelong health and well-being[4,5]. What parents and teachers believe about the relationship between nutrition and the mental development of children may affect their attitudes and behaviours regarding food provision for young people[6]. We explored their views in four European countries in order to identify gaps in awareness about the importance of nutrition for brain development and cognition, as well as the need for policies to improve public understanding.

Previously, we qualitatively examined the perceptions and beliefs of parents and teachers regarding the relationship between what children eat and their health and mental performance by conducting interviews in each of the four countries: England, Germany, Hungary and Spain[7]. The importance of developing good eating habits emerged as a concern for parents, as they

Disclaimer: This paper was published as part of a supplement to British Journal of Nutrition, publication of which was supported partially by UNILEVER, NUTRIMENTHE EU Project and an unrestricted educational grant from the University of Granada. The papers included in this supplement were invited by the Guest Editor and have undergone the standard journal formal review process. They may be cited.

Abbreviation: GHI, General Health Interest.

* **Corresponding author:** B. Egan fax +44 1483689550, email m.egan@surrey.ac.uk

perceived these habits could have long-term implications for health. Parents also identified conflict in trying to balance the provision of a healthy nutritious diet and satisfying their children's food preferences. Participants from all the countries spoke of the effects of diet in terms of physical, mental and behavioural outcomes, with attention and concentration being the aspects of mental performance most often mentioned by parents. They defined foods as 'good' and 'bad' with good foods having positive effects and bad foods having negative effects, especially as manifested by changes in mood and behaviour[7]. However, they ranked food-related factors (such as regularity of meals and what a child eats) significantly lower than physical (activity, sleep) and psychological (mood, behaviour) factors and school environment as influences on cognitive development and mental performance[8]. The objective of the present study was to examine these attitudes and beliefs on a wider scale, to compare them across four different European countries and to distil messages for public health policy.

Methods

The study design and details were agreed upon between the international research teams through several face-to-face meetings and intervening email exchanges. Ethical approval was obtained in all the countries according to local procedures.

The questionnaire was developed by the members of the research team. Relevant theoretical and empirical literature on the relationship between nutrition and mental performance was accessed to identify key factors. In addition, the findings from the qualitative interviews that had been completed with parents and teachers in each country[7] were consulted. A meeting involving researchers and four invited nutrition experts and psychologists was held in England, and a list of topics for the questionnaire was agreed upon. This was circulated to the other participating countries for comment. A preliminary questionnaire was then developed in English and translated into local languages. It was piloted in all four countries with a small number of local volunteer parents and teachers to ensure that the type, flow and number of questions were appropriate to the aims of the study, and to pre-test for clarity and comprehension. Results from the pilot study were evaluated and compared, and the content of the final questionnaire (comprising twenty-five items) was decided. Changes following the pilot study involved refinement of the wording to ensure consistency in meaning across the four countries.

In this study, we report results from the analysis of three items that explored respondents' views on the following: the extent to which diet affects the mental development and physical development of children; and the effect of diet on ten selected indicators of a child's physical (overall health, energy levels, weight, physical activity and sleep) and mental (attention, ability to learn, memory, mood and behaviour) performance (each scored on a five-point scale – extremely, very much, moderately, slightly, not at all – or don't know). Findings from other items, including those examining factors affecting parental food choice, will be reported elsewhere. Information was collected on the socio-demographic characteristics of respondents that might influence their views: age, sex, ethnicity, whether born in the country, highest level of education attained, occupation of the main earner, number of children living at home, if respondent had ever gained a qualification relating to health or nutrition, smoking status and (for teachers only) number of years teaching. Respondents also completed the General Health Interest (GHI) scale, an eight-item instrument that measures health-related food attitudes, each scored on a seven-point scale from which an average is calculated, range 1 (least interested in healthy eating) to 7 (most interested)[9].

Recruitment of participants

In order to access national samples, data collection was managed by a market research agency in England, which had links with partner organisations in the other three countries. Parents and teachers were recruited from established online panels in each country. Panel members were selected according to the inclusion criteria for individual studies, and were paid in the form of points for timely and full completion of instruments. Inclusion criteria were as follows: for parents, that they had a child aged 4–10 years old and, for teachers, that they were in mainstream (not private or special) education. Teachers had to teach the same age group. We focused on 4- to 10-year-old children because at that age parents are still likely to be having a significant influence over their diet and nutrition. We excluded parents and teachers of children with diagnosed pathologies, such as attention deficit hyperactivity disorder, because we reasoned that they may have researched dietary influences on development more thoroughly than the general population. The target was to recruit 400 parents and 100 teachers in each country, enabling the detection, using a two-sided test, with size of 5 % and power of 80 %, of an underlying difference in prevalence of 10 % for parents (20 % for teachers) with regard to any dichotomous outcome. The questionnaire was completed online and controls in the questionnaire prevented non-response to any item, and thus all the returns were complete.

Analysis

Data were transferred to SPSS (version 16; SPSS Inc.) for analysis. Summary statistics (numbers, percentages, means, standard deviations, medians and ranges) were calculated for all background variables and were broken down by respondent group (parent/teacher) and country (England/Germany/Hungary/Spain). Comparisons were performed using the appropriate statistical tests: χ^2 for categorical variables; the Mann–Whitney U test (parents *v.* teachers) or the Kruskal–Wallis test (countries) for ordinal variables; and unpaired t test (parents *v.* teachers) or one-way ANOVA (countries) for continuous variables.

The proportions of parents and teachers thinking that diet influences physical or mental development of a child extremely or very much (*v.* moderately, slightly, not at all) were compared; the four countries were also compared within the parent and teacher groups separately. Views of parents and teachers of the effect of diet on specific indicators of a child's physical and mental performance were compared using χ^2 tests

(extremely, very much *v.* moderately, slightly, not at all) and Mann–Whitney *U* tests (for a five-point ordinal scale 1 = not at all to 5 = extremely); comparisons across countries were analysed using Kruskal–Wallis tests. Associations were explored between GHI score and the importance (five-point ordinal scale) attributed to diet as an influence on mental or physical development (independent variables) and participant characteristics (including country) using step-wise linear regression modelling. Statistical significance was reported at the 5 % level.

Results

Sample characteristics

The questionnaires were returned by 1606 parents (401 in England, Germany and Hungary; 403 in Spain) and 403 teachers (100 in England, Germany and Spain; 103 in Hungary). Characteristics of the respondents are detailed in Table 1. Respondents were predominantly of white ethnicity. Higher proportions of teachers than parents were over the age of 45 years (35·3 % *v.* 18·3 %; $P < 0{\cdot}001$), and teachers were also less likely to smoke than parents (15·9 % *v.* 26·3 %, $P < 0{\cdot}001$). About one-half of the teachers reported having no children under the age of 18 years living at home. Parent responders differed significantly across countries for all the variables except for smoking rates; teachers did not differ internationally with respect to having a qualification related to health or nutrition and whether born in the home country.

The GHI mean scores were significantly higher for teachers than parents (4·83 *v.* 4·67; $P = 0{\cdot}006$), and differences existed in GHI among countries for both parents and teachers (Table 1). The step-wise regression modelling showed that parent GHI scores increased with age and were significantly higher for women (than men), non-smokers and those educated up to the college/university level. The teacher GHI was also higher for older respondents and women, and for those without a qualification in health or nutrition. In both the parent and teacher models, respondents in Spain and Germany recorded higher GHI compared with those in England; parent scores in Hungary were significantly lower than in England (Table 2).

Views about the influence of diet on the physical and mental development of a child

Overall, 80 % of the parents and teachers felt that a child's physical development depends very much or extremely (*v.* moderately, slightly, not at all) on diet; the equivalent proportion for mental development was lower (67 %). Except for Germany, higher proportions of teachers than parents thought that diet was a very/extremely important influence on both physical and mental development (parents *v.* teachers overall difference (all countries together) not significant). However, significant differences existed between countries in the views of parents and teachers on the importance of diet for both physical and mental development (Table 3).

In all four regression models (parents and teachers, physical and mental development), living in Hungary and scoring higher on the GHI (more interest in healthy eating) were associated with believing that diet had a larger influence on physical and mental development. Parents with higher education also viewed diet as more important for both types of development (than those with less education); parents without a qualification in health and nutrition (compared with those with) and parents with fewer children were more likely to think that diet strongly influenced physical development (Table 4).

Views about the influence of diet on specific indicators of a child's physical and mental performance

When asked about the effect of diet on specific indicators, the importance attributed to physical indicators of performance (especially overall health, energy levels, weight and physical activity) was generally greater than that for mental indicators, by both parents and teachers. In addition, there were no significant differences between teachers and parents in the proportions who felt that those physical indicators, and ability to learn, were influenced very much/extremely by diet. However, the proportions of parents and teachers differed significantly regarding their views on the impact of diet on other indications of mental performance (attention, mood, behaviour and (marginally) memory) and sleep. For each of these aspects, the proportion of teachers who felt that diet was a strong influence was higher compared with the proportion of parents. Differences existed between countries regarding the importance of all indicators for mental performance, except for teachers regarding memory and (marginally) mood (Table 5).

Discussion

Across all countries, larger proportions of parents and teachers regarded diet to be an important determinant of physical development than of mental development. When asked about specific indicators, responses from both groups continued to show that they thought that diet had a bigger influence on aspects of physical performance (especially overall health, energy levels, weight and physical activity) than on dimensions of mental performance (especially mood, memory and behaviour).

One reason why parents and teachers attributed less importance to the influence of diet on mental development of children than to their physical development may be due to the lack of attention paid to mental performance relative to concerns about obesity[2]. This in turn may have resulted from uncertainties in the scientific evidence about the relationship between dietary intake and mental performance, impeding the design and delivery of clear messages for consumers. Multiple factors affect mental functioning, and identifying the independent impact of nutrition is challenging[10]. Cognitive processes are complex and experimental designs are confounded by a range of factors (such as the time of day the measurement is made or composition of the foods used in interventions)[11–14]. Socio-economic factors (such as parenting, access to education and resources at home) influence background cognitive competence. Moreover, mood, motivation and arousal (themselves affected by nutrition) can additionally influence mental performance in various ways[10,14].

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Table 1. Characteristics of respondents: comparison of parents and teachers, including by country

	Parents									Teachers									All countries				
	England (*N* 401)		Germany (*N* 401)		Hungary (*N* 401)		Spain (*N* 403)		Difference between countries, *P*	England (*N* 100)		Germany (*N* 100)		Hungary (*N* 103)		Spain (*N* 100)		Difference between countries, *P*	Parents (*N* 1606)		Teachers (*N* 403)		Difference between parents and teachers, *P*
Characteristic	*n*	%	*n*	%	*n*	%	*n*	%		*n*	%	*n*	%	*n*	%	*n*	%		*n*	%	*n*	%	
Age (≥45 years)	93	23·2	77	19·2	48	12·0	75	18·6	0·001	29	29·0	26	26·0	57	55·3	31	31·0	<0·001	293	18·3	143	35·3	<0·001
Sex (male)	129	32·2	176	43·9	130	32·4	185	45·9	<0·001	35	35·0	50	50·0	16	15·5	47	47·0	<0·001	620	38·6	148	36·7	–0·478
Born home country (yes)	358	89·3	377	94·0	389	97·0	382	94·8	<0·001	92	92·0	94	94·0	100	97·1	92	92·0	0·386	1506	93·8	378	93·8	0·986
Qualification health/nutrition (yes)	37	9·2	58	14·5	57	14·2	47	11·7	0·082	15	15·0	18	18·0	24	23·3	17	17·0	0·464	199	12·4	74	18·4	0·002
Current smoker (yes)	89	22·2	117	29·2	108	26·9	109	27·0	0·145	9·0	9·0	27	27·0	14	13·6	14	14·0	0·004	423	26·3	64	15·9	<0·001
Ethnicity (White)	360	89·8	379	94·5	398	99·3	385	95·5	<0·001	84	84·0	96	96·0	101	98·1	100	100	<0·001	1522	94·8	381	94·5	0·854
Higher education (yes)*	266	66·3	212	52·9	158	39·4	226	56·1	<0·001										862	53·7			
Main earner occupation (Manag, Prof)†	130	32·4	148	36·9	122	30·4	158	39·2	0·035										558	34·7			
Parent(s) who teach (yes)	15	3·7	33	8·2	35	8·7	39	9·7	0·008										122	7·6			
Teacher in state school (yes)‡										81	81·0	76	76·0	92	89·3	37	37·0	<0·001			286	71·0	
Teacher is a parent (yes)										69	69·0	69	69·0	85	82·5	70	70·0	0·080			293	72·7	
Children <18 years of age living with respondent (none)	4	1·0	12	3·0	3	0·7	13	3·2	0·015	44	44·0	44	44·0	65	63·1	44	44·0	0·011	32	2·0	197	48·9	<0·001
Continuous variables	Mean	SD	Mean	SD	Mean	SD	Mean	SD		Mean	SD	Mean	SD	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Number of children <18 years of age living with respondent	1·82	0·88	1·81	1·15	1·90	0·80	2·10	1·17	<0·001	0·99	1·10	0·99	1·17	0·62	0·99	1·16	1·35	0·008	1·91	1·02	0·94	1·17	<0·001
Years in teaching										11·4	11·1	11·1	11·2	23·2	10·7	10·4	10·3	<0·001					
GHI: range 1–7 (most interested in healthy eating)§	4·65	0·93	4·71	1·04	4·37	1·14	4·95	1·00	<0·001	4·71	1·06	4·83	1·13	4·73	0·95	5·06	0·97	0·071	4·67	1·05	4·83	1·03	0·006

E, England; G, Germany; GHI, General Health Interest; H, Hungary; P, parents; S, Spain; T, teachers. (range 1 = least interested in healthy eating to 7 = most interested in healthy eating).

* Highest level of education is college or university.

† Managerial or professional (rather than clerical, administrative, manual, homemaker, retired, student, seeking work).

‡ Rather than independent school.

§ General Health Interest Scale χ^2 test.

Table 2. Modelling of factors associated with General Health Interest (GHI) score (*B* coefficient and their standard errors; 95 % confidence intervals)

					95 % CI	
	Factors*	*B*	SE	Significance	Lower bound	Upper bound
Parents†	Constant	3·371	0·149	0·001	3·080	3·662
	Sex (1, male; 2, female)	0·482	0·053	0·001	0·378	0·586
	Age (in 10 year bands)	0·160	0·029	0·001	0·104	0·216
	Spain	0·396	0·071	0·001	0·256	0·535
	Germany	0·164	0·071	0·022	0·024	0·304
	Hungary	–0·233	0·072	0·001	–0·374	–0·092
	Current smoker (yes)	–0·207	0·057	0·001	–0·319	–0·095
	University education (yes)	0·102	0·052	0·048	0·001	0·203
Teachers†	Constant	3·254	0·241	0·001	2·779	3·728
	Sex (1, male; 2, female)	0·635	0·104	0·001	0·431	0·839
	Age (in 10 year bands)	0·124	0·041	0·003	0·044	0·205
	Spain	0·492	0·121	0·001	0·253	0·730
	Germany	0·313	0·123	0·011	0·072	0·554
	Qualification in health or nutrition (yes)	–0·249	0·125	0·047	–0·495	–0·003

* Dependent variable: GHI score, range 1 (least interest in healthy eating) – 7 (most interest).
† Independent variables: country (England as reference); age; sex; born in home country; qualification in health or nutrition; higher (college/university) education; current smoker; and ethnicity (white or other).

Another explanation for less recognition of the role of diet in mental performance may lie in the difficulties lay members of the public experience with understanding the processes of brain development and cognition. Our previous interviews with parents of primary-school children in the four countries confirmed that they believed that diet affects mental functioning of a child as well as his/her physical health and well-being, but that they encountered problems with articulating what the concept of 'mental performance' meant to them. Cognitive processes encompass a range of complex functions (perception, psychomotor, attention, memory, language and executive functions)[3], the details of which may be hard to comprehend. Parents tended to relate most to 'attention' and 'concentration', and many expressed the view that food affected these dimensions indirectly through its impact on mood and behaviour. Consistent with findings from other studies[15,16], parents also related to 'learning' as an element of mental performance[3]. The selection of indicators of mental performance for the questionnaire in this study reflected these pragmatic considerations and the need to ensure that meaningful terminology was used. However, respondents (and parents in particular) still may have found the link between diet and mental performance less clear than that between diet and physical outcomes for children.

The lower level of awareness of the importance of diet for brain development and cognition (compared with awareness of physical outcomes) indicates potential for educating consumers. Information can be provided through a number of routes, including public health messages, health professionals and the food industry. Although the influences of nutrition on mental performance are complex, sufficient evidence has been established to allow the design of reliable information for consumers on the role of dietary factors. General messages about the need for a varied diet with good nutritional content and regular intake should highlight the advantages for cognitive functioning as well as for physical health[3,17,18]. In addition, specific ways in which diet and nutrition affect children's mental development and performance can be promoted. Beyond long-term deficiencies[19], it appears that brain function is sensitive to short-term variations in the availability of nutrients, with stronger findings for 'at-risk' groups[20]. Eating behaviours such as skipping breakfast may contribute to poor mental performance[19–21]. The lack of energy leads to decreased glucose and insulin levels in the body, which may be associated with impaired cognitive functioning[22]. Along with alleviating hunger, breakfast provides essential nutrients to the brain[23]. Potential links have also been identified between children's behaviour and food intolerance, sucrose intake and additives in foods[12,24], which might be incorporated in the information that is designed.

Understanding the differences in views between subgroups of the population is important to appropriately target public health messages. Respondents having a high interest in healthy eating and higher educational attainment (including teachers) were already more likely to regard diet as an important influence on mental development of their children, implying the need to address other groups in society. In this respect, the survey findings are consistent with other studies that have found socio-economic differences in parental knowledge about food, and specifically that higher income parents tend to discuss food in terms of health and medical issues, whereas lower income parents tend to consider the impact of food on their child's outward appearance and functional capacity[25]. Diet was regarded as more important for the physical and mental development of children in Hungary than in the other countries. Possible reasons for greater awareness in Hungary may include cultural differences or greater availability of relevant information for consumers. Exploring these reasons in greater detail may help design policies that will improve understanding in the other countries.

Although care was taken in translating and piloting the questionnaire to ensure uniformity between countries, the

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Table 3. Views about the influence of diet on physical and mental development of a child: comparison of parents and teachers, including by country

To what extent do you think a child's	*P** Between countries	*P*† Parents *v.* teachers (all countries)	England *N*	England *n*	England %	Germany *N*	Germany *n*	Germany %	Hungary *N*	Hungary *n*	Hungary %	Spain *N*	Spain *n*	Spain %	All countries *N*	All countries *n*	All countries %	P + T %
			Number of participants and percentages responding extremely or very much *v.* moderately, slightly, not at all															
Physical development depends on diet		0·187																79·8
Parents	0·001		398	281	70·6	395	289	73·2	401	375	93·5	399	319	79·9	1593	1264	79·3	
Teachers	0·001		100	74	74·0	100	70	70·0	103	102	99·0	100	83	83·0	403	329	81·6	
Mental development depends on diet		0·265																67·4
Parents	0·001		399	239	59·9	393	244	62·1	400	329	82·2	394	249	63·2	1586	1061	66·9	
Teachers	0·001		99	63	63·6	100	60	60·0	102	91	89·2	100	64	64·0	401	278	69·3	

P, parents; T, teachers.
* Kruskal–Wallis test, utilising raw ordinal values (extremely to not at all).
† Mann–Whitney *U* test, utilising raw ordinal values (extremely to not at all).

findings need to be interpreted in the light of a number of limitations. The study was based on four countries that provided geographical spread across Europe, but may not have been socially and politically representative of the entire European population. In order to recruit large national samples, respondents were drawn from market research panels. Members of the panels are volunteers and are typically re-imbursed for the time they spend completing online surveys. Hence, the people attracted to this role may not be representative of the general population in each country – for example, the samples recruited to this study from Germany included a higher proportion of current smokers than indicated by national data[26].

Data analysis revealed significant differences between countries in some characteristics of the respondents (especially among parents) regarding views. Inclusion of individual countries in the regression modelling identified key areas of international differences – for example, respondents in Hungary attributed greater importance to diet in physical and mental development of their children than respondents in the other countries. Comparisons revealed significant differences among countries in most aspects, but it should be noted that absolute differences in some cases were not big, yet the large sample size meant that even small differences become statistically significant.

Brain development and cognition are important for learning, memory, information processing, reasoning, behaviour and many other functions that affect an individual's life achievements and well-being. However, physical outcomes for children were viewed as important by more parents and teachers in our sample of countries than children's mental development and performance. Benefit may arise from increasing awareness of the potential role of diet and nutrition in both brain development and cognitive functioning of children through increasing the quantity and clarity of consumer information[27], particularly targeting groups with the responsibility of caring for and educating children. Parents in particular are important gatekeepers to a child's diet and central to the environment in which most children's eating habits are developed[28]. As such, they constitute an important target group for communication about the nutritional properties and health effects of foods. Complex household, community and social factors interact to determine parental choice of food for their children[29], and timely, consistent and evidence-based information, tailored to different groups, and delivered in a variety of formats, is needed to form a basis for rational decision making[30].

Effective nutritional communication requires the recipient to have a certain level of nutritional knowledge; where this is lacking, the target audience cannot be reached effectively and information may be misinterpreted, as highlighted in the context of EU regulation on nutrition and health claims[31]. Understanding parents' and teachers' views of the importance of diet in the mental development of children is essential before developing meaningful messages and dietary change interventions, but further research is needed to identify which dissemination strategies are most effective in reaching parents and teachers in different cultural settings and social, economic and ethnic groups.

