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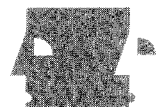
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The Development of Concrete Thought

A Manual Including Measurement Procedures and
Descriptive Analyses

Study „Individual Development and Social Structure“
Data Handbooks Part 1

Berlin 2000





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Materialien aus der Bildungsforschung

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0. Introduction

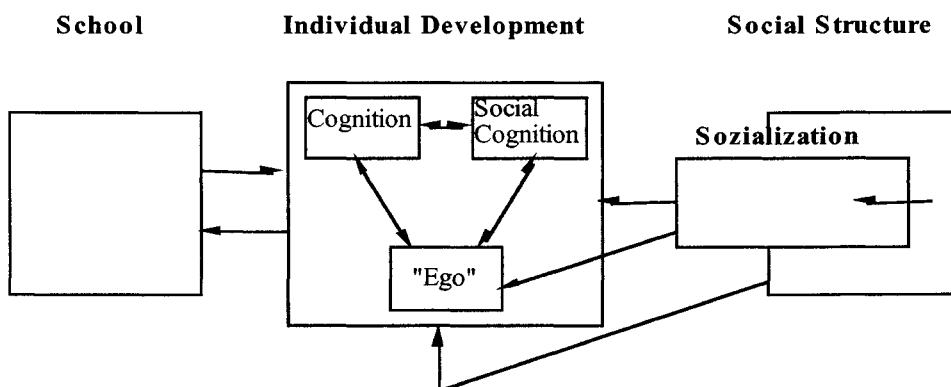
0.1. Background of the study

The data of this handbook are part of the longitudinal study "Individual Development and Social Structure" (IDSS), that was taken up in 1976 (Edelstein, Keller & Schröder, 1990).

The aim of the study was to analyze the developmental trajectories of Icelandic children in cognition (Schröder, 1989) and social cognition (Keller & Edelstein, 1991; Keller & Edelstein, 1993) and to investigate personality dimensions and ego resources (Hofmann, 1991) against the background of social-structural constraints in a society undergoing an accelerated modernization process (Björnsson, Edelstein & Kreppner, 1977).

Figure 1 specifies the hypothetical relationships between the psychological and the sociological dimensions.

Figure 1 Hypothetical model of developmental relationships



0.2. Measurement Design of the 'IDSS'- Study

The first wave of data collection took place in 1976/77 in Reykjavik. The children attended the first grade of primary school and were between 7 and 8 years old. The following measurement occasions including the Reykjavik sample took place at the ages of 8, 9, 12, 15, 17, 19 and 22 years.

A sample from three rural communities was measured two years after the investigation of the urban sample (Tab. 1) successively.

Table 1 Measurement occasions in the IDSS-Study

	Urban Sample	Rural sample	Age	Grade
Wave 1	1976/77	1978	7	1
Wave 2	1977/78	-	8	2
Wave 3	1978/79	1980	9	3
Wave 4	1981/82	1983	12	6
Wave 5	1984/85	1986	15	9
Wave 6	1986/87	-	17	-
Wave 7	1988/89	-	19	-
Wave 8	1991/92	1991/92	20 (rur) 22 (urb)	-