Table 4. Modelling of factors associated with views on the importance of diet in the physical and mental development of a child (*B* coefficient and their standard errors; 95 % confidence intervals)

					95 % CI	
	Factor*	*B*	SE	Significance	Lower bound	Upper bound
Physical development†						
Parents (*N* 1593)	Constant	2·575	0·176	<0·001	2·229	2·921
(13, incomplete data)	Hungary	0·555	0·049	<0·001	0·459	0·652
R^2 0·107	General Health Interest Scale (1–7 high)	0·161	0·020	<0·001	0·122	0·200
	Highest level of education completed (five-point scale)	0·094	0·019	<0·001	0·057	0·132
	Qualification in health or nutrition (1 = yes; 2 = no)	0·159	0·064	0·013	0·034	0·283
	Total number of boys + girls living with respondent	–0·041	0·021	0·049	–0·081	0·000
Teachers (*N* 403)	Constant	2·950	0·179	<0·001	2·598	3·303
R^2 0·169	Hungary	0·614	0·085	<0·001	0·447	0·781
	General Health Interest Scale (1–7 high)	0·207	0·036	<0·001	0·136	0·277
Mental development†						
Parents (*N* 1586)	Constant	2·488	0·125	<0·001	2·244	2·733
(20, incomplete data)	Hungary	0·513	0·052	<0·001	0·411	0·614
R^2 0·092	General Health Interest Scale (1–7 high)	0·185	0·021	<0·001	0·143	0·226
	Highest level of education completed (five-point scale)	0·077	0·020	<0·001	0·038	0·117
Teachers (*N* 401)	Constant	3·126	0·251	<0·001	2·634	3·619
(2, incomplete data)	Hungary	0·548	0·093	<0·001	0·365	0·730
R^2 0·130	General Health Interest Scale (1–7 high)	0·197	0·039	<0·001	0·120	0·273
	Ethnicity (White)	–0·408	0·178	0·022	–0·758	–0·059

* Dependent variable: diet affects the physical/ mental development of a child (five-point scale: 1 not at all – 5 extremely; don't know excluded).

† Independent variables: country (with England as the reference); age; sex; highest level of education attained by parents/years in teaching for teachers; total number of children under 18 living with respondent; GHI score; qualification in health or nutrition; and ethnicity. Current smokers were excluded from the analysis because of high correlation with GHI.

Table 5. Views about the effect of diet on indicators of a child's physical and mental performance (Numbers and percentages)

		Number and % responding extremely or very much *v.* moderately, slightly, not at all											
		Parents					Teachers					Difference in proportions: parents *v.* teachers	
				Inter-country difference					Inter-country difference				
	Indicators of physical and mental performance*	*n*	%	*P***	Rank†	Sig diffs†	*n*	%	*P***	Rank†	Sig diffs†	MW*U* (*P*)‡	χ^2 (*P*)§
To what extent do you think diet will influence a child's	Energy level	1431	89·5	<0·001	HESG	H > ESG HE > G	366	90·8	0·004	HESG	H > G	0·105	0·433
	Overall health	1409	88·1	<0·001	HSEG	H > G	358	89·1	0·035	HESG	H > SG	0·159	0·601
	Weight	1384	87·0	0·010	EHSG	EH > G	359	89·1	0·211	–	–	0·445	0·270
	Amount of physical activity	1291	81·0	<0·001	HEGS	H > EGS HE > S	329	81·6	0·002	HESG	H > SG	0·966	0·767
	Ability to learn	1140	71·8	<0·001	GHES	GH > ES	290	72·1	<0·001	EHGS	EH > S	0·311	0·903
	Attention	1107	69·8	<0·001	GHES	GHE > S	314	78·3	0·009	HEGS	H > S	<0·001	0·001
	Sleep	1066	67·2	0·018	HEGS	H > EGS	288	72·4	0·017	HESG	H > G	0·030	0·047
	Mood	1042	65·5	<0·001	EHGS	EH > S	298	74·1	0·093	–	–	0·001	0·001
	Memory	968	62·1	0·041	GHES	G > S	268	67·2	0·644	–	–	0·071	0·059
	Behaviour	887	56·2	<0·001	EHGS	E > GS	261	65·1	<0·001	EHGS	E > GS	<0·001	0·001

E, England; G, Germany; H, Hungary; S, Spain.
* The order in which indicators were presented to the respondents was rotated.
** Kruskal-Wallis tests were used, based on the five-point ordinal scale (1 = not at all to 5 = extremely).
† Significant differences between countries shown by > symbol.
‡ Mann–Whitney *U* (MWU) tests based on the five-point ordinal scale (1 = not at all to 5 = extremely).
§ χ^2 test based on comparing : extremely or very much *v.* moderately, slightly and not at all.

Acknowledgements

The authors are grateful to the parents and teachers who participated in the study.

The research was supported by the European Communities 7th framework Programme (Nutrimenthe grant agreement no. 212652).

HG contributed to the analysis and wrote the first draft; HG, BE, MR conceived the study; PW undertook the statistical analysis; all authors contributed to the design and read and approved the final manuscript.

There are no conflicts of interest.

References

1. Lopez-Dicastillo O, Grande G & Callery P (2010) Parents' contrasting views on diet versus activity of children: Implications for health promotion and obesity prevention. *Patient Educ Couns* **78**, 117–123.
2. Florence MD, Asbridge M & Veugelers PJ (2008) Diet quality and academic performance. *J Sch Health* **78**, 209–215.
3. Schmitt JA, Benton D & Kallus KW (2005) General methodological considerations for the assessment of nutritional influences on human cognitive functions. *Eur J Nutr* **44**, 459–464.
4. Alderman H, Behrman JR, Lavy V, *et al.* (1997) Child nutrition, child health, and school enrollment: a longitudinal analysis. *World Bank Policy Research Working Paper (1700).*
5. Associate Parliamentary Food and Health Forum (2008) The links between diet and behaviour. The influence of nutrition on mental health.
6. European Food Information Council. The determinants of food choice. EUFIC Review 04/2005, European Food Information Council. Accessed June 2014.
7. Brands B, Egan B, Gyorei E, *et al.* (2012) A qualitative interview study on effects of diet on children's mental state and performance. Evaluation of perceptions, attitudes and beliefs of parents in four European countries. *Appetite* **58**, 739–746.
8. Gage H, Egan B, Williams P, *et al.* (2014) Views of parents in four European countries about the effect of food on the mental performance of primary school children. *Eur J Clin Nutr* **68**, 32–37.
9. Roininen K, Lahteenmaki L & Tuorila H (1999) Quantification of consumer attitudes to health and hedonic characteristics of foods. *Appetite* **33**, 71–88.
10. Isaac E & Oates J (2008) Nutrition and cognition: assessing cognitive abilities in children and young people. *Eur J Nutr* **47**, Suppl. 3, 4–24.
11. Bellisle F, Blundell J, Dye L, *et al.* (1998) Functional food science and behaviour and psychological functions. *Br J Nutr* **80**, S173–S193.
12. Benton D (2008) The influence of children's diet on their cognition and behavior. *Eur J Nutr* **47**, 25–37.
13. Dye L & Blundell J (2002) Functional foods. Psychological and behavioural functions. *Br J Nutr* **88**, S187–S211.
14. Gibson EL & Green MW (2002) Nutritional influences on cognitive function. Mechanisms of susceptibility. *Nutr Res Rev* **15**, 169–206.
15. Russell CG, Flight I, Leppard P, *et al.* (2004) A comparison of paper-and-pencil and computerised method of 'hard' laddering. *Food Qual Prefer* **15**, 279–291.
16. Russell CG, Busson A, Flight I, *et al.* (2004) A comparison of three laddering techniques applied to an example of a complex food choice. *Food Qual Prefer* **15**, 569–583.
17. Bellisle F (2004) Effects of diet on behaviour and cognition in children. *Br J Nutr* **92**, S227–S232.
18. Tomlinson D, Wilkinson H & Wilkinson P (2009) Diet and mental health in children. *Child Adolesc Mental Health* **14**, 148–155.
19. Rausch R (2013) Nutrition and academic performance in school age children: the relation to obesity and food insufficiency. *J Nutr Food Sci* **3**, 2–4.
20. Pollitt E (1995) Does breakfast make a difference in school? *J Am Diet Assoc* **95**, 1134–1139.
21. Levy L (2013) Breakfast and cognition, review of the literature, Public Health England https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/256398/Breakfast_and_cognition_review_FINAL_publication_formatted.pdf accessed 25 May 2014).
22. Pollitt E & Mathews R (1998) Breakfast and cognition. An integrative summary. *Am J Clin Nutr* **67**, 804s–813s.
23. Hoyland A, Dye L & Lawton CL (2009) A systematic review of the effect of breakfast on the cognitive performance of children and adolescents. *NutrRes Rev* **22**, 220–243.
24. Benton D (2010) The influence of dietary status on the cognitive performance of children. *Mol Nutr Food Res* **54**, 457–470.
25. Coveney J (2004) A qualitative study exploring socio-economic differences in parental lay knowledge of food and health: implications for public health nutrition. *Public Health Nutr* **8**, 290–297.
26. OECD Health Data (2012) Eurostat Statistics Database. http://www.oecd-ilibrary.org/sites/9789264183896-en/02/05/index.html?itemId=/content/chapter/9789264183896-24-en (accessed 25 May 2014).
27. Gage H, von Rosen-von Hoewell J, Laitinen K, *et al.* (2012) Health effects of infant feeding for parents in leaflets and magazines in five European countries. *Public Underst Sci* **22**, 365–379.
28. Birch LL & Davison KK (2001) Family environmental factors influencing the developing behavioral controls of food intake and childhood overweight. *Pediatr Clin North Am* **48**, 893–907.
29. Raats M (2010) The role of consumers. In *Drivers of Innovation in Pediatric Nutrition*, pp. 161–171 [Koletzko B, Koletzko S and Rummele F, (editors)]. Basel, Switzerland: Nestle Nutrition Institute Workshop Series, Pediatric Program. Karger.
31. Jackson C, Cheater F & Reid L (2008) A systematic review of decision support needs of parents making child health decisions. *Health Expect* **11**, 232–251.
32. Van Trijp HCM (2009) Consumer understanding and nutritional communication: key issues in the context of the new EU legislation. *Eur J Nutr* **48**, S41–S48.

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Importance of mental performance in parental choice of food for children aged 4–10 years: a study in four European countries

Heather Gage[1,*], Bernadette Egan[1], Peter Williams[2], Brigitte Brands[3], Eszter Györei[4], Juan-Carlos López-Robles[5], Cristina Campoy[5], Tamas Decsi[4], Berthold Koletzko[3] and Monique Raats[1]

[1]Food, Consumer Behaviour and Health Research Centre, University of Surrey, Guildford, Surrey, GU2 7XH, UK: [2]Department of Mathematics, University of Surrey, Guildford, Surrey, UK: [3]Dr. von Hauner Children's Hospital, Ludwig-Maximilians University, Munich, Germany: [4]Department of Paediatrics, University of Pécs, Pecs, Hungary: [5]Department of Paediatrics, University of Granada, Granada, Spain

Submitted 9 May 2016: Final revision received 3 September 2016: Accepted 11 October 2016

Abstract

Objective: Typically, attention focuses on how nutrition affects physical health. The present study investigated the importance that parents attach to the impact of diet on mental performance when choosing food for their child.

Design: Questionnaire.

Setting: Four European countries.

Subjects: Parents of children aged 4–10 years (*n* 1574): England (*n* 397), Germany (*n* 389), Hungary (*n* 398) and Spain (*n* 390).

Results: Most parents (80–85 %) considered the effect of food on four elements of mental performance (child's ability to learn, attention, behaviour, mood) to be moderately, very, extremely (*v.* slightly, not at all) important in food choices; over 90 % considered healthiness of food and making food appealing to their child important; 79·8 % cost; 76·8 % convenience. Belief that food affects mental performance was 57·4 % (ability to learn), 60·5 % (attention); less than 40 % of parents agreed they were aware which foods had an effect. Parents with lower general interest in healthy eating were less likely to consider the effect of food on mental performance elements as important. Respondents from Germany were more likely to rate mental performance as important (except behaviour); those in Hungary less likely. The most important influence on parents' decisions about feeding their child was their own experience, except Spain, where family/friends/health professionals were more important.

Conclusions: Nutrition affects brain development and cognitive functioning. Low prioritisation of the effect of food on mental performance indicates potential for educating parents.

Key words
Food choice
Parents
Children
Mental performance
European countries

Parents are the main gatekeepers of the diet of children under the age of 10 years, exerting significant control over what they eat through selection of the range of foods that are offered[1] and methods such as restriction and rewards[2]. In making food choices for their children, research has shown that parents are aware of the importance of developing good eating habits for long-term health and are concerned with balancing a healthy diet with their child's food preferences[3]. Even though parents associate some foods (such as sugary drinks) with effects on mood and behaviour[4], most perceive that diet has a stronger impact on the physical development of their child than on his/her mental performance[5]. Food and nutrition, however, have important and pervasive impacts on brain development and cognitive functioning through effects on cell structure, neurotransmission, energy supply to the brain and metabolism[6,7]. Beyond the role of specific nutrients, eating patterns such as skipping breakfast are considered to contribute to poor mental performance[8] and consumption of foods containing certain additives to result in behaviour changes[9]. Hence a balanced diet is important for mental as well as physical development with implications for school performance, attainment and well-being in adulthood[10,11].

The present paper reports the findings from a questionnaire study involving the parents of children aged 4–10 years in a convenience sample of four European countries (England, Germany, Hungary and Spain).

*Corresponding author: Email h.gage@surrey.ac.uk

The countries included were those participating in a larger European programme of work on the role that diet plays in the mental performance of children (NUTRIMENTHE project). Since traditionally most attention has been paid to how nutrition affects physical health, the questionnaire particularly probed the extent to which parents took account of the impact of their food choices on the mental performance of their children. The findings reported herein relate to: (i) the relative importance of perceived healthiness, impact on elements of mental performance, attributes of food such as taste, and cost and convenience of preparation in parental food choices; (ii) the awareness and beliefs of parents about the effect of food on their child's ability to learn and attention; (iii) the characteristics of parents associated with the prioritisation of mental performance when choosing food for their children; and (iv) the main influences on parental decision making, including roles of family, friends, health professionals and the media. The inclusion of four different countries enables cultural differences to be explored.

Methods

Questionnaire development

The questionnaire was developed by members of the international research teams through several face-to-face meetings and intervening email exchanges. A preliminary questionnaire was developed in English and translated into local languages. It was piloted in all four countries with a small number of local volunteer parents to ensure that the type, flow and number of questions were appropriate to the aims of the study and to pre-test for clarity and comprehension. Results from the pilots were evaluated and compared and the content of the final questionnaire (comprising twenty-five items) agreed. Changes following the pilot involved refinement of the wording to ensure consistency in meaning across the four countries.

The first of three items on food choice asked parents to what extent (not at all/slightly/moderately/very much/extremely/don't know) they took account of eleven different factors when preparing food for their child. They were also asked to rank their top three factors. The order in which the factors were presented to respondents was rotated. The factors were selected with reference to the relevant theoretical and empirical literature and in discussion with four nutrition and psychology experts. They were divided into four groups: (i) the effect of food on physical functioning (healthiness of food, child's energy levels); (ii) the effect of food on four elements of their child's mental performance (ability to learn, attention, mood, behaviour); (iii) food-related factors (flavour, providing variety, child's food preferences); and (iv) pragmatic factors (cost, ease of preparation).

The findings from qualitative interviews with parents in each country were consulted to guide the selection of elements of mental performance[3]. Parents encountered problems with articulating what the concept of 'mental performance' meant to them. Cognitive processes encompass a range of complex functions (perception, psychomotor, attention, memory, language, executive functions)[6], the details of which may be hard for lay people to comprehend. Parents tended to relate most to 'attention' and 'concentration', and many expressed the view that food affected these dimensions indirectly through its impact on mood and behaviour. Consistent with findings from other research[12,13], parents also related to 'learning' as an element of mental performance[6]. The selection of indicators of mental performance for the questionnaire in the present study reflected these considerations and the need to ensure that the terminology used was meaningful to parents.

Second, to gain more understanding of the importance parents attribute to the effect of food on mental performance, respondents were asked the extent to which they agreed or disagreed (5-point Likert scale) with two statements: one relating to their awareness of foods that improve their child's attention and ability to learn; the other to their belief that food improves their child's attention and ability to learn. The final item related to the extent (not at all/slightly/moderately/very much/extremely/don't know) to which parents' decisions about how to feed their child were influenced by eleven different sources (including self, partner, other family, friends, health professionals and various media sources).

In addition, information was collected on the socio-demographic characteristics of respondents that might influence their views and behaviours: age, sex, ethnicity, whether born in the country, highest level of education attained, occupation of main earner, number of children living at home, if respondent had ever gained a qualification relating to health or nutrition, and smoking status. Respondents also completed the General Health Interest (GHI) scale, an eight-item instrument that measures health-related food attitudes, each scored on a 7-point scale from which an average is calculated, range 1 (least interested in healthy eating) to 7 (most interested)[14].

Recruitment of participants

In order to access national samples, data collection was managed by a market research agency in England that had links with partner organisations in the other three countries. Parents were recruited from established panels in each country. Panel members are selected according to the inclusion criteria for individual studies, which, in the present study, were that parents had a child aged 4–10 years old, in mainstream (not private or special) education. The focus on 4–10-year-old children was because, at that age, parents are still likely to be having a significant influence over their diet and nutrition. Parents of children with diagnosed pathologies, such as attention-deficit hyperactivity disorder, were excluded because it was reasoned that they may have researched dietary influences on development more

http://dx.doi.org/10.1017/S1368980016003062

thoroughly than the general population. The questionnaire was distributed and completed online in the spring of 2011. Controls in the questionnaire prevented non-response to any item so all returns were complete. Ethical approval was gained from the University of Surrey research ethics committee.

Sample size

The target was to recruit 400 parents in each country, enabling the detection, using a two-sided test, with size of 5 % and power of 80 %, of an underlying difference in prevalence of 10 % with regard to any dichotomous outcome.

Analysis

Data were transferred to the statistical software package SPSS version 16 for analysis. Summary statistics (numbers, percentages, means, standard deviations, medians, ranges) were calculated for all background variables and broken down by country. Comparisons between countries were performed using the appropriate statistical tests.

Factors in food choice were ranked according to the proportions of parents responding that they took account of the factor extremely, very much or moderately (*v.* slightly or not at all). Factors were also ranked for the proportion of respondents placing the factor among one of the top three. Rankings were compared between countries, and between parents with different sex mixes of children, because boys are generally regarded as needing more energy (at a given age) than girls[15].

The proportions of parents agreeing or strongly agreeing that they were not aware of which foods contribute to attention and ability to learn, and did not believe foods impact on attention and ability to learn, were analysed descriptively and compared between countries.

Backwards stepwise logistic regression modelling was undertaken to explore associations between parents' background characteristics and stating that they take account of each of the four mental performance factors slightly or not at all (*v.* moderately, very much or extremely) in making food choices for their child.

The importance of different sources of information used by parents in food choice decisions was re-coded on a 5-point scale (1 = not at all to 5 = extremely; don't know treated as missing). The eleven sources were combined into four groups for analysis: self (i.e. own common sense), family and friends, doctor and health professionals, and media (comprising seven items: radio, television, websites, social networks, advertisements, books, magazines). A mean score was calculated for each parent for each group. Country-level means were then compared.

Results

Sample characteristics

Questionnaires were returned by 1606 parents with children aged between 4 and 10 years (*n* 401 in England, Germany, Hungary; *n* 403 in Spain), but the children were not co-resident with some of the respondents. Since the questions specifically referred to food choice for 'their child', those parents with no children living with them were excluded from the analysis. This left a total sample of 1574 respondents. Respondents were predominantly of white ethnicity. Parent responders differed significantly across countries in all characteristics except for smoking rates (overall, 25·9 % were current smokers) and having a qualification in health and nutrition (11·8 %; Table 1).

Factors affecting food choices

Across all countries, the proportions of parents stating they took account of a factor extremely, very much or moderately (*v.* slightly or not at all) when making food choices for their child were lowest for the pragmatic factors of cost (79·8 %) and convenience (76·8 %) and highest for healthiness of food, making food appealing to their child and the perceived effect of food on energy levels (over 90 %). Between 80 and 85 % of parents considered the impact of food on the four elements of mental performance to be moderately, very much or extremely important. Differences existed between countries in the importance that parents said they attached to cost, flavour of food, child's preferences, providing variety and the effect of food on child's mood and attention (but not with respect to the effect of food on the child's energy levels, ability to learn, behaviour, ease of preparation or the healthiness of food; Table 2).

These rankings altered somewhat when the proportions of parents listing a factor in the top three most important were examined. Healthiness (80·3 %), offering variety (57·1 %) and the child's food preferences (41·9 %) were the most important to parents. A middle group of factors comprised the effect of food on the child's energy (28·0 %), flavour of food (27·3 %) and cost (20·8 %). Ease of preparation and the four factors relating to the child's mental performance were all ranked in the top three factors by less than 10 % of respondents (Table 2).