0.3. Sampling Design

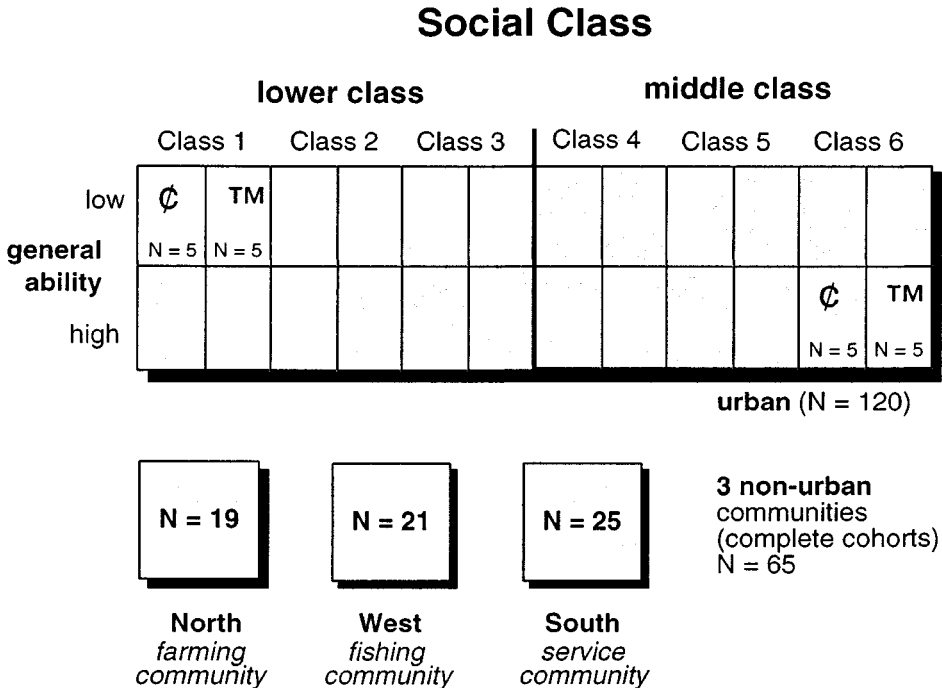
The population from which the Reykjavik sample (N=121) was selected had been stratified according to three analytically relevant dimensions:

- 1) according to the children's sex;
- 2) according to the social status of the parents as an indicator for developmentally advantageous or disadvantageous socialization and lifeworlds of children and
- 3) according to general ability level (as assessed by teachers) at the onset of schooling.

An additional sample (N = 65) includes the entire birth cohorts of three rural communities in Iceland, assumed to represent different contexts of socialization and modernization in three typical lifeworlds within the Icelandic culture: (1) a rural stray settlement, (2) a farming and service village and (3) a fishing village. This second sample should make it possible to investigate individual development against the background of different ecologies.

Figure B Sampling Design of the longitudinal study

Project IDSS - Sampling Design



The sampling design of the longitudinal study was introduced with the aim of maximizing interindividual variance. Individual differences are taken to derive from competence level at the onset of school, to children's sex, to socio-economic status of parents and to the social and cognitive ecologies of different lifeworlds.

The three dimensions according to which the urban sample was stratified were treated as factors in a quasi-experimental design. Although general ability level constituted a systematic stratifying dimension in the urban sample only, it could be derived retrodictively also for the rural children. Because the rural samples formed entire birth cohorts, the socio-economic status of parents is not equally distributed.

Competence level

During the first two weeks after school entrance teachers in all first grades of the city of Reykjavik were asked to nominate three children in the upper third, three children in the middle third and three children in the lower third of the general ability distribution in their particular classes. Subsequently, the middle third was discarded from the study. In the absence of

information about the school entrants, the teachers grounded their assessments on the cognitive, verbal and social competences of the children, as an informal inquiry showed. The children were assigned for each of the social classes to either „high competence“ or „low competence“.

The teachers' judgments can be considered as a global rating of the subjects' competence level at the onset of the longitudinal study, which was cross-validated with the cognitive and socio-cognitive data of Wave 1. The predictive power of the teacher rating proved considerable. The regression on a summary measure of cognitive competence about six month later produced a correlation coefficient of $r = .74$.

The 'competence level' was introduced to contrast differential impacts of this variable on the individual trajectories of the children and - supposing decelerated developmental speed within the 'lower competence' sample - to focus developmental processes with a finer grade.

Social class

In order to determine the social class of the parents, the status measures of Björnsson, Edelstein & Kreppner (1977, S. 29ff.) were used. Six classes were distinguished, whose relative proportions of the Icelandic population are shown in brackets:

- 1) Unskilled workers (26,1%);
- 2) Skilled workers and craftsmen (31,3%);
- 3) unskilled and skilled clerical workers and civil servants (10,0%);
- 4) technical or teaching professions, lower managerial (14,8%);
- 5) employers, businessmen or higher managerial professions (9,9%);
- 6) academic professions including secondary teachers, artists and leading occupations in the political or administrative system (7,8%)¹.

Attrition rate: Despite the wide long time range of the study (8 years from the first to the fifth wave), the drop out rate is rather small; it amounts to less than 10 % for the urban and less than 5 % for the rural sample.

0.4. Measures and Instruments

In order to measure the development of concrete operations, different tasks were administered to the children depending on the age and the presumed developmental status of the children.

At the first and the second measurement occasion (7 and 8 years), the concepts of invariance (Goldschmid & Bentler, 1968), class inclusion and logical multiplication (Smedslund, 1964) as well as verbal classification (Piaget & Inhelder, 1980) were investigated. Verbal classification and logical multiplication were administered again in Wave 3. Within the framework of this

¹ Population percentages from census data in the Handboool of statistics of Iceland.

measurement design, the cognitive development of concrete operations can be reconstructed across a time span of two years.

In Table 2, the instruments mentioned above are ordered across measurement occasions. For every task both judgment and justification were assessed.

Table 2 Overview of concrete operational concepts investigated

<i>Concrete operational concepts</i>	<i>Number of tasks administered at the age of</i>			
	<i>7</i>	<i>8²</i>	<i>9</i>	<i>12</i>
Conservation	12	12		
Class inclusion - experimental	4	4	4	
Verbal classification	13	13	13	3
Logical multiplication	4	4	4	

The tasks for repeated measurement were selected for all adequate application. Where possible, contextual variations of tasks in presentation, in content, in application contexts or in the procedure were introduced. Tasks were coded dichotomously or structurally (Lou, 1986). Thus, task performance was coded in agreement with theory, making the data generated in the study directly amenable to statistical analysis instead of using dichotomization of the median.

Table 3 Measures and sources of variance within concepts

Concepts	Sources of Variance
Conservation	Content, Performance
Class inclusion - experimental	Presentation, Performance
Verbal Classification	Content, Performance
Logical Multiplication	Content, Performance

For the sources of these measures see below.

² Only one half of the sample participated in Wave 2 ('late developed children')

In the following, the tasks administered for every concept are listed together with the operation for their measurement:

(a) **Conservation**

(Adapted from: Goldschmid, M.L. & Bentler, P. M., 1968)

<u>Task</u>	<u>Name</u>	<u>Task description:</u>
1	<i>Two dimensional space</i>	Blocks of wood arranged in a square or in a line
2	<i>Number</i>	Six eggs and six egg cups
3	<i>Substance</i>	Plastiline shaped in form of a ball and in form of a pancake
4	<i>Continuous Quantity</i>	Glass of water poured into five small beakers
5	<i>Weight</i>	Plastiline divided into five little balls
6	<i>Discontinuous Quantity</i>	Corn filled in a tall or corn filled in a wide beaker
7	<i>Area I</i>	Amount of grass with different placements of two barns in an area
8	<i>Area II</i>	Amount of grass with different placements of six barns in an area
9	<i>Area III</i>	Amount of grass with different placement of twelve barns in an area
10	<i>Length Ia</i>	Two sticks of equal length in shifted arrangement (Blue-red)
11	<i>Length Ib</i>	Two sticks of equal length in shifted arrangement (Red-blue)
12	<i>Length II</i>	Two sticks of equal length in shifted arrangement (Blue-red, the blue stick with arrowheads)

(b) **Class Inclusion**

(Adapted from: Smedslund, J., 1964)

<u>Task</u>	<u>Name</u>	<u>Task description:</u>
1	Red rounds and red squares	Uncovered Presentation
2	Red rounds and red squares	Covered Presentation
3	White squares and white rounds	Uncovered Presentation
4	White squares and white rounds	Covered Presentation