Differences existed between countries in the proportions ranking factors in the top three for all factors except healthiness, where there was close agreement. Compared with the other countries, respondents in Hungary were less likely to rate the four elements of mental performance among the top three factors influencing their food choices, while those in Germany were more likely to do so (other than behaviour). The child's food preferences were important in Hungary, and less so in Spain, where variety and providing energy were relatively important considerations (Table 2). In Germany, low proportions of parents considered variety of food as important. Cost was relatively unimportant in both Germany and Spain. Ease of

http://dx.doi.org/10.1017/S1368980016003062

Table 1 Characteristics of respondents and comparison across countries: convenience sample of parents of children aged 4–10 years from four European countries, 2011

Characteristic	All countries (*n* 1574)		England (*n* 397)		Germany (*n* 389)		Hungary (*n* 398)		Spain (*n* 390)		Difference between countries, *P*
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	
Age (years)											
18–24	96	6·1	20	5·0	48	12·3	4	1·0	24	6·2	0·031‡
25–34	514	32·7	141	35·5	127	32·6	137	34·4	109	27·9	
35–44	678	43·1	144	36·3	141	36·2	210	52·8	183	46·9	
≥45	286	18·2	92	23·2	73	18·8	47	11·8	74	19·0	
Sex											
Male	598	38·0	127	32·0	166	42·7	128	32·2	177	45·4	<0·001§
Born in home country											
Yes	1475	93·7	354	89·2	366	94·1	386	97·0	369	94·6	<0·001§
Qualification health/nutrition											
Yes	186	11·8	36	9·1	51	13·1	57	14·3	42	10·8	0·097§
Ever smoked											
Yes	870	55·3	209	52·6	217	55·8	219	55·0	225	57·7	0·555§
Current smoker											
Yes	408	25·9	86	21·7	111	28·5	107	26·9	104	26·7	0·142§
Ethnicity											
White	1491	94·7	356	89·7	367	94·3	395	99·2	373	95·9	<0·001§
College/university education											
Yes	847	53·8	263	66·2	207	53·2	158	39·7	219	56·2	<0·001§
Main earner occupation											
Managerial, professional*	545	34·6	130	32·7	144	37·0	120	30·2	151	38·7	0·046§
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
No. of children <18 years living with respondent	1·95	0·99	1·83	0·86	1·86	1·12	1·92	0·78	2·17	1·13	<0·001‖
GHI: range 1–7 (most interested in healthy eating)†	4·67	1·05	4·65	0·93	4·70	1·03	4·37	1·15	4·95	1·00	<0·001‖

*Managerial or professional (rather than clerical, administrative, manual, homemaker, retired, student, seeking work).
†General Health Interest scale[14].
‡Using the Kruskal–Wallis test.
§Using the χ^2 test.
‖Using the *t* test.

preparation was unimportant in all countries but particularly so in Hungary.

Comparing parents with different sex mixes of children

Of the 1574 parents with children living at home, 536 (34·1 %) had only boys; 385 (24·5 %) had only girls; 653 (41·5 %) had both boys and girls. Within each country separately, there was no significant difference between parents with only girls, only boys or both in the extent to which parents said they took account of any of the eleven factors or in the proportions that ranked any factor among the top three (data not shown).

Combining all four countries, the sex mix of children had a significant effect on the extent to which parents said they took account of the child's food preferences ($P = 0·003$) and marginally the flavour of food ($P = 0·077$). Both these factors were more important to parents who had only girls, than to those who had only boys, or both. There was no significant difference between parents with only girls, only boys or both in the extent to which parents said they took account of any of the other nine factors or in the proportions that ranked any factor in the top three (data not shown).

Awareness and beliefs of parents about the effect of food on their child's ability to learn and attention

Across all countries, some 60 % of parents stated that they believed that food affected ability to learn (57·4 %) or attention (60·5 %). Similar proportions stated they were not aware which foods affected the ability to learn (65·2 %) or attention (62·2 %) of their child (Table 3). There was a highly statistically significant positive association between stating awareness and belief; for ability to learn, of those aware, 85·9 % also believed; 89·3 % for attention (χ^2 test, $P < 0·0005$ for both). Also, parents stating they were not aware or did not believe were significantly more likely to state they only slightly or not at all (*v.* moderately, very much or extremely) took account of the effect of foods on their child's ability to learn or attention (χ^2 test, $P < 0·0005$ for each association).

Characteristics of parents prioritising different factors when choosing foods for their children

Regression modelling identified that parents having a higher GHI mean score were more likely to consider elements of mental performance as being moderately, very or extremely important when making food choices

http://dx.doi.org/10.1017/S1368980016003062

Table 2 Factors affecting food provision for children among a convenience sample of parents of children aged 4–10 years from four European countries, 2011

	When providing food for your child, to what extent do you take account of the following?																	
		No. and % responding extremely, very much or moderately (*v.* slightly or not at all)						No. and % ranking factor in top three most important										
		Overall ranking		Inter-country differences				All countries (*n* 1574)		England (*n* 397)		Germany (*n* 389)		Hungary (*n* 398)		Spain (*n* 390)		
Factors influencing food provision, ranked*	No. stating 'don't know'	*n*	%	*P*†	Rank‡	Sig. diff.‡	Factors in top three most important influences on food provision, ranked	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	Difference between countries, *P*§
Healthiness of food	21	1505	96·9	0·123	HGES	–	Healthiness of food	1264	80·3	321	80·9	302	77·6	330	82·9	331	79·7	0·305
Offering a variety of food	24	1469	94·8	<0·001	HESG	HES > G	Offering a variety of food	899	57·1	212	53·4	162	41·6	221	55·5	304	77·9	<0·001
Flavour of food	23	1475	95·1	<0·001	HEGS	H > EGS	Child's food preferences	659	41·9	138	34·8	177	45·5	249	62·6	95	24·1	<0·001
Child's food preferences	21	1474	94·9	<0·001	HGES	H > EG > S	Effect of food on child's energy levels	440	28·0	97	24·4	84	21·6	90	22·6	169	43·3	<0·001
Effect of food on child's energy levels	25	1440	93·0	0·985	HESG	–	Flavour of food	429	27·3	101	25·4	121	31·1	114	28·6	93	23·8	<0·001
Effect of food on child's behaviour	39	1306	85·1	0·098	EGSH	–	Cost of foods	328	20·8	117	29·5	58	14·9	120	30·2	33	8·5	<0·001
Effect of food on child's attention	46	1291	84·5	0·013	GESH	G > SH	Effect of food on child's ability to learn	152	9·7	39	9·8	56	14·4	15	3·8	42	10·8	<0·001
Effect of food on child's mood	48	1283	84·1	0·017	GEHS	G > S	Effect of food on child's attention	147	9·3	32	8·1	74	19·0	13	3·3	28	7·2	<0·001
Effect of food on child's ability to learn	49	1277	83·7	0·097	GSHE	–	Ease of preparation	146	9·3	46	11·6	51	13·1	10	2·5	39	10·0	<0·001
Cost of foods	23	1237	79·8	<0·001	HEGS	HE > GS	Effect of food on child's behaviour	141	9·0	55	13·9	31	8·0	21	5·3	34	8·7	<0·001
Ease of preparation	24	1190	76·8	0·040	EGSH	E > H	Effect of food on child's mood	117	7·4	33	8·3	51	13·1	11	2·8	22	5·6	<0·001

*Note that order of presentation of factors to respondents was rotated.
†Using one-way ANOVA based on the 5-point linear scale (1 = not at all to 5 = extremely).
‡For rank and significant differences (sig. diff.): E = England, G = Germany, H = Hungary and S = Spain.
§Using the χ^2 test.

Table 3 Awareness and beliefs of parents about the effect of food on their child's ability to learn and attention, and comparisons between countries, among a convenience sample of parents of children aged 4–10 years from four European countries, 2011

To what extent do you agree or disagree with each of the following statements?*

No. and % agreeing or strongly agreeing (*v*. neither agreeing nor disagreeing, disagreeing, strongly disagreeing or don't know)

	Ability to learn											Attention										
	All countries (*n* 1574)		England (*n* 397)		Germany (*n* 389)		Hungary (*n* 398)		Spain (*n* 390)		Difference between countries, *P*†	All countries (*n* 1574)		England (*n* 397)		Germany (*n* 389)		Hungary (*n* 398)		Spain (*n* 390)		Difference between countries, *P*†
	n	%	*n*	%	*n*	%	*n*	%	*n*	%		*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
I am aware which foods contribute to my child's …	548	34·8	136	34·3	152	39·1	117	30·0	143	35·9	0·061	595	37·8	162	40·8	164	42·4	115	29·5	154	38·7	0·001
I believe food has an impact on my child's …	904	57·4	256	64·5	204	52·4	195	50·0	249	62·6	< 0·001	952	60·5	260	65·5	226	58·1	219	56·2	247	62·1	0·036

*Negative statements have been reversed for clarity.
†Using the χ^2 test.

for their child; hence, putting low priority on mental performance factors was associated with less interest in healthy eating. Parents in Germany (compared with those in England) were more likely to consider a child's ability to learn, attention and mood to be moderately, very or extremely important when making food choices for their child. Similarly, parents in Hungary prioritised ability to learn. White ethnicity was associated with increased likelihood of considering a child's behaviour as important in food choices. Having more children in the family made parents less likely to consider the effect of the food on their child's mood to be moderately, very or extremely important in their food choices (Table 4).

Influences on parents' food choice decisions

Parents reported that their own common sense and experience was the most important influence on decisions about how to feed their child; media sources had little influence in all countries. Differences existed between countries. In contrast to England where parents reported above-average reliance on self and less reliance on family/friends and health professionals, parents in Spain attributed more importance to family/friends and health professionals and less to their own common sense (Table 5).

Discussion

Dietary choices are influenced by a complex web of factors, including palatability (taste, smell, texture), nutritional content, calorific value, cost, convenience and the social context[16]. Almost all parents in each of the four European countries included in the present study rated healthiness of food to be important when choosing food for their child. Lower proportions (80–85 %) considered the impact of food on their child's attention, ability to learn, mood and behaviour to be important, and even lower proportions (about 60 %) stated they believed that food impacted their child's ability to learn and attention. Cost considerations, food variety, flavour and effect of food on energy levels were all more likely to be rated in the top three factors considered by parents in making food choices than the four elements of mental performance. These findings differ somewhat from those of other European[17] and US[18] food and nutrition surveys which found cost and taste to be more important than healthiness, possibly reflecting a reordering of priorities when selecting foods for children. Neither of these major surveys offered mental performance as factors in food choice, indicating the general focus on food as a determinant of physical rather than cognitive functioning.

Across all countries parents with only girls were more likely to state that their child's food preferences were important in their choice of food for the child than parents who had only boys or a mix of boys and girls. Consistent

Table 4 Characteristics and country* of parents considering mental performance factor is moderately, very much or extremely (*v.* not at all or slightly) important when making food choices for their child among a convenience sample of parents of children aged 4–10 years from four European countries, 2011

	No. stating factor is important					95 % CI	
Factor in food choice/dependent variable	Slightly/ not at all	Moderately/ very much/ extremely	Significant characteristics	Exp B†	*P*	Lower	Upper
Effect of food on child's ability to learn	248	1277	GHI mean	1·638	<0·0005	1·451	1·925
			Germany	1·477	0·033	1·033	2·111
			Hungary	1·494	0·024	1·055	2·116
Effect of food on child's attention	237	1291	GHI mean	1·703	<0·0005	1·280	1·959
			Germany	1·510	0·025	1·054	2·165
Effect of food on child's behaviour	229	1306	GHI mean	1·702	<0·0005	1·477	1·961
			White ethnicity	1·932	0·019	1·115	3·345
Effect of food on child's mood	243	1283	Number of children	0·873	0·050	0·762	1·000
			GHI mean	1·549	<0·0005	1·353	1·774
			Germany	1·456	0·037	1·024	2·070

*Independent variables/characteristics of parents included in the modelling: total number of children living at home; General Health Interest (GHI) mean score (1 = low to 7 = high interest/healthy eater); ethnicity white (yes *v.* no); age (in six categories); sex; born in country (yes *v.* no); qualification related to health or nutrition (yes *v.* no); university or college education (*v.* educated to age 18 years at most); country (with England as the reference). Current smoker was omitted due to correlation with GHI: mean (SD) GHI of 1166 non-smokers was 4·73 (1·04) *v.* 4·51 (1·08) for current smokers ($P<0·0005$, unpaired *t* test).
†Adjusted odds ratio for considering the effect of food on element of mental performance to be moderately, very or extremely (*v.* slightly, not at all) important.

with other evidence that shows similarities in parents' feeding styles for boys and girls[19], no other factor in food choice differed according to the sex of the child. It has been shown that parents are likely to modulate their feeding strategies to match each individual child's eating behaviours and that the relationship is complex and interactive[20].

Geographical location can affect access to certain foods, cultural traditions can account for dietary differences, and knowledge and beliefs about the risks and benefits of alternative nutritional decisions influence ability to choose healthy options[21–24]. In this regard, differences were found between countries in their rankings of the factors influencing food choices. For example, providing variety was significantly less important to parents in Germany and most important in Spain. Parents in Hungary generally prioritised elements of mental performance less than parents in England; parents in Germany considered them more important (except for the effect of food on behaviour). Cultural differences in attitudes to foods are well recognised[25,26], but accounting for differences between countries in our results is to some extent speculative as this was not explicitly explored by the questionnaire. It may, however, reflect national differences in policies and public health messages[27].

Lower prioritisation of the effect of food on mental performance indicates the potential for educating parents and building public awareness. Recently, public health concerns have focused heavily on childhood obesity[28] and scope exists to redress this imbalance. Uncertainties exist, however, in the scientific evidence about the relationship between dietary intake and mental performance, resulting in a lack of clear messages for consumers[29–32]. Poor knowledge and understanding were indicated by parental responses to the survey, with less than 40 % reporting they were aware which foods contributed to ability to learn and attention. Multiple factors affect mental functioning, however, and identifying the independent effect of nutrition, from social, economic, genetic and parenting factors, is challenging[7,29]. Further research in this area is required, along with robust dissemination strategies to ensure that key messages about the role of nutrients and eating behaviours, such as skipping breakfast, reach the target audiences[9,33–35]. Respondents in each country stated that decisions about food choices for their children were less influenced by media sources than by health professionals, and that they relied on their own experience and common sense the most, so innovative methods of getting messages over may need to be identified. Understanding subgroups of populations is important for effective public policy; for example, parents with lower general interest in healthy eating were less likely to prioritise all mental performance issues, so may warrant special targeting.

Although care was taken in translating and piloting the questionnaire to ensure uniformity between countries, the findings need to be interpreted in the light of a number of limitations. The study was based on a convenience sample of four countries that provided geographical spread across Europe but may not have been socially and politically representative of the whole European population. In order to recruit large national samples, respondents were drawn from market research panels and significant differences existed between countries in some characteristics. Members of panels are volunteers and are typically reimbursed for the time they spend completing online surveys, so the people attracted to this role are self-selected and may not be representative of the general population in each country[36,37]. The weakness of such approaches is well documented[38] and further research on the representativeness of online samples has been

http://dx.doi.org/10.1017/S1368980016003062

Table 5 Influences on parents' decisions about how to feed their child, and comparisons between countries, among a convenience sample of parents of children aged 4–10 years from four European countries, 2011

How much is your decision about how to feed your child influenced by	Mean score based on 1 = not at all to 5 = extremely (don't know treated as missing)															Difference between countries, *P**
	All countries			England			Germany			Hungary			Spain			
	n	Mean	SD	*n*	Mean	SD	*n*	Mean	SD	*n*	Mean	SD	*n*	Mean	SD	
Self (common sense/experience)	1553	4·08	0·85	388	4·15	0·86	381	4·04	0·94	396	4·17	0·74	388	3·96	0·82	0·001
Family and friends (partner, other family and friends)	1557	3·02	0·94	390	2·78	1·03	382	3·14	0·99	397	3·04	0·86	388	3·15	0·85	<0·0005
Doctor and health professionals	1550	3·27	1·20	387	2·76	1·27	380	3·01	1·27	397	3·51	1·03	386	3·79	0·97	<0·0005
Media (radio, television, advertisements, books, magazines, websites, social networks)	1556	2·31	0·91	390	2·12	0·99	381	2·32	0·98	397	2·34	0·73	388	2·37	0·90	0·095

*Using one-way ANOVA based on the 5-point linear scale (1 = not at all to 5 = extremely).

recommended[37]. Some 38 % of respondents were men and fathers have been shown to have different attitudes to feeding children to those of mothers[39]. At individual and country level, differences were not found between reported awareness and beliefs of men and women about the effect of food. Taking all countries together, however, female respondents were more aware than men of which foods affected their child's attention and ability to learn. Women were also more likely to believe that food affected their child's ability to learn, but there were no differences between men and women in beliefs about the impact of food on their child's attention. The study did not test the nutrition knowledge and understanding of respondents.

Brain development and cognition are important for learning, memory, information processing, reasoning, behaviour and many other functions that affect an individual's life achievements and well-being. Benefit may arise from increasing awareness of the potential role of diet and nutrition in both the brain development and cognitive functioning of children through increasing the quantity and clarity of consumer information[40]. Parents in particular are important gatekeepers to a child's diet and central to the environment in which most children's eating habits are developed[41]. As such they constitute an important target group for communication on the nutritional properties and health effects of foods. Timely, consistent and evidence-based information, tailored to different groups, and delivered in a variety of formats, is needed to form a basis for rational decision making around food choices[42].

Acknowledgements

Acknowledgements: The authors are grateful to the parents who participated in the study. *Financial support:* This work was supported by the European Communities 7th Framework Programme (NUTRIMENTHE; grant agreement no. 212652). The funder had no role in the design, analysis or writing of this article. *Conflict of interest:* All the authors declare no conflicts of interest. *Authorship:* C.C., T.D., B.K., B.E., H.G. and M.R. conceived and designed the study. Data collection and analysis were undertaken by B.B., E.G. and J.-C.L.-R. The statistical analysis was conducted by P.W. The paper was drafted by H.G., B.E. and P.W., and approved by all other authors. *Ethics of human subject participation:* Ethical approval was gained from the University of Surrey research ethics committee.

References

1. Koivisto H (1999) Factors influencing children's food choice. *Ann Med* **31**, Suppl. 1, 26–32.
2. Brown R & Ogden J (2004) Children's eating attitudes and behaviour: a study of the modelling and control theories of parental influence. *Health Educ Res* **19**, 261–271.