(c) Verbal Classification

(Adapted from Piaget, J. & Inhelder, B., 1980)

<u>Task</u>	<u>Name</u>	<u>Task description:</u>
1	Volkswagen	Cars
2	Boys vs. girls	Children
3	Trawlers	Ships
4	Cats	Pets
5	Lego blocks	Toys
6	White sheep	Sheep
7	Black Sheep	Sheep
8	Pants vs. Dresses	Clothes
9	Ducks	Birds
10	Bonbons	Candy
11	Buttercups	Flowers
12	Reykjavik citizens vs. Moscow citizens	Icelanders Russians
13	Oranges	Fruit

(d) Logical Multiplication:

(Adapted from: Smedslund, J., 1964)

(i) Multiplication of classes

<u>Task</u>	<u>Task description</u>
1	Form * Colour: Completion of cross tabulation with four entries Uncovered presentation
2	Form * Colour: Completion of cross tabulation with four entries Covered presentation

(ii) Multiplication of relations

<u>Task</u>	<u>Task description</u>
3	Hue * Size: Rectangles in three adjacent cells ; completion of the third cell; Uncovered presentation
4	Hue * Size: Rectangles in three adjacent cells ; completion of the third cell; Covered presentation

0.5. Aim of the Data Handbook

The data handbook describes the cognitive concepts and the instruments included in the longitudinal study, documents the measurement procedure and the method applied as well as the results of a number of basic statistical analyses.

This data handbook provides a quick and systematic overview in the domain of concrete operations for all those interested in the IDSS-project. Moreover, it provides an orientation for planning investigations and makes a descriptive comparison of different studies focussing on Piagetian concepts possible.

0.6. Content of the Data Handbook

The data handbook covering concrete operations includes four concepts.

Every chapter starts with an introduction to the specific concept, then describes the measures, materials and the scoring procedures utilized in the study; finally a description of the testing procedure and the instructions is presented .

Information concerning the electronic storage of the data is limited to a listing of the English variable names and their labels.

Results are documented separately for each measurement occasion, only descriptive statistics (cell frequencies) are reported.

0.7. References

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1. Conservation

1.1. Description of the concept

In cognitive psychology, the concept of invariance refers to the conservation of an attribute in a reference object undergoing a spatial or temporal change (transformation) (Piaget & Szeminska, 1975; Piaget & Inhelder 1975a). The dimension which is relevant in conservation can include several physical and geometrical characteristics. In substance conservation, for example, the child must designate the quantity (amount) of the clay (substance) as identical and equal in amount, as well as belonging to the same reference object, whether the clay is shaped into a ball or a form like a hot-dog. The question is therefore formulated to assess the child's ability to compare quantitatively the amounts of the initial condition and transformed condition. Elkind (1967) offered a more differentiated conception of Piaget's notion of conservation by separating the conservation of identity from the conservation of equivalence of mass. The first form of conservation is concerned with the transformation of the same respective amount (for example, a lump of clay that is reshaped). The second form concerns the relation between two amounts that are compared (for example, number invariance in the correspondence between eggs and egg cups). The following are the most important demands placed on the children in accomplishing the task:

1) perceiving the transformative action separately from the non-transformed condition of the object's characteristics; 2) decentering the perspective, i.e. coordinating those aspects of the situation perceived by the different senses; 3) coordinating the operation with its result (or effect); and 4) specific forms of reversibility -- the internalized or assumed reversal of the action in order to conceptualize the preservation of the characteristics affected by the action.

The reasons children give for their conservation judgments offer information about the underlying operational logic. The children can present a) the identity argument ("The amount is the same as before, nothing was taken away"), either as the direct or the inverse operation; they can assert b) the reversibility of the operation ("You can just pour it back"), when dealing with

the preservation of continuous amounts, a form of reversibility that refers directly to the action; or c) the compensation of two attributes is analyzed, and the relations ("What is higher here was broader before"), in the sense of consolidated concrete operations, are logically multiplied (Piaget & Szeminska 1975, p. 129). The conceptual proximity of conservation tasks to different forms of reasoning is particularly clear in the third kind of argument, although one should not go into the differently developed levels of argumentation in the sense of a horizontal displacement (development in specific domains). While reflexive or argumentative styles in solving an isomorphic problem can vary, it is important that the operational structure of invariance tasks is less complex than that of additive or multiplicative classification, since classificatory tasks always imply the fundamental operation of conservation. Piaget regards the concept of conservation as signalling transition or access to concrete operations.

1.2. Description of the measures: equipment and materials

This study used the test of Goldschmid and Bentler (1968) to examine conservation by assessing operations concerned with preservation as generated in a quasi-experimental situation. The concept of conservation was tested with reference to the content of the following eight domains:

- | | |
|--------------------------|--------------------------|
| 1) two-dimensional space | 5) weight |
| 2) number | 6) discontinuous amounts |
| 3) substance | 7) surface area |
| 4) continuous amounts | 8) length. |

The conservation tasks for surface and length were each divided into further tests with three different levels of complexity. Table 0 gives a depiction of the tasks with the different domains that were assessed in the study. A more thorough description can be found in Goldschmid and Bentler (1968).

Table 0
Conservation Tasks from Goldschmid and Bentler (1968)

Domain	Task
two-dimensional space	two squares made of 16 wooden blocks- one of them is transformed into a single line
number	two parallel lines consisting of 6 eggs and egg-cups each - one of them is spread out by the experimenter
substance	two balls of clay, one of them is transformed into a pancake
continuous amounts	two glasses with equal amount of water- the content of the first one is poured into five small glasses
weight	two balls of clay - one of them is transformed into five little balls
discontinuous amounts	two glasses filled with corn - the content of one of them is poured into a tall glass
surface area	<p>(I) two boards are presented symbolizing pastures with one cow and one barn - two more barns are added and put in different places on the board - subject has to compare the amount of grass left for the cows</p> <p>(II) Same as (I) but with six barns</p> <p>(III) Same as (I) with twelve barns</p>
length	<p>(I) two sticks of different colour (red and blue) arranged in parallel- the position of the blue stick is shifted</p> <p>(II) two sticks of different colour (red and blue) arranged in parallel- the position of the red stick is shifted</p> <p>(III) two sticks of different colour (red and blue) arranged in parallel- the position of the blue stick is shifted</p>

1.3. Investigation procedures and instructions

The child observes the experimental manipulation of the materials. Throughout this process, the investigator raises questions to assess if the child could follow the presentation of the task. The substance conservation task will serve to exemplify the testing procedures and instructions.

The investigator (I) forms the clays into two balls of the same size and says to the subject (S):

- "Here are two balls of play doh. There is the same amount of play doh in each ball. They are both alike."

After this presentation, I ascertains the subject's understanding with the question:

- "Is there as much play doh in this ball as in that one or does one have more ?"

If the child is able to compare the amounts and conclude that they are the same, I begins with the actual preservation experiment. Should the child see differences in the amounts, the balls are reportioned until the child agrees with the quantitative correspondence between the balls.

At this point, I flattens one of the balls to a pancake-like shape and comments:

- "Watch what I do. See, I'm making the ball into a pancake."

After the object has been transformed in front of the child, I asks the question:

- "Now, is there (I points to the ball) as much play doh in this one as in that one (I points to the pancake), or does one have more ?"

- "Why ?"

1.4. Scoring instructions and coding rules

The children's responses are recorded in the following way: 1) a so-called behavior score is assigned to correspond to the children's judgment of the test question ("it's the same" - "the ball has more" - "the pancake has more"), and 2) the children's reasons for their invariance judgment are noted. The type (1) responses are then coded as to whether conservation is adequately demonstrated or not. The children's explanations of the given judgment are termed appropriate when they present at least one of the following three argumentations:

- 1) Identity: "Nothing was added and nothing was taken away" or "They were the same before and the amount didn't change."
- 2) Reversibility: "Even if we mold the pancake into a ball, it's still the same."
- 3) Compensation: "The pancake may be wider than the ball, but it's not as high."