3. Brands B, Egan B, Györei E *et al.* (2012) A qualitative interview study on effects of diet on children's mental state and performance. Evaluation of perceptions, attitudes and beliefs of parents in four European countries. *Appetite* **58**, 739–746.
4. Hart K, Herriott A, Bishop J *et al.* (2003) Promoting healthy diet and exercise patterns amongst primary school children; a qualitative investigation of parents' perspectives. *J Hum Nutr Diet* **16**, 18–96.
5. Egan B, Gage H, Williams P *et al.* (2016) The effect of diet on the physical and mental development of children: views of parents and teachers in four European countries. *Br J Nutr* (Epublication ahead of print version).
6. Schmitt JA, Benton D & Kallus KW (2005) General methodological considerations for the assessment of nutritional influences on human cognitive functions. *Eur J Nutr* **44**, 459–464.
7. Isaacs E & Oates J (2008) Nutrition and cognition: assessing cognitive abilities in children and young people. *Eur J Nutr* **47**, Suppl. 3, 4–24.
8. Bellisle F (2004) Effect of diet on behaviour and cognition in children. *Br J Nutr* **92**, Suppl. 2, S229–S232.
9. Benton D (2008) The influence of children's diet on their cognition and behaviour. *Eur J Nutr* **47**, 25–37.
10. Alderman H, Behrman JR, Lavy V *et al.* (1997) Child Nutrition, Child Health, and School Enrollment. A Longitudinal Analysis. Policy Research Working Paper. http://elibrary.worldbank.org/doi/abs/10.1596/1813-9450-1700 (accessed December 2016).
11. Associate Parliamentary Food and Health Forum (2008) The links between diet and behaviour. The influence of nutrition on mental health. Report of an inquiry held by the Associate Parliamentary Food & Health Forum, January 2008. http://www.fabresearch.org/viewitem.php?id=7302 (accessed May 2015).
12. Russell CG, Flight I, Leppard P *et al.* (2004) A comparison of paper-and-pencil and computerised method of 'hard' laddering. *Food Qual Prefer* **15**, 279–291.
13. Russell CG, Busson A, Flight I *et al.* (2004) A comparison of three laddering techniques applied to an example of a complex food choice. *Food Qual Prefer* **15**, 569–583.
14. Roininen K, Lahteenmaki L & Tuorila H (1999) Quantification of consumer attitudes to health and hedonic characteristics of foods. *Appetite* **33**, 71–88.
15. Zelman K (2002) Estimated calorie requirements. Based on Estimated Energy Requirements (EER) from the Institute of Medicine Dietary Reference Intakes Macronutrients report. http://www.webmd.com/diet/features/estimated-calorie-requirement (accessed December 2015).
16. Raats M (2010) The role of consumers. *Nestle Nutr Workshop Ser Pediatr Program* **66**, 161–171.
17. Lappalainen R, Kearney J & Gibney M (1998) A pan EU survey of consumer attitudes to food, nutrition and health: an overview. *Food Qual Prefer* **9**, 467–478.
18. International Food Information Council Foundation (2011) Food and Health Survey: Consumer Attitudes Toward Food Safety, Nutrition and Health. http://www.foodinsight.org/Content/3840/2011%20IFIC%20FDTN%20Food%20and%20Health%20Survey.pdf (accessed May 2015).
19. Webber L, Cooke L, Hill C *et al.* (2010) Associations between children's appetite traits and maternal feeding practices. *J Am Diet Assoc* **110**, 1718–1722.
20. Webber L, Cooke L & Wardle J (2010) Maternal perceptions of causes and consequences of sibling differences in eating behaviour. *Eur J Clin Nutr* **64**, 1316–1322.
21. Pheasant H (2008) Social, behavioural and other determinants of choice of diet. http://www.healthknowledge.org.uk/public-health-textbook/disease-causation-diagnostic/2e-health-social-behaviour/social-behavioural-determinants#1 (accessed January 2015).
22. Shepherd R (1999) Social determinants of food choice. *Proc Nutr Soc* **58**, 807–812.
23. Gibney M, Margetts B, Kearney J *et al.* (Editors) (2004) *Public Health Nutrition*, pp. 147–152. Oxford: Wiley-Blackwell.
24. European Food Information Council (2005) The determinants of food choice. *EUFIC Review* 04/2005. http://www.eufic.org/article/en/expid/review-food-choice/ (accessed January 2015).
25. Trichopoulou A, Naska A & Costacou T; DAFNE III Group (2002) Disparities in food habits across Europe. *Proc Nutr Soc* **61**, 553–558.
26. Musher-Eizenman D, de Lauzon-Guillain B, Holub S *et al.* (2009) Child and parent characteristics related to parental feeding practices. A cross-cultural examination in the US and France. *Appetite* **52**, 89–95.
27. Capacci S, Mazzocchi M, Shankar B *et al.* (2002) Policies to promote healthy eating in Europe: a structured review of policies and their effectiveness. *Nutr Rev* **70**, 188–200.
28. Florence MD, Asbridge M & Veugelers PJ (2008) Diet quality and academic performance. *J Sch Health* **78**, 209–215.
29. Gorbey HE, Brownawell AM & Falk MC (2010) Do scientific dietary constituents and supplements affect mental energy? Review of the evidence. *Nutr Rev* **68**, 697–718.
30. Weichselbaum E & Buttriss J (2011) Nutrition, health and school children. *Nutr Bull* **36**, 295–355.
31. Attuquayefio T & Stevenson RJ (2015) A systematic review of longer-term dietary interventions on human cognitive function: emerging patterns and future directions. *Appetite* **95**, 554–570.
32. Haapala EA, Eloranta A-M, Venalainen T *et al.* (2015) Associations of diet quality with cognition in children – the Physical Activity and Nutrition in Children Study. *Br J Nutr* **114**, 1080–1087.
33. Benton D (2010) The influence of dietary status on the cognitive performance of children. *Mol Nutr Food Res* **54**, 457–470.
34. Hoyland A, Dye L & Lawton CL (2009) A systematic review of the effect of breakfast on the cognitive performance of children and adolescents. *Nutr Res Rev* **22**, 220–243.
35. Levy L (2013) Breakfast and cognition, review of the literature. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/256398/Breakfast_and_cognition_review_FINAL_publication_formatted.pdf (accessed May 2014).
36. Craig B, Hays R, Pickard S *et al.* (2013) Comparison of US panel vendors for online surveys. *J Med Internet Res* **15**, e260.
37. Khazaal Y, van Singer M, Chatton A *et al.* (2014) Does self-selection affect samples' representativeness in online surveys? An investigation in online video game research. *J Med Internet Res* **16**, e164.
38. Evans JR & Mathur A (2005) The value of online surveys. *Internet Res* **15**, 195–219.
39. Blissett J, Meyer C & Haycraft E (2006) Maternal and paternal controlling feeding practices with male and female children. *Appetite* **47**, 2112–2219.
40. Gage H, von Rosen-von Hoewel J, Laiteinen K *et al.* (2012) Health effects of infant feeding for parents in leaflets and magazines in five European countries. *Public Underst Sci* **22**, 365–379.
41. Birch LL & Davison KK (2001) Family environmental factors influencing the developing behavioral controls of food intake and childhood overweight. *Pediatr Clin North Am* **48**, 893–907.
42. Jackson C, Cheater F & Reid L (2008) A systematic review of decision support needs of parents making child health decisions. *Health Expect* **11**, 232–251.

10.2. APPENDIX 2

PUBLISHED PAPERS RELATED TO THE PRESENT THESIS

Appetite 58 (2012) 739–746

Contents lists available at SciVerse ScienceDirect

Appetite

journal homepage: www.elsevier.com/locate/appet

Research report

A qualitative interview study on effects of diet on children's mental state and performance. Evaluation of perceptions, attitudes and beliefs of parents in four European countries ☆

Brigitte Brands [a,*], Bernadette Egan [b], Eszter Györei [c], Juan Carlos López-Robles [d], Heather Gage [b], Cristina Campoy [d], Tamás Decsi [c], Berthold Koletzko [a], Monique M. Raats [b]

[a] Dr. von Hauner Children's Hospital, University of Munich Medical Centre, Lindwurmstr. 4, 80337 Munich, Germany
[b] Food, Consumer Behaviour and Health Research Centre, University of Surrey, GU2 7XH Guildford, United Kingdom
[c] Department of Paediatrics, University of Pécs, József Attila Str. 7, H-7623 PÉCS, Hungary
[d] Department of Paediatrics, School of Medicine, University of Granada, Avda. de Madrid, 11, 18012 Granada, Spain

ARTICLE INFO

Article history:
Received 3 June 2011
Received in revised form 15 October 2011
Accepted 2 January 2012
Available online 10 January 2012

Keywords:
Parental views
Child diet
Health
Mental performance

ABSTRACT

Nutrition is one of the many factors that influence a child's cognitive development and performance. Understanding the relationship between nutrition and mental performance in children is important in terms of their attainment and productivity both in school and later life. Since parents are seen as nutritional gatekeepers for their children's diets, their views and beliefs are of crucial importance. The present study aims to qualitatively examine parents' perceptions of the relationship between diet and mental performance of children. The study was conducted with a total of 124 parents in four European countries using a semi-structured interview schedule. Parents speak of the effects of diet at two levels; the nature of the effects of diet and the characteristics of the foods responsible for these effects. Mental outcomes are related to diet, with the effects perceived to be associated with attention and concentration, often mediated by effects on children's mood and behaviour. Parents categorise foods as 'good' or 'bad' with positive effects related generally to a healthy balanced diet while negative effects are perceived to be associated with sugary and fatty foods. Understanding parental perceptions is important for many purposes including the targeting of dietary advice and prioritising of public health issues.

Introduction

Nutrition is one of a number of factors that may influence a child's development as well as genetic, socio-economic, environmental and behavioural factors. There is much interest in the role of nutrition in a child's physical development but understanding the relationship between nutrition and mental development and performance in children is equally important in terms of their attainment and productivity both in school and in later life (Alderman, Behrman, Lavy, & Menon, 1997; Florence, Asbridge, & Veugelers, 2008). Adequate nutrition in terms of recommended intake levels of macro- and micronutrients is required for the development of the brain and therefore may influence the development of cognitive abilities (Bryan et al., 2004; Morley, 1998).

As the brain grows and develops throughout childhood, one might expect greater demands on the provision of nutrition during periods of rapid growth e.g. from the last trimester of pregnancy until 2 years of age, which if deficient could impair brain structure development (Benton, 2010). This could have long-term consequences for mental functioning. For instance, brain development during childhood includes that of the frontal lobes – nutrition could affect frontal lobe development, influencing the higher cognitive functions they control, such as focusing attention and inhibiting irrelevant stimulation (Bryan et al., 2004).

The role of nutrients in brain development

At a more detailed level, certain nutrients can affect brain cell integrity and structures, signal transduction and neurotransmission as well as brain energy supply and metabolism (Schmitt,

☆ *Acknowledgements:* This research is funded by the European Community's 7th Framework Programme (FP7/2008-2013) under Grant agreement No. 212652 (NUTRIMENTHE project "The Effect of Diet on the Mental Performance of Children"). The research group would like to thank all participating schools and parents. M.R., C.C., T.D., B.K. conceived the study. The interview schedule was designed by B.E., H.G., M.R., B.B., E.G., J-CL-R, and data were gathered and analysed by B.B., B.E., E.G., J-CL-R. The paper was drafted by B.B., with assistance from B.E. and M.R. All authors have reviewed and approved the final version. The authors declare no conflicts of interest.

* Corresponding author.
E-mail address: Brigitte.Brands@med.uni.-muenchen.de (B. Brands).

0195-6663/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
doi:10.1016/j.appet.2012.01.004

Benton, & Kallus, 2005). Micronutrients such as iron may play a critical role in cognitive development as well as in later performance (Thomas, Grant, & Aubuchon-Endsley, 2009). A deficit in iron may result in decreased metabolic activity of brain cells which perturbs cognitive functions in the long term (Bourre, 2006a). Other micronutrients such as iodine and zinc are also considered to be of crucial importance. A deficiency of either iodine during critical periods of cerebral development induces a slowing of brain cell metabolic activity and permanent alterations in the development of the brain. Iodine deficiency is anticipated to lower the IQ on average by 10–15 points at a general population level (Delange, 2001). Zinc plays a role in a multitude of molecular and physiological mechanisms, so even mild to moderate forms of zinc deficiency in children have been associated with reduced development and growth as well as impaired immune function (Bhutta et al., 1999; Brown, Peerson, Rivera, & Allen, 2002). Vitamins also play a role in brain development and function, with all B-vitamins shown to be essential for normal functioning of the brain (Bourre, 2006a).

In terms of macronutrients, polyunsaturated fatty acids (PUFAs) omega-3 and omega-6, particularly Docosahexaenoic acid (DHA) and Eicosapentaenoic acid (EPA), are deemed to be of particular importance for brain development and function since the brain contains a large amount (60%) of lipids (Bryan et al., 2004). Their main mechanism of action seems to be through the maintenance of cell membrane integrity and cell compartment functioning in the Central Nervous System (Bourre, 2006a). Proteins seem to be important during development but also for brain function, as the brain needs a sufficient supply of amino acids for the synthesis of certain neurotransmitters (e.g. catecholamines, serotonin). The quality of dietary proteins influences the nature and quantities of cerebral proteins and neurotransmitters. Since the human body does not possess a reserve for proteins, essential amino acids have to be acquired from food every day (Bourre, 2006b).

The association between diet and cognitive functions

In addition to affecting brain structure, nutrition may also affect cognitive function and performance. 'Cognitive functions' is a broad term used to represent a range of functions and processes associated with the brain, and these functions can be delineated into six main domains: perception, psychomotor functions, attention, memory and learning, language and executive functions (Schmitt et al., 2005), each of which also can be further subdivided into more specific modalities. These domains are closely interlinked and may also be modulated by a range of other factors including arousal, mood and motivation (Fig. 1). Several authors have reviewed the evidence for the influence of nutrition on cognitive functions (Bellisle et al., 1998; Benton, 2008a; Dye & Blundell, 2002; Gibson & Green, 2002) and indicate that measuring the effects of nutrition on mental state and performance is challenging, given the complex nature of cognitive functions, a range of confounding factors such as the time of day the measurement is made, or the composition of the foods used in interventions, and whether short-term or long-term effects are being examined. Various studies have investigated the effects of nutritional interventions across a range of cognitive domains, though principally attention and memory. Results from such studies include the findings that a carbohydrate-rich/protein-poor meal is sedating, while a protein-rich/carbohydrate-poor meal tends to produce mental arousal and improved reaction times; facilitating a rise in blood glucose enhances performance of memory and reaction times (Dye & Blundell, 2002). As well as direct effects on cognitive domains, the effects of nutrition may be mediated through changes in mood or arousal (Gibson & Green, 2002).

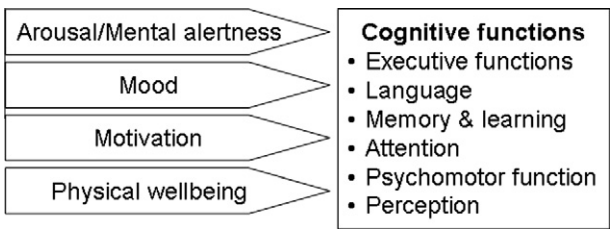

Fig. 1. Expert model of classification of cognitive functions and their modulating factors (redrawn from Schmitt et al., 2005). Cognitive functions can be classified into six areas: perception, psychomotor functions, attention, language, memory and learning and executive functions. Those functions may be modulated by different factors such as the level of arousal (mental arousal or energy), mood and motivation and physical wellbeing.

Beyond specific nutrients and their role in cognitive development and function, eating behaviours such as skipping breakfast is considered to potentially contribute to poor mental performance (Pollitt & Mathews, 1998). The effect of breakfast on cognitive performance may be by providing essential nutrients to the brain as well as alleviating hunger (Bellisle, 2004). A lack of energy leads to decreased glucose and insulin levels in the body which may be associated with impaired cognitive functioning (Benton, 2010). If such a lack of energy provision to the brain occurs frequently, it may be reflected in the level of school performance in the long run (Pollitt, 1995). Children and adolescents seem to be most likely to skip breakfast (Rampersaud, Pereira, Girard, Adams, & Metzl, 2005) – an increased awareness of this has led to the initiation of school breakfast programmes in various European countries, especially in the UK. While skipping breakfast induces short term changes in metabolism, it may also affect overall nutritional status on a long term basis.

Adverse effects of diet

It is also important to consider the potential adverse effects of diet on brain function. In a review of the influence of children's diet on their cognition and behaviour, Benton (2008a) and Benton (2008b) comprehensively cover the potential links between children's behaviour and food intolerance, sucrose intake and additives in foods. Various studies have identified a range of foods and additives that may elicit adverse effects, including cow's milk, chocolate, wheat, grapes, the artificial colourant tartrazine and preservative sodium benzoate. Despite the common perception that sugar adversely influences behaviour e.g. in children with Attention-Deficit Hyperactivity Disorder (ADHD), there is little, if any, evidence of this (Benton, 2008a, 2008b; Ruxton, Gardner, & McNnulty, 2010).

Overall it appears that brain function is sensitive to short-term variations in the availability of nutrients, with stronger findings for 'at-risk' groups (Pollitt, 1995). Thus, children should have a varied diet with good nutritional content and regular intake to ensure the best possible cognitive development and function (Bellisle, 2004; Florence et al., 2008; Tomlinson, Wilkinson, & Wilkinson, 2009) since diet is providing both, the building blocks from which the brain is constructed and the fuel on which it runs (Benton, 2010).

The family is seen as one of the major contexts of a child's development which includes cognitive development and achievement (Scott-Jones, 1984) and specifically parents provide the environment in which young children develop knowledge, behaviours and values (Birch & Davison, 2001). Parents influence all aspects of a child's life to some degree including the development of food choices as well as controlling the availability and types of food in the home (Brown & Ogden, 2004; Golan & Crow, 2004). Moreover, parents' own eating behaviours influence those of their children (Birch & Davison, 2001) and thus the family provides a key

environment for children to learn and develop food preferences and eating habits. Since parents are seen as nutritional gatekeepers, with responsibility for their children's diets, their views and beliefs are of crucial importance (Brown, Ogden, Vogele, & Gibson, 2008).

To date there is little published research about the perceptions and awareness of parents regarding the relationship between nutrition and children's mental performance. Understanding parental perceptions of these relationships is important for many purposes including the development of policy and communication of nutritional information e.g. advice on the appropriate wording of claims. The purpose of the present study was to explore parental perceptions of the relationship between what children eat and their mental performance, and to compare and contrast their views with currently accepted expert models of the role of nutrition in mental performance.

Methods

Qualitative interviews were conducted with a total of 124 parents of children aged 4–10 years who were recruited through state schools in the cities and urban areas of Munich (Germany), Guildford (UK), Pécs (Hungary) and Granada (Spain). The four countries were selected to add strength to the study, reflecting diversity in both health and educational systems as well as differences in family attitudes to food and eating behaviours.

Recruitment of participants

Letters of invitation were sent to the Head Teachers of state schools in socio-economically different districts of each of the participating cities. In Germany, 1–3 schools from each of the 25 districts of Munich were randomly selected and 32 schools contacted, five schools from different districts committed to participate in the study. In England, a sample of state primary schools in the Guilford area was identified and twenty-two schools were approached of which four agreed to participate; subsequently two schools dropped out. In Hungary all 18 state schools were contacted and four schools confirmed their participation. In Spain, six public schools from different districts were contacted and one agreed to participate; a further two semi-private schools also agreed to take part in the study.

The participating schools in the four countries distributed letters to parents via their children. Parents were asked to volunteer to give a short interview by returning a brief screening questionnaire that collected contact details and socio-demographic background information. Participation was encouraged by entering the names of all volunteers in a prize draw for vouchers from a store of the winner's choice. Based on the socio-demographic data provided, parents were invited for interview from a variety of age groups, with different levels of education, and with children of different ages and genders. Inclusion criteria included the ability to speak the native language and being a parent of a child aged 4–10 years. Parents of children with special educational needs or with a diagnosis of a medical or behavioural condition were excluded from the study. Background data collected included the number, ages and gender of participants' children, as well as their employment status and level of education. All data were recorded in a Statistical Package of the Social Sciences (SPSS) database.

Prior to conducting the interviews approval for the study was obtained from the relevant Ethics Committees in all four countries.

Qualitative interviews

A semi-structured interview schedule was developed, based on the aim of the study and relevant literature. A list of topics for the interview questions was agreed upon by the four participating countries and a preliminary interview format developed. Topics included questions on parents' beliefs and perceptions of the effects of diet on children aged 4–10, such as effects on wellbeing and development, physical and mental status, effects of specific foods on their mental or physical state as well as prompting for short or long term effects of diet and foods (Table 1). The preliminary schedule was translated and piloted in all countries to ensure that the type, flow and number of questions were appropriate to the aims of the study and to pre-test for clarity and comprehension. Transcripts of the pilot interviews were evaluated and compared and a final interview schedule agreed. Based on experiences with pilot interviews, the schedule also included revised prompts to aid interview progress when parents' answers were brief and to ensure that crucial points were covered.

Interviews were conducted with parents on school premises and lasted 15–20 min. All interviews were audio-taped with the interviewee's permission and transcribed verbatim.

Data analysis

All transcripts were subjected to thematic analysis (Braun & Clarke, 2006) using the software NVivo 8 (Welsh, 2002). Data were analysed primarily by researchers in the national languages in order to minimise the risk of losing participants' meanings and to present a comprehensive overview of the content of each data set at national level. Subsequently, a cross-national coding tree was developed which included definitions of each code to ensure standardised coding (Graneheim & Lundman, 2004). Interview transcripts in each country were then analysed and detailed national reports, with supporting quotations, prepared in English for each country. Based on

Table 1
Interview structure.

Questions	Prompts
Thinking about children in general (aged 4–10) do you think that food has an effect on children's wellbeing and development?	In what ways does it affect children? Can you give me some examples?
Do you think that what children eat affects them physically?	In what way does it affect them physically – weight, sleep, energy levels?
Do you think what children eat affects their mood/behaviour?	How would you recognise these effects?
If so, how and in what ways - positive and negative?	(Alertness, restlessness, calm/excited, arousal, anger, fatigue, lethargy, confusion and irritability)
Do you think that food might affect children's mental performance? If so, how and in what ways?	Academic performance, concentration, attention, memory.
Do you think that what children eat affects them now or could it affect them in the future?	In what ways might food affect them?
Thinking about foods, are there any specific foods that you think affect children, either positively or negatively?	Can you give me some examples of foods that affect children- good and/or bad effects? How do you think these foods might have these effects?

Table 2
Characteristics of participating parents in the different European countries.

		Percentage of parents in				
		Germany	Spain	England	Hungary	Total
Sample size, *n*		35	35	31	23	124
Number of children in the family	1	17.1	17.1	16.1	39.1	21.0
	2	62.9	65.7	45.2	56.5	58.1
	3	11.4	14.3	25.8	4.3	14.5
	4	8.6	2.9	9.7	0	5.6
	5	0	0	3.2	0	0.8
In paid employment	Yes	60.0	80.0	71.0	100.0	75.8
	No	37.1	20.0	29.0	0	23.4
	Missing	2.9	0	0	0	0.8
Highest level of education completed	Primary school	0	25.7	0	0	7.3
	Secondary school age15/16	5.7	17.1	16.1	4.3	11.3
	Secondary school age 17/18	37.1	22.9	3.2	39.1	23.4
	College	25.7	20.0	51.6	30.4	31.5
	University	31.4	14.3	29.0	26.1	25.0
Participant relation to child(ren) aged 4–10	Mother	94.3	77.1	90.3	100.0	89.5
	Father	5.7	22.9	9.7	0	10.5

these national reports, key themes and relations were identified across the four countries for comparison in a final step resulting in a cross-national report. This report was systematically cross-checked in each country for appropriateness of interpretation and quotes by several researchers (B.B., B.E., E.G., J-CL-R) in order to increase the credibility and validity of the results, a process referred to as investigator triangulation (Patton, 1999). During the analysis, a particular emphasis was placed on examining parental perceptions of the relationship between food and mental performance.

Results

Between October 2008 and May 2009 a total of 124 face-to-face interviews were conducted with parents in the four countries. The majority of parents interviewed were mothers except for Spain where approximately a fifth of participants were fathers (Table 2). Over half of the participants had a college degree or higher except for Spain where about 65% had a lower educational level. More than 60% of parents had two or three children while the rate of single child families was highest in Hungary compared to the other countries. Parents were responsible for choosing the food being served at home in all countries. More than 60% of participants were in paid employment at the time of the interviews while in Hungary this rate was 100%.