The children's explanations are termed inappropriate when the conservation judgment is incorrect or when the reason does not correspond to the types of argumentation listed above: "I'm not sure," "I heard it," or "They look the same to me."

Conservation was assessed at the age of seven and eight years.

1.5. List of variables

1.5.1. Variables including data of the seven-year-old-children

- INA101** Adequacy of judgment / Conservation of two dimensional space (Task A)
INA102 Adequacy of judgment / Conservation of Number (Task B)
INA103 Adequacy of judgment / Conservation of Substance (Task C)
INA104 Adequacy of judgment / Conservation of Continuous Quantity (Task D)
INA105 Adequacy of judgment / Conservation of Weight (Task E)
INA106 Adequacy of judgment / Conservation of Discontinuous Quantity (Task F)
INA107 Adequacy of judgment / Conservation of Area 1 (Task AI)
INA108 Adequacy of judgment / Conservation of Area 2 (Task AII)
INA109 Adequacy of judgment / Conservation of Area 3 (Task AIII)
INA110 Adequacy of judgment / Conservation of Length 1 (Task BI)
INA111 Adequacy of judgment / Conservation of Length 2 (Task BII)
INA112 Adequacy of judgment / Conservation of Length 3 (Task BIII)
- INB101** Adequacy of justification / Conservation of two dimensional space (Task A)
INB102 Adequacy of justification / Conservation of Number (Task B)
INB103 Adequacy of justification / Conservation of Substance (Task C)
INB104 Adequacy of justification / Conservation of Continuous Quantity (Task D)
INB105 Adequacy of justification / Conservation of Weight (Task E)
INB106 Adequacy of justification / Conservation of Discontinuous Quantity (Task F)
INB107 Adequacy of justification / Conservation of Area 1 (Task AI)
INB108 Adequacy of justification / Conservation of Area 2 (Task AII)
INB109 Adequacy of justification / Conservation of Area 3 (Task AIII)
INB110 Adequacy of justification / Conservation of Length 1 (Task BI)
INB111 Adequacy of justification / Conservation of Length 2 (Task BII)
INB112 Adequacy of justification / Conservation of Length 3 (Task BIII)

1.5.2. Variables including data of the eight-year-old children

INA201 Adequacy of judgment / Conservation of two dimensional space (Task A)

INA202 Adequacy of judgment / Conservation of Number (Task B)

INA203 Adequacy of judgment / Conservation of Substance (Task C)

INA204 Adequacy of judgment / Conservation of Continuous Quantity (Task D)

INA205 Adequacy of judgment / Conservation of Weight (Task E)

INA206 Adequacy of judgment / Conservation of Discontinuous Quantity (Task F)

INA207 Adequacy of judgment / Conservation of Area 1 (Task AI)

INA208 Adequacy of judgment / Conservation of Area 2 (Task AII)

INA209 Adequacy of judgment / Conservation of Area 3 (Task AIII)

INA210 Adequacy of judgment / Conservation of Length 1 (Task BI)

INA211 Adequacy of judgment / Conservation of Length 2 (Task BII)

INA212 Adequacy of judgment / Conservation of Length 3 (Task BIII)

INB201 Adequacy of justification / Conservation of two dimensional space (Task A)

INB202 Adequacy of justification / Conservation of Number (Task B)

INB203 Adequacy of justification / Conservation of Substance (Task C)

INB204 Adequacy of justification / Conservation of Continuous Quantity (Task D)

INB205 Adequacy of justification / Conservation of Weight (Task E)

INB206 Adequacy of justification / Conservation of Discontinuous Quantity (Task F)