A number of themes emerged from the analysis of the interviews regarding the relationship between diet and mental performance. Concerning diet, participants spoke of the characteristics of a healthy diet, characteristics of foods and drinks which constitute diet and the quantity and timing of foods and drinks. Regarding mental performance, the key findings relate primarily to attention, mood and behaviour (Fig. 2). In addition, the issue of hydration was identified as important in the German data. Details of the findings, which reflect the views of the majority of parents are presented, supported by relevant quotations from participants that best describe the findings.

Parents were initially asked the question if they thought diet had an effect on a child's wellbeing and development and if so in what way. Parents in all countries referred to a number of physical and mental outcomes which are associated with what children eat. In describing these outcomes, parents often mentioned their first-hand observations of the effects in their own children and also in the children of friends and relatives.

In all countries, the majority of parents were of the basic opinion that what a child eats affects their development, wellbeing and health:

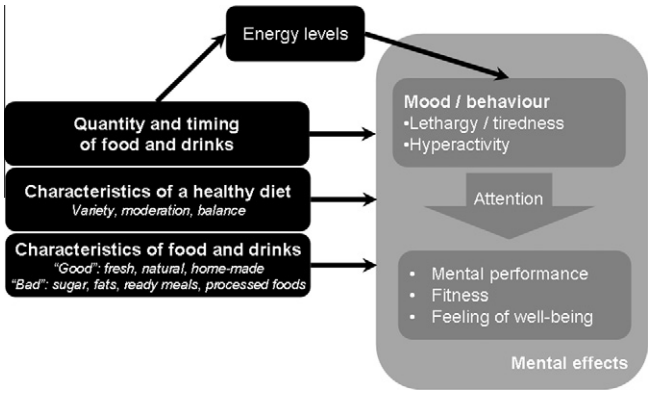

Fig. 2. Schematic representations of parental perceptions of the relationship between diet and mental outcomes in children. Effects of diet on mental performance are related to foods in specific ways: parents speak about the characteristics and quantity of foods, clearly distinguishing between "good" and "bad" foods. Positive outcomes are related to a healthy diet, with effects on mental performance, fitness and well-being. More specific effects are mainly perceived to be on attention; often mediated by a child's mood and behaviour which in turn is influenced by a child's energy level.

> "*I strongly believe that there is a very close relationship between nutrition and development. We are what we eat*". (Hungary – P03)

> "*I am a great believer in you are what you eat so if you have burgers, burgers, burgers, honestly that would not be good for your health surely*". *(England* – P03)

Many of the parents interviewed spoke initially in general terms about the relationship between what children eat and their development and only spoke of more specific effects of diet when probed. However more than half of the parents in England and Germany did refer to more specific physical and mental outcomes without probing, mentioning in particular hyperactivity, concentration and changes in behaviour linked to diet.

The effect of what children eat on their energy levels was one of the main outcomes referred to by the majority of participants in all four countries and was in turn seen to be closely related to the mental effects of diet. Food is perceived as being the source of a child's energy, with parents distinguishing between the effects of different types of foods and the amount of food consumed; e.g. having eaten too little or too much food results in tiredness and lethargy:

"*Short term, it (the diet) could have an influence on all that we have been saying before, when you are in school for example, you notice the tiredness because sometimes they do not have the energy that they should*". (Spain – P32)

"*If we give fat rich stew to a smaller child, he will become full and he will suffer from tiredness. On the other hand, if we give some greens which are easier to digest then I think he will have enough energy and he will be more vigorous, able to play, to run […]*". (Hungary – P08)

Often parents seemed to be referring to 'mental energy' though generally they did not distinguish between this and what could be termed physical/biological energy, with only a handful of parents referring to alertness.

Across all countries the predominant aspects of mental performance to emerge were concentration and attention, as well as on a more general level, mental fitness and the feeling of well-being. For many of the parents the feeling of well-being achieved by a balanced and healthy diet seems to be a fundamental requirement for good performance.

"*I am not a scientist but I believe in the saying a healthy mind is in a healthy body [...] we try in our family to have a varied diet and doing lot of physical exercise, too […]*". (Spain – P45)

"*I think if they do not eat the food it will affect their concentration and if they are at school, those are times you need to concentrate, so your morning period, if you have eaten well in the morning you will be fine but then obviously in the afternoon if you do not eat properly your concentration's going to suffer". (England* – P07)

While some parents spoke of the effects of diet in terms of a specific aspect of cognitive function, such as attention, others related the effect of diet to changes in mood and behaviour. Very often the effects of foods were perceived to be mediated by their effects on children's mood and behaviour, which in turn affected concentration and mental performance.

"*Well when my children eat too many sweets, they get nervous and can not concentrate any more*". (Germany – P07)

"*[…] with a balanced diet, rice, chicken fish […] they are happy, they are sitting quietly and I have seen that their behaviour is quite nice after that". (England* – P01)

Quite often parents used the terms diet, nutrition and food interchangeably and more rarely referred to specific nutrients. However for the majority of parents there was a very clear delineation between what they considered to be 'good' and 'bad' foods, with this categorisation based on the effects associated with these foods.

Parents in all four countries referred to the general concept of a healthy diet which involves balance, variety and moderation. This ideal diet should be fresh and natural as opposed to being ready made and containing artificial ingredients. Foods that form part of this ideal diet are described in such terms as good, healthy and often include meals that are home-cooked.

"*Yes, everything should be covered […] enough milk products, fruit and then also vegetables and every once and a while meat and also some sweet stuff. There should not be any prohibitions but it should all be balanced, not too much of one thing and too little of the other*". (Germany – P47)

Parents associated positive effects on mental performance with a diet that is often described in general terms:

"*I am a firm believer in a balanced diet of lots of fruit and vegs and the right types of food for their concentration during the day, slow release foods so I do not put biscuits and things in their lunchbox […]". (England* -– P14)

In contrast, parents referred to certain food in distinctly negative terms, being described as junk food, rubbish food, bad food or fast food. Unlike the general nature of positive foods, parents mentioned very specific foods in negative terms; including sugar, sweets, ready meals, processed foods and foods rich in fat:

"*Obesity […] much McDonalds and such a things can cause it, we do not eat there regularly, just occasionally, I fight against the fast foods, I cook, well*". (Hungary – P06)

"*Erm, obviously if they were to eat a load of what I consider to be junk foods, sweets and cakes and bits they obviously then are going to become obese, and again not willing to participate in exercise and things like that*". (England – P03)

Most of the parents in all four countries considered foods rich in sugar as negatively influencing behaviour and mental performance. However, a clear dose-dependent relationship was attributed to sugar and its short term effects. Low sugar levels were perceived to result in a lack of energy, reducing mental performance in general and more specifically the ability to concentrate, whereas high sugar levels caused hyperactive behaviour and an inability to focus and concentrate.

"*Well, as you know sugar makes them change a bit, for example when you give them a lot of sugar in the evening I have the feeling they are climbing up the walls*". (Spain – P55)

"*For instance, in my opinion, when a child is hypoglycaemic […] no matter if in school or in the afternoon when they return from school, from the after school care centres, and eat something at home, that they, that this gives back the ability to concentrate better again, for instance, or as I indicated earlier, the more sugar the more nervous. Well, this is really something that I can confirm*". (Germany – P09)

Regarding meals, parents in all countries perceived breakfast to be important in terms of its effects on children's mental performance, particularly in the context of school performance.

"*For example, if a child does not have breakfast in the morning or the wrong things for breakfast it may happen that after an hour or two in class, the child just does not perform as well as other children*". (Spain – P26)

"*Attention and concentration relates to whether they had breakfast or not, very significantly*". (Hungary – P10)

"*[…] but a good whole hearty breakfast will keep you full, in theory, until mid-morning but if you do not have breakfast it makes you lethargic and lacks concentration but also to a certain extent, can be good or bad, everything in moderation*". (England – P02)

The majority of parents spoke of breakfast in these general terms, often referring to simply having breakfast as being important, without specifying what the nutritional composition of such a breakfast might be.

"*[…] Well one says that when you have not had a good breakfast that you can not do good work. Well, I do think that it is important, I insist that they eat something for breakfast even though this might be very little*". (Germany – P48)

"*Breakfast, well it has always been said that it is very important: it is the first meal of the day and it has to be important, it gives you all the energy that you need throughout the day – having a good breakfast is very important*". (Spain –P33)

In addition to the influence of types of food eaten, the amount of food consumed by children was perceived to be equally important in terms of its effects on their mental performance.

Having sufficient food was considered important and necessary both to alleviate hunger and to provide energy. Hunger was perceived to be a distraction and barrier to concentration and mental performance as well as causing bad moods. Eating too little potentially reduces mental performance either because children are being distracted by feelings of hunger or by a lack of energy which results in children being unable to concentrate and work.

"*Yes, when you leave the house in the morning and haven't eaten something then I think that you can't concentrate because you are hungry and you can not concentrate on anything else and I also think that what you eat is important*". (Germany – P34)

"*Yes, I do because again if you are hungry, all you are thinking about is hunger. You are not concentrating*". *(England – 43)*

"*If they are hungry, their thoughts focus on eating. If they are full or have eaten too much, they are sleepier or pay less attention*". (Hungary – P19)

In Germany and Hungary, the majority of parents mentioned that consuming junk foods, foods rich in fat or simply eating too much causes lethargy and thus decreases performance and the feeling of wellbeing. This was not mentioned by many of the English parents and even less so by Spanish parents.

"*[. . .] Well they are so flabby, well when they are so [. . .] I have seen that once, when they have eaten too much or those fatty things and then meat, than they are so tired and lazy. Well, one [. . .] Yes. You can see it that they don't have any motivation and get into a bad mood [. . .]*". *(Germany–* P26)

In contrast to the other countries, German parents referred to a good level of hydration as being very important for good mental performance – a lack of hydration is perceived to result in mental lethargy or bad mood. Noticeably, German parents mention liquids in general rather than giving examples of what kind of liquids are seen to be positive or negative.

"*[. . .] I think that simply a healthy mixture of all, all what the body needs should be in place. What I believe is very important are liquids and that enough is being drunk in order to. . . Yes, because it makes you floppy and tired when one doesn't drink enough, right?*" (Germany – P14)

In summary across all four countries the majority of parents believe that there is a relationship between what children eat and their mental performance. The findings reveal that parents speak of the effects of diet on mental performance at two levels: the nature of the effects observed and the characteristics of foods responsible for these effects. More specifically parents observe diet affecting attention and concentration, both directly and indirectly; with the indirect effects of diet mediated by effects on children's mood and behaviour. Generally parents refer to the more immediate, short-term effects of diet on brain function and attribute these effects primarily to the nature of the diet consumed. Parents distinguish between 'good' and 'bad' foods with this dichotomy related to the effects associated with these foods. The quantity of food consumed is also important, both in terms of the energy supplied and the alleviation of hunger. Hydration emerges as an important issue for German parents.

Discussion

Most of the research to date on parental perceptions of the effects of diet relates to physical outcomes such as obesity (Hart, Herriot, Bishop, & Truby, 2003; Hesketh, Waters, Green, Salmon, & Williams, 2005; Withall, Jago, & Cross, 2009) with little published research on the effects of diet on mental outcomes. This study addressed the question as to whether parents relate diet to a child's mental performance, what their predominant perceptions and beliefs are about this relationship and how these compare to current expert models.

In terms of the effects of diet on mental performance, parents spoke predominantly of effects on "attention" and "concentration". Attention is a major cognitive process, which appears to underlie other abilities such as learning, memory or more complex mental abilities (Hughes & Bryan, 2003). Numerous studies on the potential effects of nutrition on performance have used tasks which measured attention, though results are difficult to compare because of the heterogeneity of the studies. We can interpret concentration as sustained attention.

Although parents spoke of some direct effects of food on attention and concentration, quite often these effects were described as being mediated by effects on mood and behaviour. Mood is not in itself a cognitive function but an affective state, closely related to emotion (Westenhoefer et al., 2004). Mood is thus malleable and changes in mood associated with diet were quite clearly linked by parents to changes in mental performance. There is ample evidence of the effects of food on mood (Rogers, 1995), though many studies have focused on the effects on mood as the primary outcome, rather than the mediating effects of mood on changes in cognitive function.

Parents in all countries related the effects on mental performance to foods in specific ways; speaking about the characteristics and quantity of food and drinks. Positive effects are most often associated with children having a healthy balanced diet and positive foods such as fruits, vegetables and wholegrain products. Overall, there is a remarkable degree of similarity across the four countries regarding parent's concept of a healthy diet. This reflects the findings of a review of perceptions of healthy eating which reported considerable homogeneity across studies from different countries, involving different age groups, sexes and socio-economic status (Paquette, 2005).

Parents consistently represented a healthy diet as one encompassing balance, variety and moderation and including foods such as fruit and vegetables, with low levels of fat, salt and sugar. The quality aspects of food were also important with foods described as natural, fresh, homemade and unprocessed. Similar results were reported in a study of the meaning of healthy and unhealthy eating among adolescents where foods were described either in terms of food characteristics, using summary terms such as "right types of food" "natural stuff" or by naming specific foods or food groups (Croll, Neumark-Sztainer, & Story, 2001).

Positive mental effects were perceived to be a longer term outcome of a healthy diet; in contrast negative effects were perceived to be more immediate and short term and associated with specific foods and nutrients. Parents named numerous foods that they considered to be unhealthy, many more than in the healthy category. These included sugar, fat chips, sweets, fast food, fizzy drinks and pizza.

Parents distinguished very clearly between good and bad foods and see the composition of a child's diet as crucial for their physical and mental wellbeing. In previous research on food evaluation and health it was found common for individuals to categorise foods according to a good–bad dichotomy, based on specific food qualities (Rozin, Ashmore, & Markwith, 1996). In discussing "good" and "bad" foods parents often mentioned the importance of achieving an optimum balance and this is well illustrated by their perceptions of the effect of sugar.

Parents in all four countries spoke of sugar as having a dose-dependent effect: having too little is associated with a lack of energy and low blood sugar levels which result in mental lethargy, tiredness, bad mood and the inability to concentrate. In contrast, having food containing high sugar levels leads to an excess of

energy resulting in hyperactive behaviour and thus the inability to sit still and concentrate. From a scientific perspective, glucose is the primary source of energy for the human brain – an inadequate supply of glucose has been shown to result in a significant loss of mental function (Hoyland, Lawton, & Dye, 2008). A high intake of sugar has been associated in several studies with behavioural problems and hyperactivity in children, particularly in those with Attention-Deficit Hyperactivity Disorder (ADHD), although the majority of controlled experimental studies were not able to support this hypothesis (Associate Parliamentary & Health, 2008; Bellisle, 2004; Brown & Ogden, 2004).

As diet is perceived to be the source of a child's energy, parents view a lack of food as having a significant effect on children's performance. In addition to the lack of energy resulting from not eating, feelings of hunger are perceived to be a barrier to a child's ability to concentrate and to perform well mentally. This is particularly relevant in the context of missing breakfast before school, although eating something for breakfast is perceived to be more important than its nutritional composition. Hunger and lack of breakfast have been shown as significant factors negatively affecting learning and academic achievement by studies assessing nutritional influences on mental performance in children (Florence et al., 2008; Grantham-McGregor, 2005; Hoyland et al., 2008; Hughes & Bryan, 2003) .

The interviews highlight that parents' aim for children to have a constant supply of energy which in turn ensures a constant level of attention and concentration. Parents believe that this can be achieved by children having sufficient quantities of those foods which are constituents of a healthy balanced diet.

An important issue for the majority of German parents was the level of hydration of a child, which was perceived to play an important role in mental performance. Too little fluid intake during the school day is seen to be a major cause of lethargy and bad mood as well as the inability to concentrate. A negative effect of dehydration on cognitive functions of children has been shown by studies in the field (Bar-David, Urkin, & Kozminsky, 2005; D'Anci, Constant, & Rosenberg, 2006). This awareness of the importance of hydration may be due to public health initiatives in Germany that recommend good hydration of children in order to promote good physical and mental performance (e.g. public health initiative "Trinken im Unterricht" which promotes the availability of liquids at school and especially during classes, www.trinken-im-unterricht.de).

The methodological approach in the present paper calls for some caution when interpreting the findings. Since participants volunteered for the study, the sample may not be representative of the community of parents in terms of socio-demographics, knowledge and awareness or other values. The majority of participants from the four countries were mothers and very similar in terms of education, age and gender, which limits the interpretation of the findings somewhat. Due to the qualitative nature of the data selection bias may have occurred, though there were standardised procedures to increase objectivity and reliability. However, the results do not claim to reflect an exhaustive census, but are useful for revealing meaningful findings which are being used as the basis for a quantitative study which should provide further insights from a more diverse sample.

In summary, parents of the 4–10 years old children in all four participating countries attest to a relationship between what children eat and their mental performance. The effects are perceived to be primarily on attention and concentration, often mediated by effects on mood and behaviour. Positive effects are associated with a healthy balanced diet with beneficial effects on feelings of wellbeing, mental fitness and performance; in contrast, parents perceive specific foods and nutrients as having negative effects on mental outcomes such as attention, concentration, mood and behaviour. In feeding their children parents strive to achieve an ideal optimal nutritional balance, which ensures that children can perform well, both in terms of development and performance.

Overall the effects of diet on mental performance reported by parents correlate in the main with those reported in the literature, as described earlier. Although parents focus mainly on a single aspect of cognition, attention, this is the domain often used to assess nutritional influences on performance. Similarly parents recognise the effects of diet on mood, which is considered a modulating factor of cognitive performance. Given the acknowledged complexity of assessing nutritional influences on cognitive performance, research on parental perceptions in this area is needed if policy and appropriate interventions are to be developed. Such research should provide valuable input to inform effective nutritional communication, education and public health initiatives where mental performance is an important outcome.

References

Alderman, H., Behrman, J. R., Lavy, V., Menon, R., (1997). Child Nutrition, Child Health, and School Enrollment. A Longitudinal Analysis.SSRN eLibrary.

Associate Parliamentary, F., & Health, F., (2008). *The Links Between Diet and Behaviour. The influence of nutrition on mental health.*.

Bar-David, Y., Urkin, J., & Kozminsky, E. (2005). The effect of voluntary dehydration on cognitive functions of elementary school children. *Acta Paediatrica, 94*(11), 1667–1673.

Bellisle, F. (2004). Effects of diet on behaviour and cognition in children. *British Journal of Nutrition, 92*(Suppl 2), S227–S232.

Bellisle, F., Blundell, J. E., Dye, L., Fantino, M., Fern, E., Fletcher, R. J., et al. (1998). Functional food science and behaviour and psychological functions. *British Journal of Nutrition, 80*(Suppl 1), S173–193.

Benton, D. (2008a). The influence of children's diet on their cognition and behavior. [Article]. *European Journal of Nutrition, 47*, 25–37.

Benton, D. (2008b). Sucrose and behavioral problems. [Review]. *Critical Reviews in Food Science and Nutrition, 48*(5), 385–401.

Benton, D. (2010). The influence of dietary status on the cognitive performance of children. [Review]. *Molecular Nutrition & Food Research, 54*(4), 457–470.

Bhutta, Z. A., Black, R. E., Brown, K. H., Gardner, J. M., Gore, S., Hidayat, A., et al. (1999). Prevention of diarrhea and pneumonia by zinc supplementation in children in developing countries. Pooled analysis of randomized controlled trials. Zinc Investigators' Collaborative Group. *Journal of Pediatrics, 135*(6), 689–697.

Birch, L. L., & Davison, K. K. (2001). Family environmental factors influencing the developing behavioral controls of food intake and childhood overweight. *Pediatrics Clinical North America, 48*(4), 893–907.

Bourre, J. M. (2006a). Effects of nutrients (in food) on the structure and function of the nervous system. Update on dietary requirements for brain. Part 1. Micronutrients. *Journal of Nutrition Health and Aging, 10*(5), 377–385.

Bourre, J. M. (2006b). Effects of nutrients (in food) on the structure and function of the nervous system. Update on dietary requirements for brain. Part 2. Macronutrients. *Journal of Nutrition Health and Aging, 10*(5), 386–399.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101.

Brown, R., & Ogden, J. (2004). Children's eating attitudes and behaviour. A study of the modelling and control theories of parental influence. *Health Education and Research, 19*(3), 261–271.

Brown, K. A., Ogden, J., Vogele, C., & Gibson, E. L. (2008). The role of parental control practices in explaining children's diet and BMI. [Article]. *Appetite, 50*(2–3), 252–259.

Brown, K. H., Peerson, J. M., Rivera, J., & Allen, L. H. (2002). Effect of supplemental zinc on the growth and serum zinc concentrations of prepubertal children. A meta-analysis of randomized controlled trials. *American Journal of Clinical Nutrition, 75*(6), 1062–1071.

Bryan, J., Osendarp, S., Hughes, D., Calvaresi, E., Baghurst, K., & van Klinken, J. W. (2004). Nutrients for cognitive development in school-aged children. *Nutrition Reviews, 62*(8), 295–306.

Croll, J. K., Neumark-Sztainer, D., & Story, M. (2001). Healthy eating. What does it mean to adolescents? *Journal of Nutrition Education, 33*(4), 193–198.

D'Anci, K. E., Constant, F., & Rosenberg, I. H. (2006). Hydration and Cognitive Function in Children. *Nutrition Reviews, 64*(10), 457–464.

Delange, F. (2001). Iodine deficiency as a cause of brain damage. *Postgraduate Medical Journal, 77*(906), 217–220.

Dye, L., & Blundell, J. (2002). Functional foods. Psychological and behavioural functions. *British Journal of Nutrition, 88*, S187–S211.

Florence, M. D., Asbridge, M., & Veugelers, P. J. (2008). Diet Quality and Academic Performance*. *Journal of School Health, 78*(4), 209–215.

Gibson, E. L., & Green, M. W. (2002). Nutritional influences on cognitive function. Mechanisms of susceptibility. *Nutrition Research Reviews, 15*(1), 169–206.

Golan, M., & Crow, S. (2004). Parents are key players in the prevention and treatment of weight-related problems. *Nutrition Reviews, 62*(1), 39–50.

Graneheim, U. H., & Lundman, B. (2004). Qualitative content analysis in nursing research. Concepts, procedures and measures to achieve trustworthiness. *Nurse Education Today, 24*(2), 105–112.
Grantham-McGregor, S. (2005). Can the provision of breakfast benefit school performance? *Food Nutrition Bulletin, 26*(Suppl 2), S144–158.
Hart, K. H., Herriot, A., Bishop, J. A., & Truby, H. (2003). Promoting healthy diet and exercise patterns amongst primary school children. A qualitative investigation of parental perspectives. *Journal of Human Nutrition Diet, 16*(2), 89–96.
Hesketh, K., Waters, E., Green, J., Salmon, L., & Williams, J. (2005). Healthy eating, activity and obesity prevention. A qualitative study of parent and child perceptions in Australia. *Health Promotion International, 20*(1), 19–26.
Hoyland, A., Lawton, C. L., & Dye, L. (2008). Acute effects of macronutrient manipulations on cognitive test performance in healthy young adults. A systematic research review. *Neuroscience & Biobehavioral Reviews, 32*(1), 72–85.
Hughes, D., & Bryan, J. (2003). The assessment of cognitive performance in children. Considerations for detecting nutritional influences. *Nutrition Reviews, 61*(12), 413–422.
Morley, R. (1998). Nutrition and cognitive development. *Nutrition, 14*(10), 752–754.
Paquette, M. C. (2005). Perceptions of healthy eating. State of knowledge and research gaps. *Canadian Journal of Public Health, 96*(Suppl 3). S15–19, S16–21.
Patton, M. Q. (1999). Enhancing the quality and credibility of qualitative analysis. [Proceedings Paper]. *Health Services Research, 34*(5), 1189–1208.
Pollitt, E. (1995). Does breakfast make a difference in school? *Journal of American Diet Association, 95*(10), 1134–1139.
Pollitt, E., & Mathews, R. (1998). Breakfast and cognition. An integrative summary. *American Journal of Clinical Nutrition, 67*(4), 804s–813s.
Rampersaud, G. C., Pereira, M. A., Girard, B. L., Adams, J., & Metzl, J. D., (2005). Breakfast habits, nutritional status, body weight, and academic performance in children and adolescents. *Journal of American Diet Association, 105*(5), 743-760; quiz 761–742.
Rogers, P. J. (1995). Food, mood and appetite. *Nutrition Research Reviews, 8*(1), 243–269.
Rozin, P., Ashmore, M., & Markwith, M. (1996). Lay American conceptions of nutrition. Dose insensitivity, categorical thinking, contagion, and the monotonic mind. *Health Psychology, 15*(6), 438–447.
Ruxton, C. H. S., Gardner, E. J., & McNnulty, H. M. (2010). Is Sugar Consumption Detrimental to Health? A Review of the Evidence 19952006. [Review]. *Critical Reviews in Food Science and Nutrition, 50*(1), 1–19.
Schmitt, J. A., Benton, D., & Kallus, K. W. (2005). General methodological considerations for the assessment of nutritional influences on human cognitive functions. *European Journal of Nutrition, 44*(8), 459–464.
Scott-Jones, D. (1984). Family Influences on Cognitive Development and School Achievement. *Review of Research in Education, 11*, 259–304.
Thomas, D., Grant, S., & Aubuchon-Endsley, N. (2009). The Role of Iron in Neurocognitive Development. [Review]. *Developmental Neuropsychology, 34*(2), 196–222.
Tomlinson, D., Wilkinson, H., & Wilkinson, P. (2009). Diet and Mental Health in Children. [Article]. *Child and Adolescent Mental Health, 14*(3), 148–155.
Welsh, E. (2002). Dealing with Data. Using NVivo in the Qualitative Data Analysis Process. Forum Qualitative Sozialforschung/Forum. *Qualitative Social Research, 3*(2), Art.26.
Westenhoefer, J., Bellisle, F., Blundell, J. E., de Vries, J., Edwards, D., Kallus, W., et al. (2004). PASSCLAIM. Mental state and performance. [Review]. *European Journal of Nutrition, 43*, 85–117.
Withall, J., Jago, R., & Cross, J. (2009). Families' and health professionals' perceptions of influences on diet, activity and obesity in a low-income community. *Health Place, 15*(4), 1078–1085.

European Journal of Clinical Nutrition (2014) **68**, 32–37

www.nature.com/ejcn

ORIGINAL ARTICLE

Views of parents in four European countries about the effect of food on the mental performance of primary school children

H Gage[1], B Egan[2], P Williams[3], E Györei[4], B Brands[5], J-C López-Robles[6], C Campoy[6], B Koletzko[5], T Decsi[4] and M Raats[2]

BACKGROUND/OBJECTIVES: Several factors affect the mental performance of children. The importance that parents attribute to food-related determinants, compared with genetic, socio-economic and school environment, was investigated.
SUBJECTS/METHODS: Parents of school children (aged 4–11) were recruited through state primary schools in four European countries. Interviews were conducted in which participants were asked to sort 18 cards representing possible determinants of four elements of mental performance (attention, learning, mood and behaviour) according to perceived strength of effect. Determinants were identified from the literature and grouped in six categories: food-related, school environment, physical, social, psychological and biological. Effects were scored: 0 = none; 1 = moderate; and 2 = strong. Views were compared between and within countries.
RESULTS: Two hundred parents took part (England: 53; Germany: 45; Hungary: 52; Spain: 50). Differences existed between countries in the proportions reporting university education and being in employment. Taking all countries together, parents consider the food category (mean 1.33) to have a lower impact on a child's mental performance than physical (activity and sleep, 1.77), psychological (mood and behaviour, 1.69) and school environment (1.57). Social (1.12) and biological (0.91) determinants were ranked lower than food. Of determinants in the food category, parents thought regularity of meals had more influence on mental performance (1.58) than what a child eats now (1.36), food at school (1.35), nutrition as a baby/infant (1.02).
CONCLUSION: Scope exists to improve parental awareness of the repercussions of their dietary choices for the mental performance of their children.

European Journal of Clinical Nutrition (2014) **68,** 32–37; doi:10.1038/ejcn.2013.214; published online 27 November 2013

Keywords: Food; mental performance; children; parents; European countries

INTRODUCTION

Nutrition is one of several factors affecting the cognitive development and mental performance of children; other possible influences include genetics, socio-economic background and educational environment.[1] Children need a varied diet with good nutritional content for optimal cognitive development and functioning.[2–5] In early years, a child's nutrition is largely determined by the home environment. Parents' choices affect the provision of food[6–8] so their beliefs, views and behaviours are important.[9] Although parental perceptions and awareness of the impact of diet on physical health is an important public health issue, little attention has been devoted to exploring parents' views about the relationship between nutrition and children's mental performance.[3]

Qualitative interviews with parents of primary school children undertaken previously by the authors confirm that parents believed that diet affects the mental performance, as well as the physical health and wellbeing, of children.[10] The findings from further interviews with a new sample of parents of primary school children are reported in the current paper. This subsequent study aimed to investigate how important parents think food is as an influence on mental performance, compared with other possible relevant factors, such as home background and the school environment. It also explored parents' views about the importance of four different food-related behaviours on mental performance. The study was conducted in four culturally diverse European countries and focussed on children aged 4–10 years, because beyond that age range parental influence over diet and nutrition of their children is likely to diminish.

MATERIALS AND METHODS

The study design and details were agreed between the international research teams through several face-to-face meetings and intervening e-mail exchanges. Ethical approval was gained in all countries according to local procedures.

Participants' views about the relative importance of food, compared with other possible influences on mental performance of children, were collected using a sorting experiment.[11] Parents were asked to sort cards representing 18 possible determinants of mental performance according to whether they thought each determinant had a strong, moderate or no effect on each of four different elements of mental performance. There are many different dimensions to cognitive functioning, and interactions between them are complex.[12] Only four elements (attention, learning, mood and behaviour) were selected for use in the experiment, to reduce respondent burden and to try and ensure engagement during the administration of the whole experiment.

Conceptual framework

Basing the sorting experiment on concepts that were meaningful to respondents was considered important, so selection of the elements of

[1]Department of Economics, University of Surrey, Guildford, UK; [2]Food, Consumer Behaviour and Health Research Centre, University of Surrey, Guildford, UK; [3]Department of Mathematics, University of Surrey, Guildford, UK; [4]Department of Paediatrics, University of Pécs, Pécs, Hungary; [5]Dr von Hauner Children's Hospital, Ludwig-Maximilians University, Munich, Germany and [6]Department of Paediatrics, University of Granada, Granada, Spain. Correspondence: Professor H Gage, Department of Economics, University of Surrey, Staghill, Guildford, Surrey GU2 7XH, UK.
E-mail: h.gage@surrey.ac.uk
Received 14 February 2013; revised 10 July 2013; accepted 11 August 2013; published online 27 November 2013

mental performance was informed by findings from previous qualitative interviews with parents of primary school children in the study countries. These had shown that, of all the different dimensions of mental performance, parents related most to 'attention' and 'concentration'. In addition, many respondents expressed the view that food affected a child's attention and concentration indirectly through its impact on mood and behaviour.[10] These findings were consistent with other research investigating the rationale underlying parents' food choices,[13–15] which also identifies the importance that parents place on learning as a construct in mental performance.[14,15] Moreover, teachers have been found to highlight behaviour, including attentiveness, as a key factor affecting cognitive and academic performance.[16]

Eighteen possible determinants of the four selected elements of mental performance were identified from relevant social science, psychological and nutrition literature. These were grouped for analysis into six higher level categories of determinants, as summarised in Table 1. This schema provided a structural framework for the experiment.

Activity (or exercise) and sleep (or its corollary–tiredness) are established influences on mental performance[17] and were incorporated in the physical category. Class size, teaching quality and classroom discipline affect the school environment.[18] A complex array of family factors, including access to material resources (affecting nutrition and food security) and social status, potentially influence mental performance and school achievement.[8,19–21] These were represented in a social category by four determinants: birth order; household income; parental education; and stimulation at home. Biological influences on mental performance were identified as arising from inherited genetic predisposition, overall intelligence (cognitive abilities across a range of different aspects[22] present at birth) and birth weight, because low birth weight has been associated with a negative effect on cognition.[23]

The food category contained four determinants: nutrition as a baby, to reflect the role of breast milk[24] and other nutrients[1] in brain development, and the debate about the impact of breastfeeding on IQ of children;[25,26] what the child eats now, to reflect the importance of current nutrition on mental performance of school children;[3,27–32] food at school, because school meals have been observed to have an impact on pupil behaviour[33] and performance;[21] and regular meals, because of the impact on mental energy of skipping meals such as breakfast.[5,22,34–37] Although mood and behaviour had been identified as elements of mental performance in their own rights, the evidence pointing to the links between food and mood[38,39] and between nutrition and behaviour[33] meant that mood and behaviour were also included as determinants of the other two elements (attention and learning) in the psychological category.

Table 1. Possible determinants of mental performance–conceptual framework

18 Possible determinants of mental performance →	*6 Categories of determinants →*	*4 Elements of mental performance*[a]
What child eats now Eating regular meals Food at school (lunches, snacks) Nutrition as a baby and infant	Food	Attention
Birth weight Intelligence child is born with Genetic/inherited factors	Biological	
Class size Quality of teaching School discipline	School environment	Learning
Amount of sleep/tiredness Amount of exercise/physical activity	Physical	Mood
Birth order/family size Household income Parents' education Stimulation at home	Social	Behaviour
Mood Behaviour	Psychological (attention and learning elements only)	

[a]Brief descriptions were included on the cards, as follows: attention: not being easily distracted, maintaining concentration. Learning: the ability to take in and use new information, both at home and at school. Mood: feeling happy or sad. Behaviour: being cooperative, disruptive and so on.

Recruitment of schools and participants

Letters explaining the study were sent to the head teachers of state primary schools (children aged 4–11years) in districts with varied socio-economic population profiles around the research sites in 2009. Of 78 schools contacted (22 England; 32 Germany; 18 Hungary; and 6 Spain), 12 agreed to participate (2, 5, 4 and 1, respectively). Two semi-private schools were subsequently recruited in Spain to complete the sample.

Letters about the study were distributed to parents via the children. Parents were asked to volunteer to participate by returning a brief screening questionnaire that asked for information on their age (<30, 30–39, $\geqslant 40$ years), gender, ethnicity, highest level of education, employment status, children (number, age and gender) and relationship to the school pupil. Participation was encouraged by entering the names of all volunteers into a prize draw in each country for vouchers at a local store. Parents were eligible for inclusion if they had a child aged 4–10 years and could speak the native language, and excluded if they had a child with special educational needs or a diagnosed medical or behavioural condition. The recruitment target was 50 parents per country, reflecting available resources, and to generate a sufficiently large sample overall to gain an understanding of differences between countries and socio-economic groups.[40]

Data collection

Four packs of cards, colour-coded for each of the four elements (attention, learning, mood and behaviour) were prepared. The packs for attention and learning contained cards for all 18 possible determinants; those for mood and behaviour omitted the possible psychological determinants (mood and behaviour) and contained 16 cards. The study was pilot tested in England, and cards were then translated into the other languages and back translated and tested in each country to ensure the terminology was appropriately understood.

Best practice sorting experiment methodology was followed.[41] Cards were the same size and clearly printed. Interviews were conducted at a large desk, clear of other papers and took place in the schools at a time arranged between the interviewer and volunteer. Participants were given a large card with one of the elements of mental performance printed on it, for example, attention, and a brief explanation of the term (Table 1). The pack of cards containing the possible determinants for that element was then put on the table, and participants were asked to sort through the cards and consider each determinant in relation to the others (rather than one at a time), and to show how much of an effect they thought each had on the element of mental performance by placing the card in one of three boxes labelled: no effect, moderate effect and strong effect. When the participant had completed the sorting, the interviewer collected the cards from the boxes and recorded the decisions onto a form. The exercise was then repeated for each of the other three elements of mental performance. The order in which the four elements were presented was determined by a prior randomisation process using a Latin Square in blocks of four, and was noted so that the analysis could check for ordering effects.

Analysis

Data from each country were entered into SPSS (version 15; SPSS Inc, Chicago, IL, USA) for analysis. Scores were attributed to responses (0, no effect; 1, moderate effect; and 2, strong effect) and mean scores for each determinant were calculated in each country. Mean scores for categories of determinants (indicating the extent to which participants thought each category affected each element of mental performance) were calculated from the mean scores of the relevant determinants for each country separately and for all countries together. Mean category scores were compared using one way analysis of variance and associated 95% confidence intervals to establish relative importance of categories for each element of mental performance. Associations between participant

Table 2. Demographic and socio-economic characteristics of participants

Characteristic	All countries (n = 200)		England (n = 53)		Germany (n = 45)		Hungary (n = 52)		Spain (n = 50)		Difference between countries (p)
	Mean (s.d.) range		Mean (s.d.) range		Mean (s.d.) range		Mean (s.d.) range		Mean (s.d.) range		One way ANOVA
Age group[a]	2.37 (0.65) 0.5–3.5		2.40 (0.57) 1–3		2.62 (0.53) 1–3		2.11 (0.66) 0.5–3.5		2.38 (0.73) 1–3		0.002
Number of children (years)	2.00 (0.84) 1–5		2.25 (0.94) 1–5		1.87 (0.76) 1–4		1.94 (0.78) 1–4		1.90 (0.81) 1–5		ns
Age of eldest child	10.22 (4.72) 4–26		9.26 (4.67) 4–24		10.31 (2.67) 6–17		10.86 (4.69) 6–26		10.53 (6.10) 4–25		ns
	N	%	N	%	N	%	N	%	N	%	χ^2
Gender: female	182	91.0	50	94.3	40	88.9	48	92.3	44	88.0	ns
In paid employment	140	70.0	35	66.0	38	84.4	44	84.6	23	46.0	<0.001
University education	63	31.5	23	43.4	17	37.8	8	15.4	15	30.0	0.014
Educated to age 16 only	44	22.0	10	18.9	3	6.7	19	36.5	12	24.0	0.005
First language is local language	186	93.0	50	94.3	35	77.8	52	100	49	98.0	<0.001
Have only one child	55	27.5	9	17.0	15	33.3	16	30.8	15	30.0	ns

Abbreviation: ANOVA, analysis of variance. ns: not significant, $P > 0.05$. [a]Age groups England, Germany, Spain: <30 years = 1; 30–39 years = 2; ⩾40 years = 3. Alternative groups were used for Hungary so the scaling was altered accordingly: <25 years = 0.5; 25–34 years = 1.5; 35–44 years = 2.5; ⩾45 years = 3.5.

characteristics and mean category scores were explored using unpaired (two-sided) *t*-tests and Spearman's Rank correlation tests. Significance was set at $P < 0.05$.

Further analysis was conducted on the food category. Mean scores for each of the four determinants in the food category were compared using one way analysis of variance and associated 95% confidence intervals to establish relative importance of each determinant for each element of mental performance.

RESULTS

Characteristics of the sample

A total of 200 parents took part (England: 53; Germany: 45; Hungary: 52; and Spain: 50); over 90% were women. Respondents in Germany were significantly older and more likely not to have the local language as their first language compared with those in the other three countries. More respondents in England and Germany reported university level education than in Hungary and Spain. Less than half of participants in Spain were in full-time employment (Table 2).

Perceived effect of categories of determinants on mental performance

Taking all countries together, parents consider the food category (mean 1.33) to have a lower impact on a child's mental performance than physical (that is, activity and sleep, 1.77), psychological (that is, mood and behaviour, 1.69) and school environment (1.57) determinants. Social (1.12) and biological (0.91) determinants were ranked lower than food. This ranking holds for each element of mental performance separately, although mean scores vary significantly between elements for each category of determinants except psychological and food (Table 3). This ranking of categories is largely maintained within each country, with a few exceptions (data not shown). No statistically significant association was found between the order in which elements were assigned and the responses of parents.

Associations between participant characteristics and views about the effect of categories of determinants on mental performance

Taking all countries together, no statistically significant associations were found between parents' age, education, employment status or number of children and their views about the effect of the food or social categories on elements of mental performance. However, participants who were educated beyond the age of 16 years, compared with those with less education, thought the physical and psychological categories had a lower effect, and the biological category a larger effect, on mental performance. Those in paid employment, compared with those that were not, thought that the physical category had a smaller effect and the social category had a larger effect (data not shown).

Perceived effect of determinants of food category on mental performance

Across all countries, participants considered that regularity of meals (mean 1.58) had more influence on mental performance than the other determinants in the food category, and nutrition as a baby/infant was the least important influence (1.02). What a child eats now and food at school were rated in between (1.36, 1.35 respectively) (Table 4).

Differences exist between countries regarding the views of participants about the importance of food determinants on elements of mental performance. There is a tendency for participants from Spain to think that regularity of meals has less effect, and early nutrition has a higher effect, on mental performance compared with participants in the other countries. Respondents in England tend to attribute more importance to

Table 3. Perceived effect of categories of determinants on mental performance (ranked by size of effect), all countries combined

Categories	*Determinants*	*Elements of mental performance*					*Difference between elements p*[a]
		Attention	*Learning*	*Mood*	*Behaviour*	*All*	
Physical	Sleep/tiredness, activity/exercise	1.79	1.72	1.82	1.76	1.77	0.036
Psychological	Mood, Behaviour	1.67	1.71	N/A	N/A	1.69	0.432
School environment	Class size, Teaching quality, Discipline	1.67	1.63	1.36	1.61	1.57	<0.001
Food	What child eats now, Regular meals, Food at school, Baby/infant nutrition	1.36	1.34	1.28	1.32	1.33	0.416
Social	Birth order, Household income, Parents' education, Stimulation at home	1.07	1.20	1.05	1.15	1.12	0.001
Biological	Birth weight, Intelligence born with, Genetic/inherited	0.92	1.06	0.73	0.92	0.91	<0.001

Scoring: 0, no effect; 1, moderate effect; and 2, strong effect. [a]One way ANOVA, analysis of variance.

Table 4. Perceived effect of determinants of food category on mental performance (ranked by size of effect), by country

Determinants of food category	*Country*	*Elements of mental performance*					*Difference between elements p*[a]
		Attention	*Learning*	*Mood*	*Behaviour*	*All*	
Regularity of meals	England	1.66	1.64	1.68	1.60	1.65	0.907
	Germany	1.71	1.64	1.53	1.60	1.62	0.480
	Hungary	1.83	1.65	1.65	1.46	1.65	0.008
	Spain	1.24	1.40	1.34	1.58	1.39	0.044
	All	1.61	1.59	1.55	1.56	1.58	0.750
Difference between countries: *P*[a]		<0.001	0.063	0.011	0.578	<0.001	
What child eats now	England	1.57	1.51	1.66	1.57	1.58	0.576
	Germany	1.31	1.36	1.31	1.18	1.29	0.625
	Hungary	1.39	1.38	1.31	1.18	1.32	0.360
	Spain	1.24	1.20	1.18	1.26	1.22	0.912
	All	1.38	1.36	1.37	1.30	1.36	0.622
Difference between countries: *P*[a]		0.058	0.072	0.001	0.009	<0.001	
Food at school	England	1.58	1.51	1.57	1.55	1.55	0.939
	Germany	1.40	1.47	1.13	1.16	1.29	0.035
	Hungary	1.49	1.37	1.31	1.18	1.34	0.085
	Spain	1.24	1.12	1.14	1.24	1.19	0.725
	All	1.43	1.37	1.29	1.29	1.35	0.100
Difference between countries: *P*[a]		0.051	0.015	0.001	0.012	<0.001	
Nutrition as a baby/infant	England	0.85	1.02	0.77	1.00	0.91	0.244
	Germany	0.84	0.84	0.67	0.84	0.80	0.525
	Hungary	1.24	1.10	1.06	1.15	1.14	0.657
	Spain	1.10	1.24	1.14	1.46	1.24	0.061
	All	1.01	1.06	0.91	1.12	1.02	0.049
Difference between countries: *P*[a]		0.016	0.062	0.005	<0.001	<0.001	

Scoring: 0, no effect; 1, moderate effect; 2, strong effect. [a]One way ANOVA, analysis of variance.

what the child eats now and food at school than the respondents in Germany, Hungary and Spain (Table 4).

Within each country, there is a tendency for participants to perceive that determinants have similar effects on each element of mental performance. There are a few exceptions: in Spain, nutrition as a baby tends to be rated more highly for its effect on behaviour compared with the other elements of mental performance; in Germany and (marginally) Hungary, food at school is considered to be a more important influence on attention and learning than on mood and behaviour; in Hungary, regular meals are considered to have a relatively large effect on attention and relatively small effect on behavior; and in Spain the perceived effect of regular meals is reversed.

DISCUSSION

This study investigated the perception of parents in four different European countries about the relative importance of six categories of determinants on mental performance of primary school children. The study particularly sought to identify the role parents attribute to nutrition and eating behaviour to inform the design and targeting of public health messages that seek to improve parental understanding of the importance of diet for the mental performance of their children.

Across all countries, the food category was rated as having a low moderate effect (mean 1.33), ahead of social and biological influences, which were rated lowest, and behind physical, psychological and school environment categories, which were deemed to be the most important influences on mental performance. Previous research has indeed highlighted the prevalence of suboptimal sleep in school-aged children and the association of quantity and quality of sleep with measures of cognitive ability and school performance.[42] There is also increasing evidence for an association between physical activity, cardiovascular fitness and cognitive function during childhood and adolescence.[43] Parents also rated the psychological factors of mood and behaviour more highly than food. Parents had previously reported the effects of food on mental performance as being mediated by effects on mood,[10] and this perception is supported by research findings.[44]

Of the food determinants, parents identified regularity of meals as a more important influence on mental performance than the current composition of a child's diet and food at school. Nutrition as a baby or infant was considered the least important. In previous research, parents have highlighted the need for children to have a constant supply of energy to ensure adequate mental performance.[10] Children's diets were perceived to be the source of this energy. Other studies have provided evidence that a regular supply of food ensures less fluctuation in blood sugar levels, which has in turn supported mental state and performance during the school day.[34,45]

Other evidence suggests that socio-economic differences exist in parental lay knowledge about food, and that higher income parents discuss food in relation to health and medical issues, whereas lower income parents tend to consider the impact of food on their child's outward appearance and functional capacity.[46] However, respondent characteristics were not found to be associated with the rating of the importance of the food category, or individual food determinants, in this study, implying a need to communicate messages to all parents, rather than targeting particular groups. The issue of the effect of nutrition on mental performance is complex and concerns have been expressed about a lack of robust evidence to support causal links.[47] Research into the effect of nutrition on the mental performance of children faces many challenges,[12,22,48–50] and uncertainties in knowledge need to be communicated to parents.

This survey of parents was conducted rigorously and in accordance with procedures agreed through regular contact between partners in each country. An inspection of the standard deviations of the mean difference between subjects' food and other category rankings revealed a maximum of 0.48 (food–biological). With our sample of 200, this indicates an ability to detect an underlying difference of 0.1 in mean difference of rankings of food against any other category, using a two-sided test with size = 5%, and a power of at least 83%.

However, the study is limited in several ways. The four countries provide geographical spread across Europe, and international differences in parental views about how determinants affect elements of mental performance were observed. The extent to which this variation reflects differences in cultural, social, political and health-care system features requires further investigation, so policies can be tailored to local circumstances. The recruitment process involved securing the cooperation of schools, so that participants could be identified from the parent body. Many schools declined the invitation, possibly due to the extra administration associated with the project. However, schools recruited reflected socio-economically diverse catchment areas, and it is unlikely that the low participation rate introduced bias. Those volunteering within schools may have been influenced by the incentive of entry into a prize draw, and the views of this group may not be representative of all parents.

Mental performance was represented in the study by four elements (attention, learning, mood and behaviour), which may not be generally regarded as those most central to cognitive functioning.[12,22] Mood is an affective state that impacts on cognitive functioning, rather than being a cognitive function in its own right.[4,51] Including attention (which when sustained becomes concentration) had the advantage of covering (by implication) more complex abilities, which it underpins, such as memory. The choice of elements was pragmatic, driven by findings from prior qualitative interviews, which suggested that parents could understand these concepts, in what is otherwise a technical area.[10] Piloting of the sorting experiment suggested that asking respondents to consider more than four elements would be too burdensome and result in biases arising from repetition of the task.

The choice of determinants based on the literature may not be comprehensive or reflective of the most robust evidence. Determinants that were identified were combined into categories pragmatically following discussion between researchers. A principal components analysis performed retrospectively produced no obvious groupings of possible determinants into factors, suggesting that each should be considered separately. The food category incorporated four elements related to behaviours that parents were able to relate to, rather than nutritional content of food, around which uncertainties of effect arise. In depth analysis of the components of the food category is included in this paper but further consideration of the other categories is warranted.

Parents have difficulty conceptualising what is meant by mental performance but were able in this study to rate the importance of varied determinants on attention, learning, mood and behaviour of children. In general, nutrition and dietary behaviours were considered less important than sleep, exercise and the school environment for attention and learning. Public health policy tends to focus on the importance of childhood nutrition for physical health, and scope exists to improve parental awareness of the repercussions of their dietary choices for the mental performance of their children. This may require both clarification of the existing evidence base about the links between nutrition and mental performance and further research into the most effective means of communicating messages to parents.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ACKNOWLEDGEMENTS

We are grateful to the schools that enabled us to undertake this study, and to the parents who took part in the experiment. We thank two anonymous reviewers for their helpful comments that have enabled us to significantly improve the paper. This study was supported by the European Communities 7th Framework Programme (NUTRIMENTHE Grant agreement number: 212652).

AUTHOR CONTRIBUTIONS

HG contributed to the analysis and wrote the first draft; BE assisted with writing the paper; BE, EG, BB, J-CL-R collected data and contributed to analysis; HG, BE, MR conceived the study; PW undertook the statistical analysis; all authors contributed to the design and read and approved the final manuscript.

REFERENCES

1 Isaacs E, Oates J. Nutrition and cognition: assessing cognitive abilities in children and young people. *Eur J Nutr* 2008; **47**(Suppl 3): 4–24.
2 Bellisle F. Effects of diet on behaviour and cognition in children. *Br J Nutr* 2004; **92**(Suppl 2): S227–S232.
3 Florence MD, Asbridge M, Veugelers PJ. Diet Quality and Academic Performance. *J School Health* 2008; **78**: 209–215.
4 Tomlinson D, Wilkinson H, Wilkinson P. Diet and Mental Health in Children. *Child Adolesc Mental Health* 2009; **14**: 148–155.
5 Benton D. The influence of dietary status on the cognitive performance of children. *Mol Nutr Food Res* 2010; **54**: 457–470.
6 Brown R, Ogden J. Children's eating attitudes and behaviour. A study of the modelling and control theories of parental influence. *Health Edu Res* 2004; **19**: 261–271.
7 Golan M, Crow S. Parents are key players in the prevention and treatment of weight-related problems. *Nutr Rev* 2004; **62**: 39–50.
8 Birch LL, Davison KK. Family environmental factors influencing the developing behavioral controls of food intake and childhood overweight. *Pediatr Clin North Am* 2001; **48**: 893–907.
9 Brown KA, Ogden J, Vogel C, Gibson EL. The role of parental control practices in explaining children's diet and BMI. *Appetite* 2008; **50**: 252–259.
10 Brands B, Egan B, Gyorei E, Lopez-Robles J-C, Gage H, Campoy C *et al.* A qualitative interview study of diet on children's mental state and performance. Evaluation of perceptions, attitudes and beliefs of parents in four European countries. *Appetite* 2012; **58**: 739–746.
11 Barnett J. The Multiple Sorting Procedure (MSP). Chapter 12. In: *Breakwell GM. Research Methods in Social Psychology*. BPS Blackwell: Oxford, UK, 2004, p 389.
12 Schmitt JA, Benton D, Kallus KW. General methodological considerations for the assessment of nutritional influences on human cognitive functions. *Eur J Nutr* 2005; **44**: 459–464.
13 Hart KH, Herriot A, Bishop JA, Truby H. Promoting healthy diet and exercise patterns amongst primary school children. A qualitative investigation of parental perspectives. *J Hum Nutr Diet* 2003; **16**: 89–96.
14 Russell CG, Flight I, Leppard P, van Lawick van Pabst JA, Syrette J *et al.* A comparison of paper-and-pencil and computerised method of 'hard' laddering. *Food Qual Prefer* 2004; **15**: 279–291.
15 Russell CG, Busson A, Flight I, Bryan J, van Lawick van Pabst JA *et al.* A comparison of three laddering techniques applied to an example of a complex food choice. *Food Qual Prefer* 2004; **15**: 569–583.
16 Giannopulu I, Escolano S, Cusin F, Citeau H, Dellatolas G. Teacher's reporting of behavioural problems and cognitive – academic performance in children aged 5–7 years. *Br J Edu Psychol* 2008; **78**: 127–147.
17 Hale-Evans R. Mind Performance Hacks ISBM 0596101538.
18 Blatchford P, Russell A, Basett P, Brown P, Martin C. The effect of class size on the teaching of pupils aged 7-11 years. *School Effectiveness School Improvement* 2007; **18**: 147–172.
19 Bradley R, Corwyn R. Socio economic status and child development. *Ann Rev Psychol* 2002; **53**: 371–399.
20 Zaslow M, Bronte-Tinkew J, Capps R, Horowitz A, Moore K, Weinstein D. Food security during infancy: implications for attachment and mental proficiency in Toddlerhood. *Matern Child Health J* 2009; **13**: 66–80.
21 Scott-Jones D. Family influences on cognitive development and school achievement. *Rev Res Edu* 1984; **11**: 259–304.
22 Hughes D, Bryan J. The assessment of cognitive performance in children. Considerations for detecting nutritional influences. *Nutr Rev* 2003; **61**: 413–422.
23 Grantham-McGregor SM, Fernald LC, Sethuramen K. Effects of health and nutrition on cognitive and behavioural development of children in the first 3 years of life. Part 1: low birth weight, breastfeeding, and protein—energy malnutrition. *Food Nutr Bull* 1999; **20**: 53.
24 Gordon N. Nutrition and cognitive function. *Brain Dev* 1997; **19**: 165–170.
25 McCarthney M. Mixed messages over breastmilk and brainy babies. *Br Med J* 2007; **335**: 1074.
26 Jacobson S, Jacobson V. Breastfeeding and intelligence in children. *Br Med J* 2006; **333**: 928–930.
27 Associate Parliamentary Food and Health Forum The links between diet and behaviour. The influence of nutrition on mental health 2008.
28 Arija V, Esparo G, Fernandez-Ballart J, Murphy MM, Biarnes E, Carels J. Nutritional status and performance in testsof verbal and non verbal intelligence in 6 year old children. *Intelligence* 2006; **34**: 141–149.
29 Taras H. Nutrition and student performance at school. *J School Health* 2005; **75**: 199–213.
30 Bateman B, Warner JO, Hutchinson E, Dean T, Rowlandson P, Gant C *et al.* The effects of a double blind, placebo controlled, artificial food colourings and benzoate preservative challenge on hyperactivity in a general population sample of preschool children. *Arch Dis Childhood* 2006; **89**: 506–511.
31 McCann D, Barrett A, Cooper A, Crumpler D, Dalan L, Grimshaw K *et al.* Food additives and hyperactive behaviour in 3 year old and 8/9 year old children in the community: a randomised double—blinded placebo controlled trial. *Lancet* 2007; **37**: 1560–1567.
32 Bryan J, Osendarp S, Hughes D, Calvaresi E, Baghurst K, van Klinken JW. Nutrients for cognitive development in school-aged children. *Nutr Rev* 2004; **62**: 295–306.
33 Golley R, Baines E, Bassett P, Wood L, Nelson M. School lunch behaviour: systematic observation of classroom behaviour following a school dining room intervention www.schoolfoodtrust.org.uk (accessed 10/04/09).
34 Hoyland A, Lawton CL, Dye L. Acute effects of macronutrient manipulations on cognitive test performance in healthy young adults. A systematic research review. *Neurosci Biobehav Rev* 2008; **32**: 72–85.
35 Kleinman R, Hall S, Green H, Korzec-Ramirez D, Patten K, Pagano ME *et al.* Diet, breakfast, and academic performance in children. *Ann Nutr Metab* 2002; **46**(suppl 1): 1–24.
36 Grantham-McGregor S. Can the provision of breakfast benefit school performance? *Food Nutr Bull* 2005; **26**(Suppl 2): S144–S158.
37 Dye L, Lawton CL. A systematic review of the effect of breakfast on the cognitive performance of children and adolescents. *Nutr Res Rev* 2009; **22**: 230–243.
38 Rogers PJ. Food, mood and appetite. *Nutr Res Rev* 1995; **8**: 243–269.
39 Benton D, Donohoe RT. The effects of nutrients on mood. *Public Health Nutr* 1999; **2**: 403–409.
40 Mack N, Woodsong C, MacQueen KM, Guest G, Namey E. *Qualitative Research Methods: A Data Collector's Field Guide. Module 1: Qualitative Research Methods Overview*. Family Health International, US Agency for International Development, 2005.
41 Rugg G, McGeorge P. The sorting techniques: a tutorial paper on card sorts, picture sorts and item sorts. *Expert Systems* 1997; **14**: 80.
42 Taras H, Potts-Datema W. Sleep and student performance at school. *J Sch Health* 2005; **75**: 248–254.
43 Donnelly JE, Lambourne K. Classroom-based physical activity, cognition, and academic achievement. *Prev Med* 2011; **52**: S36–S42.
44 Rogers PJ. Food, mood and appetite. *Nutr Res Rev* 1995; **8**: 243–269.
45 Benton D, Parker PY. Breakfast, blood glucose, and cognition. *Am J Clin Nutr* 1998; **67**: 772S–778S.
46 Coveney J. A qualitative study exploring socio-economic differences in parental lay knowledge of food and health: implications for public health nutrition. *Public Health Nutr* 2004; **8**: 290–297.
47 Ells L, Hillier P, Shucksmith J, Crawley H, Harbige L, Shield J *et al.* A systematic review of the effect of dietary exposure that could be achieved through normal dietary intake on learning and performance of school aged children of relevance to UK schools. *Br J Nutr* 2008; **100**: 927–936.
48 Bellisle F, Blundell JE, Dye L, Fantino M, Fern E, Fletcher RJ *et al.* Functional food science and behaviour and psychological functions. *Br J Nutr* 1998; **80**(Suppl 1): S173–S193.
49 Dye L, Blundell J. Functional foods. Psychological and behavioural functions. *Br J Nutr* 2002; **88**: S187–S211.
50 Gibson EL, Green MW. Nutritional influences on cognitive function. Mechanisms of susceptibility. *Nutr Res Rev* 2002; **15**: 169–206.
51 Westenhoefer J, Bellisle F, Blundell JE, de Vries J, Edwards D, Kallus W *et al.* PASSCLAIM. Mental state and performance. *Eur J Nutr* 2004; **43**: 85–117.

10.3. APPENDIX 3

QUESTIONNAIRE PERFORMED IN 4 EUROPEAN COUNTRIES

PARENTS ONLY

S1. Are you the parent of a child aged 4-10 years old?

Yes

No (CLOSE IF NO)

PARENTS ONLY

S2. Has your child/children been diagnosed with learning or behaviour issues?

Yes (CLOSE IF YES)

No

TEACHERS ONLY

S3. Do you currently teach children aged 4-10 years old?

Yes

No (CLOSE IF NO)

TEACHERS ONLY

S4. Do you mainly teach children who have been diagnosed with learning or behaviour issues?

Yes (CLOSE IF YES)

No

INTRODUCTION

The University of Surrey is currently carrying out a research project to find out what parents and teachers think about the way in which diet affects the health and wellbeing of children aged 4-10 years.

FOR TEACHERS

When considering your responses please answer as a teacher of 4-10 year old children.

FOR PARENTS

When considering your responses please answer as a parent of 4-10 year old children.

ALL RESPONDENTS

Q1. To what extent do you think that a child's physical development depends on diet?

Not at all	Slightly	Moderately	Very much	Extremely	Don't know

ALL RESPONDENTS

Q2. To what extent do you think that a child's mental development depends on diet?

Not at all	Slightly	Moderately	Very much	Extremely	Don't know

ALL RESPONDENTS

Q3. To what extent do you think diet will influence a child's…?

PLEASE SELECT ONE BOX ONLY ON EACH ROW. ROTATE ORDER. GRID QUESTION

	Not at all	Slightly	Moderately	Very much	Extremely	Don't know
Energy levels						
Ability to learn						
Weight						
Memory						
Amount of physical activity						
Behaviour						
Sleep						
Mood						
Overall health						
Attention						

ALL RESPONDENTS

Q4a. To what extent do you think a child's attention, i.e. the ability to concentrate on tasks, is influenced by …?

PLEASE SELECT ONE BOX ONLY ON EACH ROW. ROTATE ORDER. GRID QUESTION

	Not at all	Slightly	Moderately	Very much	Extremely	Don't know
Amount of exercise taken						
Having breakfast						
A child's mood						
Nutrition as a baby and infant						
Amount of sleep						
Having meals at regular times						
Class size						
A child's everyday diet						
Quality of teaching						
Taking dietary supplements						
A child's behaviour						
Type of snacks eaten						

Q4b. Is there anything else you think influences a child's attention, i.e. the ability to concentrate on tasks? WRITE IN BELOW

ALL RESPONDENTS

Q5. Please name up to three foods (including drinks) or nutrients, that you think may affect, either positively or negatively, a child's attention, i.e. the ability to concentrate on tasks.

ALLOW PLENTY OF SPACE ON SCREEN. DO NOT ALLOW NON-RESPONSE. OPEN RESPONSE. 1 BOX FOR FOOD/NUTRIENT (INCLUDING DRINKS) AND 1 BOX FOR EXPLANATION X 3

Food (including drinks)/nutrient	Please explain in what way this affects their attention?
1	
2	
3	

ALL RESPONDENTS

Q6a. To what extent do you think a child's ability to learn is influenced by the following?

PLEASE SELECT ONE BOX ONLY ON EACH ROW. ROTATE ORDER. GRID QUESTION

	Not at all	Slightly	Moderately	Very much	Extremely	Don't know
Amount of exercise taken						
Having breakfast						
A child's mood						
Nutrition as a baby and infant						
Amount of sleep						
Having meals at regular times						
Class size						
A child's everyday diet						
Quality of teaching						
Taking dietary supplements						
A child's behaviour						
Type of snacks eaten						

Q6b. Is there anything else you think influences a child's ability to learn? WRITE IN BELOW

ALL RESPONDENTS

Q7. Please name up to three foods (including drinks) or nutrients, that you think may affect, either positively or negatively, a child's ability to learn.

ALLOW PLENTY OF SPACE ON SCREEN. DO NOT ALLOW NON-RESPONSE. OPEN RESPONSE. 1 BOX FOR FOOD/NUTRIENT (INCLUDING DRINKS) AND 1 BOX FOR EXPLANATION X 3

Food (including drinks)/nutrient	Please explain in what way this affects their attention?
1	
2	
3	

PARENTS ONLY

Q8. When providing foods for your child, to what extent do you take account of the following?

PLEASE SELECT ONE BOX ONLY ON EACH ROW. ROTATE ORDER. GRID QUESTION

	Not at all	Slightly	Moderately	Very much	Extremely	Don't know
Cost of foods						
Effect of foods on child's mood						
Ease of preparation of foods						
Offering a variety of foods						
Effect of foods on child's attention						
Effect of foods on child's energy levels						
Effect of foods on child's ability to learn						
Healthiness of food						
Effect of foods on child's behaviour						
Flavour of food						
Your children's food preferences						

PARENTS ONLY

Q9. When providing foods for your child which three of the following are most important? FORCE SELECTION TO 3. ROTATE ORDER

Cost of foods	1
Effect of foods on child's mood	2
Ease of preparation of foods	3
Offering a variety of foods	4
Effect of foods on child's attention	5
Effect of foods on child's energy levels	6
Effect of foods on child's ability to learn	7
Healthiness of food	8
Effect of foods on child's behaviour	9
Flavour of food	10
Your children's food preferences	11

PARENTS ONLY

Q10. To what extent do you agree or disagree with each of the following statements? PLEASE SELECT ONE BOX ONLY ON EACH ROW. ROTATE ORDER. GRID QUESTION

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Agree strongly	Don't know
Providing a diet that may contribute to my child's ability to learn is expensive						
Providing a diet that may contribute to my child's ability to learn is less convenient						
My child won't like a diet that may contribute to their ability to learn						
I am not aware which foods affect my child's ability to learn						
I don't believe food has an impact on my child's ability to learn						
Providing a diet that may improve my child's attentionis expensive						
Providing a diet that may improve my child's attention is less convenient						
My child won't like a diet that may improve their attention						
I am not aware which foods improve my child's attention						
I don't believe food improves my child's attention						

PARENTS ONLY

Q11. How much is your decision about how to feed your child influenced by the following?

PLEASE SELECT ONE BOX ONLY ON EACH ROW. ROTATE ORDER. GRID QUESTION

	Not at all	Slightly	Moderately	Very much	Extremely	Don't know
Common sense/ experience						
Your partner						
Other family members						
Friends						
Your family doctor/health professionals						
Food product advertising						
Radio/Television programmes						
Internet websites						
Social networking sites						
Books						
Magazines						

ALL RESPONDENTS

Q12. Please indicate to what extent the following statements are true of you.

PLEASE SELECT ONE BOX ONLY ON EACH ROW. ROTATE ORDER. GRID QUESTION.

7 point scale going from Completely true – Completely false

	1	2	3	4	5	6	7
I am very particular about the healthiness of food							
I always follow a healthy and balanced diet							
It is important for me that my diet is low in fat							
It is important for me that my daily diet contains a lot of vitamins and minerals							
I eat what I like and do not worry much about the healthiness of food							
I do not avoid any foods, even if they may raise my cholesterol							
The healthiness of food has little impact on my food choices							
The healthiness of snacks makes no difference to me							

CLASSIFICATION (ALL)

ALL RESPONDENTS

Q13. What is your age?

18-24
25-34
35-44
45-54
54-64
65+

ALL RESPONDENTS

Q14. Are you…?

Male
Female

ALL RESPONDENTS

Q15. Were you born in the UK/Germany/Hungary/Spain? COUNTRY AS APPROPRIATE

Yes
No

ALL RESPONDENTS

Q16. Have you ever gained a qualification related to health or nutrition?

Yes
No

ALL RESPONDENTS

Q17a. Have you ever smoked?

Yes
No

ALL RESPONDENTS WHO HAVE EVER SMOKED

Q17b. Do you currently smoke?

Yes
No

ALL RESPONDENTS

Q18. What is your ethnicity?

White
Mixed
Asian
Black
Chinese
Other

PARENTS ONLY

Q19. Which of the following describes the occupation of the main income earner in your household?

High managerial, administrative or professional	Housewife / Homemaker
Intermediate managerial, administrative or Professional	Retired
Supervisor; clerical; junior managerial, administrative or professional	Student
Skilled manual worker	Unemployed
Semi-skilled or unskilled manual worker	

PARENTS ONLY

Q20a. How many boys do you have living with you, under the age of 18?
And what is/are their age(s)?
GRID QUESTION. SPACE FOR AGE OF EACH BOY

None
One
Two
Three
Four
Five

PARENTS ONLY

Q20b. How many girls do you have living with you, under the age of 18?
And what is/are their age(s)?
GRID QUESTION. SPACE FOR AGE OF EACH GIRL

None
One
Two
Three
Four
Five

PARENTS ONLY

Q21. What is the highest level of education that you completed?
PLEASE SELECT ONE ONLY.

Primary or less
Secondary school to age 15/16
Secondary school to age 17/18
College
University

PARENTS ONLY

Q22a. Are you a teacher?

Yes
No

PARENTS WHO TEACH

Q22b. What age group do you teach?

Predominantly preschool 0-4
Primary school 5-11
Secondary school 12-18
Higher education

TEACHERS ONLY

Q23. How many years have you been teaching?

OPEN RESPONSE FOR NUMBER OF YEARS.

TEACHERS ONLY

Q24. Do you work for a state or independent (private) school?

State school
Independent (private) school

TEACHERS ONLY

Q25. Are you a parent?

Yes
No

TEACHERS WITH CHILDREN

Q26a. How many boys do you have living with you, under the age of 18?
And what is/are their age(s)?
GRID QUESTION. SPACE FOR AGE OF EACH BOY

None
One
Two
Three
Four
Five

TEACHERS WITH CHILDREN

Q26b. How many girls do you have living with you, under the age of 18?
And what is/are their age(s)?
GRID QUESTION. SPACE FOR AGE OF EACH GIRL

None
One
Two
Three
Four
Five

11. Curriculum Vitae

11. CURRICULUM VITAE

11.1. PUBLISHED PEER-REVIEWED PAPERS

1. Gage, H., Egan, B., Williams, P., Brands, B., Györei, E., López-Robles, J.C., Campoy, C., Decsi, T., Koletzko, B. and Raats, M. Importance of mental performance in parental choice of food for children aged 4–10 years: a study in four European countries. Public Health Nutrition 2017; Apr;20(6):992-1000. (IF: 2.433).

2. Egan B, Gage H, Williams P, Brands B, Györei E, López-Robles JC, Campoy C, Decsi T, Koletzko B, Raats M. The effect of diet on the physical and mental development of children: views of parents and teachers in four European countries. Br J Nutr. 2016 Jan; 22:1-9. (IF: 3.453)

3. Gage H, Egan B, Williams P, Györei E, Brands B, López-Robles JC, Campoy C, Koletzko B, Decsi T, Raats M. Views of parents in four European countries about the effect of food on the mental performance of primary school children. Eur J Clin Nutr. 2014 Jan;68(1):32-7. (IF: 2.756)

4. Anjos T, Altmäe S, Emmett P, Tiemeier H, Closa-Monasterolo R, Luque V, Wiseman S, Pérez-García M, Lattka E, Demmelmair H, Egan B, Straub N, Szajewska H, Evans J, Horton C, Paus T, Isaacs E, van Klinken JW, Koletzko B, Campoy C; *The NUTRIMENTHE Research Group. Nutrition and neurodevelopment in children: focus on NUTRIMENTHE project.* Eur J Nutr. 2013 Dec;52(8):1825-42. (IF: 3.127)

5. Brands B, Egan B, Györei E, López-Robles JC, Gage H, Campoy C, Decsi T, Koletzko B, Raats MM. *A qualitative interview study on effects of diet on children's mental state and performance. Evaluation of perceptions, attitudes and beliefs of parents in four European countries*. Appetite. 2012 Apr; 58(2):739-746. (IF: 2.844)

11.2. PUBLISHED ABSTRACTS

1. Ladino, L., Parejo-Laudicina, E., Moreno-Torres, R., Brandi, P., López-Robles, JC., Campos, D., Campoy, C. and Preobe Research Group."The type of feeding at 3 months is related to meat intake at pre-school age: Preobe study" ESPGHAN 48th Annual Meeting, Abstract Book. Journal of Pediatric Gastroenterology & Nutrition JPGN 2015; 60, S1: 780

2. Campos, D., Hernández-Torres, JJ., Comino, M., Macias, MV., López-Robles, JC., Campoy, C. "Analysis of food advertising for children in Spanish television: where are we going?" ESPGHAN 47th Annual Meeting, Abstract Book. Journal of Pediatric Gastroenterology & Nutrition JPGN 2014; 58, S1: 462.

3. Rusanova, I., Jerez-Calero, A., Ibañez-Casas, I., Garcia-Valdés, L., López-Robles, JC., Piqueras, MJ., Moreno-Torres, R., Padilla, C., Campoy, C., and the PREOBE Research Group. "Impact of maternal body mass index and gestational diabetes on neonatal outcome" Annals of Nutrition & Metabolism, 2013; 63 (suppl 1): 510-511.

4. Herández-Torres, JJ., López-Robles, JC., Macías, V., Iribar, C., Miranda, MT. and C., Campoy. "A qualitative interview study on ethical aspects of marketing and food advertising for chilchren. Evaluation of perceptions, attitudes and beliefs of parents" Annals of Nutrition & Metabolism, 2013; 63(suppl 1): 524.

5. Gage, H., Egan, B., Williams, P., Györei, E., Brands, B., López-Robles, JC., Brown, KA., Campoy, C., Koletzko, B., Decsi, T., Raats, M. "Views of parents in four European countries about the effect of food on the mental performance of primary school children" Annals of Nutrition & Metabolism, 2013; 63(suppl 1): 1132.

6. Gage, H., Egan, B., Williams, P., Györei, E., Brands, B., López-Robles, JC., Campoy, C., Koletzko, B., Decsi, T., Raats, M. "Association between diet and mental performance of children: views of parents and teachers in four European countries" Annals of Nutrition & Metabolism, 2013; 63 (suppl 1): 1862.

7. Gage, H., Egan, B., Williams, P., Györei, E., Brands, B., López-Robles, JC., Campoy, C., Koletzko, B., Decsi, T., Raats, M. "Factors affecting food choices of parents of children aged 4-10 years in four European countries" Annals of Nutrition & Metabolism, 2013; 63(suppl 1): 1862.

8. Gage, H., Egan, B., Williams, P., Györei, E., Brands, B., López-Robles, JC., Campoy, C., Koletzko, B., Decsi, T., Raats, M. "Association between diet and physical and mental development of children: views of parents and teachers in four European countries" Annals of Nutrition & Metabolism. 2013; 63(suppl 1): 1863.

9. López-Robles, JC., Egan, B., Brands, B., Györei, E., Gage, H., Raats, M., Koletzko, B.,Decsi, T., Campoy, C. "Teacher's knowledge of the influence of nutrition on children's mental performance in four European countries". Annals of Nutrition & Metabolism, 2011; 58(suppl 3): 409.

10. Piqueras, MJ., García-Valdés, L., Segura, MT., Rousanova, I., Haro, E., López-Robles, JC., Pascual, H., García-Morales, N., Rodríguez-López, L., Flores-Navarro, C., Padilla, MC., Campoy, C. "Analysis of nutritional intake in obese and gestational diabetic pregnant women participans in the Preobe Project". Annals of Nutrition & Metabolism, 2011; 58(suppl 3): 247.

11. Györei, E., Egan, B., Gage, H., Williams, P., Raats, M., Brands, B., López-Robles, JC., Campoy, C., Koletzko, B., Decsi, T. "Effects of food on learning: views of parents in four European countries". Annals of Nutrition & Metabolism, 2011; 58(suppl 3): 137-138.

12. López-Robles, JC; Egan, B; Gage, H; Györei, E; Brands, B; Raats, M; Martín-Bautista, E; Decsi, T; Koletzko, B; Campoy, C. "Quantitative study of spanish parents beliefs of what effects children's mental performance". The 43rd ESPGHAN Annual Meeting, Abstract Book. Journal of Pediatric Gastroenterology & Nutrition JPGN; 2010; 50, S7: 191.

13. Brands, B; Egan, B; Gage, H; López-Robles, JC; Györei, E; Raats, M; Martin-Bautista, E; Decsi, T; Campoy, C; Koletzko, B. "The effect of diet on children's mental performance – a qualitative study of perceptions, attitudes and beliefs of parents in four European countries". The 43rd ESPGHAN Annual Meeting, Abstract Book. Journal of Pediatric Gastroenterology & Nutrition JPGN; 2010; 50, S7: 189.

14. López, JC; Cid, P; Santiago, G; Robles, C; Molina, JA; Campoy, C. Pediatría para educadores: Desarrollo del catálogo de habilidades docentes mediante un programa de prácticas en aula hospitalaria. Revista de Educación Médica Internacional, 2007; 10 (3): 166.

15. López, JC; Santiago, G; Robles, C; Molina, JA; Campoy, C. Pediatría para educadores: Experiencia innovadora docente. Revista de Educación Médica Internacional. 2005; Sep 8 (3): 71.

11.3. OTHER COMMUNICATIONS

1. B. Egan, B. Brands, E.Gyorei, J.C.Lopez-Robles, H. Gage, M Raats, B. Koletzko, T.Desci; C.Campoy. 'The role of diet in the mental performance of children- what do parents think?'. II World Congress of Public Health Nutrition and I Latinamerican Congress of Community Nutrition, Porto Portugal, September 23-25, 2010.
2. Pascual-Ochando H.; Lopez-Robles JC.; Anjos T.; Campoy C. "Implementation of the teaching guide to support teachers and students in a semi-virtual master' programme". 3rd Valencia Global 2010 Conference, Universidad Politécnica de Valencia, Escuela Técnica Superior de Ingeniería del Diseño ETSID del 22 al 24 de abril de 2010 en Valencia.
3. Torres-Espinola, FJ.; López-Robles, JC; Anjos, T; Campoy, C. "Comparación y similitudes en 3 países europeos: modelo de análisis cualitativo de profesores sobre la influencia de la nutrición en el rendimiento mental de los niños". III Jornadas del Instituto de Neurociencias "Federico Olóriz". Parque de las Ciencias de Granada, 18 de marzo de 2010.
4. Pascual-Ochando, H; López-Robles, JC; Anjos, T; Campoy, C. "Comparación y similitudes en 3 países europeos: modelo de análisis cualitativo de profesores sobre la influencia de la nutrición en el rendimiento mental de los niños". III Jornadas del Instituto de Neurociencias "Federico Olóriz". Parque de las Ciencias de Granada, 18 de marzo de 2010.
5. López-Robles, JC; Pascual-Ochando, H; Anjos, T; Campoy, C. "El conocimiento de los padres sobre lo que afecta al desarrollo mental de sus hijos". III Jornadas del Instituto de Neurociencias "Federico Olóriz". Parque de las Ciencias de Granada, 18 de marzo de 2010.

6. López-Robles, JC; Pascual-Ochando, H; Anjos, T; Campoy, C. "Conocimiento de los maestros sobre lo que afecta en el rendimiento mental de los niños: modelo español". III Jornadas del Instituto de Neurociencias "Federico Olóriz". Parque de las Ciencias de Granada, 18 de marzo de 2010.

7. Lopez-Robles, JC; Pascual-Ochando, H; Egan, B; Gage, H; Györei, E; Brands, B; Raats, M; Martín-Bautista, E; Decsi, T; Koletzko, B. "Parents knowledge on what affects children's mental performance" (Poster of distinction). The Power of Programming. International conference on developmental origins of health and disease. University Hospital of Munich, Germany, Del 6 al 8 de Mayo de 2010.

8. Lopez-Robles, JC; Pascual-Ochando, H; Egan, B; Gage, H; Györei, E; Brands, B; Raats, M; Martín-Bautista, E; Decsi, T; Koletzko, B; Campoy, C. "Teacher's knowledge on what affects children's mental performance: Spanish model" (*Poster of distinction*). The Power of Programming. International conference on developmental origins of health and disease University Hospital of Munich, Germany, Del 6 al 8 de Mayo de 2010.

9. Lopez-Robles, JC; Pascual-Ochando, H; Egan, B; Gage, H; Györei, E; Brands, B; Raats, M; Martín-Bautista, E; Decsi, T; Koletzko, B; Campoy, C. "Comparison & similarities in 3 European countries: teacher's model on the influence of nutrition in children's mental performance" (*Poster of distinction*). The Power of Programming. International conference on developmental origins of health and disease. University Hospital of Munich, Germany, Del 6 al 8 de Mayo de 2010.

10. Brands, B; Egan, B; Gage, H; Györei, E; Lopez-Robles, JC; Raats, M; Decsi, T; Campoy, C; Koletzko, B. "The effects of diet on children's mental performance – a qualitative study of perceptions, attitudes and beliefs of parents in four

European countries" (Poster of distinction). The Power of Programming. International conference on developmental origins of health and disease. University Hospital of Munich, Germany, Del 6 al 8 de Mayo de 2010

11. Brands, B; Egan, B; Gage, H; Györei, E; Lopez-Robles, JC; Raats, M; Decsi, T; Campoy, C; Koletzko, B. "Parents' understanding of mental performance – a qualitative study in three European countries" (Poster of distinction). The Power of Programming. International conference on developmental origins of health and disease University Hospital of Munich, Germany, Del 6 al 8 de Mayo de 2010.

12. B. Hegan, H. Gage, M. Raats, B. Brands, B.Koletzho, E. Gyorei, T. Desci, E. Martín-Bautista, JC. López-Robles, C. Campoy. "The effect of diet on children's mental performance- attitudes, knowledge and perceptions of parents in four European countries". 3rd bi-annual General Assembly NUTRIMENTHE Meeting, Hotel HUSA Imperial Tarraco, 21-23 October 2009.

13. López-Robles, JC; Campoy, C; Santiago, G; Robles-Vizcaino, C; Requena-Zurita, L. "La ansiedad de los niños hospitalizados en relación con su participación en el aula hospitalaria". I Congreso Iberoamericano. Humanización de los Cuidados de Enfermería. Dolor y Sufrimiento del Niño y su Familia. Asociación Iberoamericana del Dolor en la Infancia. Palacio de Congresos y Exposiciones de Granada, del 2 al 4 de octubre de 2008

14. López, JC; Martínez, C; Jiménez, MN; Santiago, GC. **Aula Hospitalaria**. VIII Jornadas Andaluzas de Organización y Dirección de Instituciones Educativas; Granada, 15-17 diciembre de 2003.

15. López, JC; Martínez, C; Jiménez, MN; Santiago, GC. Las escuelas rurales: satisfacción del profesorado. VIII Jornadas Andaluzas de Organización y Dirección de Instituciones Educativas; Granada, 15-17 diciembre de 2003.

11.4. BOOK CHAPTERS

1. López Robles, JC., Escudero-Marín, M., Parejo-Laudicina, E., Troca-Redondo, J., Campoy, C. En: Gijón-Puerta, J. and García-Sempere, P. (eds.): Conference on Enabling Teachers for Entrepreneurship Education (ENTENP2014). Chapter Title: Implementation of Entrepreneurship Skills in the Nutrenvigen-G+D Factors Master Program: A Pilot Experience. Book of papers. Editorial Universidad de Granada, 2014; Pag. 93-102. ISBN; 978-84-338-5697-5.
2. Robles, MC; López Robles, JC. En: Ruíz-Extremera A and Robles MC (eds.) Pediatría en Ciencias de la Salud. Chapter 36: Trastornos por Déficit de Atención e Hiperactividad. Editorial Universidad de Granada, 2013; Pag. 411-418. ISBN; 975-84-338-5481-0.
3. Robles, MC and López Robles, JC. En: Ruíz-Extremera A and Robles C (eds.): Pediatría en Ciencias de la Salud. Chapter 37: Síndromes Genéticos con Alteraciones del Desarrollo. Fenotipos Conductuales: X-Frágil, Angelman, Prader-Willi, Williams, Rett. Editorial Universidad de Granada, 2013; Pag. 419-428. ISBN; 975-84-338-5481-0.

4. López-Robles, JC; Martín-Bautista, E; Martín-Lagos, JA; Campoy, C; Font, JA. "Desarrollo e Implantación del Programa de Doctorado Multidisciplinar NUTRENVIGEN-G+D FACTORS, pionero en su área temática en España"; Editorial: Universidad de Granada, 2011; Pag. 169. ISBN 978-84-691-3972-1.
5. Romeo J, Martín-Bautista E, García-Valdés L, López-Tarragona R, Segura-Moreno MT, Marti-Romero MA, Florido J, Diaz LE, Martín-Lagos JA, Martino J, López-Robles JC, Bueso M, Piqueras MJ, Campoy C, Marcos A. Changes in lymphocyte subsets at weeks 24 and 34 in normal and overweight/obese pregnant women. Preliminary results of the PREOBE study. En: Campoy C, Bayés R, Molina-Font JA (eds.): '*Demonstrating Early Nutrition Programming in Human and Animal Models*'. Editorial: Universidad de Granada, 2008; Pag. 117. ISBN: 978-84-338-4842-0.

11.5. RESEARCH PROJECTS PARTICIPATION

Project Title: *Elaboración de un paquete que contemple la normativa e instrumentos para salas especializadas de estimulación temprana para el tratamiento de rezagos en niños/as de 0 a 4 años en el marco del programa de Desarrollo Infantil Temprano* ***"CRECER BIEN PARA VIVIR BIEN".***

Financial entity: BID- Ministerio Salud Bolivia

Length: 2014 – 2015; Coordinator: Manuel Fernández Cruz. (Universidad de Granada)

Project title: *NUTRIMENTHE:* *Effect of diet on mental performance in children*

Financial entity: FP7 KBBE-2007-1. European Commission - DG Research. Directorate E - Life Sciences: biotechnology, agricultural and food research. Ref. number: 212652

Length: 2008 – 2013; Coordinator: Prof. Cristina Campoy - UGR

http://www.nutrimenthe.eu/

Project title: *EARNEST:* *"Early programming and long term consequences"*

Financial entity: European Union; European Project FP6. FOOD-CT-2005-007036.

Length: 2005 – 2010; Coordinator: Prof. Berthold Koletzko (University Ludwig-Maximilians, Munich). Principal investigator UGR: Prof. Cristina Campoy

http://www.metabolic-programming.org

Project title: *PREOBE:* *The role of nutrition and maternal genetics on the programming and development of foetal fatty tissue. Search for obesity biomarkers*

Financial entity: Consejería de Innovación, Ciencia y Empresa de la Junta de Andalucía. (P06-CTS-02341). Excellence Project.

Length: 2007 – 2010; Coordinator: Prof. Cristina Campoy

http://www.proyectopreobe.com/

Project title: ***EVASYON:*** *Development, application and evaluation of the efficiency of a therapeutically and nutritional program to teenagers with obesity.*

Financial entity: Coordinated Project. Fondo de Investigaciones sanitarias (FIS).05/2369.

Length: 2006 – 2009; Coordinator: Prof. Ascensión Marcos (ICTAN-CSIC-Madrid). Principal investigator UGR: Prof. Cristina Campoy

http://www.estudioevasyon.com/