INB207 Adequacy of justification / Conservation of Area 1 (Task AI)

INB208 Adequacy of justification / Conservation of Area 2 (Task AII)

INB209 Adequacy of justification / Conservation of Area 3 (Task AIII)

INB210 Adequacy of justification / Conservation of Length 1 (Task BI)

INB211 Adequacy of justification / Conservation of Length 2 (Task BII)

INB212 Adequacy of justification / Conservation of Length 3 (Task BIII)

1.6. References

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1.7. Assessment of the seven-year old children

Urban sample

Table 1
Concept of invariance:
Solution probabilities at age seven
Urban sample

Task	Judgment	Justification	N
INA/B101 Task A: Two Dimensional Space	0.868	0.645	121
INA/B102 Task B: Number	0.917	0.860	121
INA/B103 Task C: Substance	0.785	0.620	121
INA/B104 Task D: Continuous Quantity	0.744	0.579	121
INA/B105 Task E: Weight	0.719	0.612	121
INA/B106 Task F: Discontinuous. Quantity	0.835	0.711	121
INA/B107 Task AI: Area 1	0.860	0.818	121
INA/B108 Task AII: Area 2	0.711	0.661	121
INA/B109 Task AIII: Area 3	0.628	0.587	121
INA/B110 Task BI: Length 1	0.702	0.603	121
INA/B111 Task BII: Length 2	0.686	0.587	121
INA/B112 Task BIII: Length 3	0.785	0.612	121

Table 2
Concept of invariance:
Solution probabilities at age seven
by teacher rating
Urban sample

Teacher rating	Task	low			high		
		Judgment	Justification	N	Judgment	Justification	N
INA/B101	Task A: Two Dimensional Space	0.738	0.443	61	1.000	0.850	60
INA/B102	Task B: Number	0.852	0.738	61	0.983	0.983	60
INA/B103	Task C: Substance	0.639	0.377	61	0.933	0.867	60
INA/B104	Task D: Continuous Quantity	0.607	0.410	61	0.883	0.750	60
INA/B105	Task E: Weight	0.492	0.377	61	0.950	0.850	60
INA/B106	Task F: Discontinuous Quantity	0.672	0.508	61	1.000	0.917	60
INA/B107	Task AI: Area 1	0.754	0.689	61	0.967	0.950	60
INA/B108	Task AII: Area 2	0.508	0.426	61	0.917	0.900	60
INA/B109	Task AIII: Area 3	0.410	0.344	61	0.850	0.833	60
INA/B110	Task BI: Length 1	0.492	0.344	61	0.917	0.867	60
INA/B111	Task BII: Length 2	0.459	0.311	61	0.917	0.867	60
INA/B112	Task BIII: Length 3	0.623	0.361	61	0.950	0.867	60

Table 3
Concept of invariance:
Solution probabilities at age seven
by gender
Urban sample

Sex	Task	female			male		
		Judgment	Justification	N	Judgment	Justification	N
INA/B101	Task A: Two Dimensional Space	0.877	0.649	57	0.859	0.641	64
INA/B102	Task B: Number	0.930	0.860	57	0.906	0.859	64
INA/B103	Task C: Substance	0.825	0.684	57	0.750	0.563	64
INA/B104	Task D: Continuous Quantity	0.702	0.579	57	0.781	0.578	64
INA/B105	Task E: Weight	0.737	0.649	57	0.703	0.578	64
INA/B106	Task F: Discontinuous Quantity	0.842	0.754	57	0.828	0.672	64
INA/B107	Task AI: Area 1	0.807	0.772	57	0.906	0.859	64
INA/B108	Task AII: Area 2	0.737	0.667	57	0.688	0.656	64
INA/B109	Task AIII: Area 3	0.596	0.561	57	0.656	0.609	64
INA/B110	Task BI: Length 1	0.702	0.632	57	0.703	0.578	64
INA/B111	Task BII: Length 2	0.702	0.614	57	0.672	0.563	64
INA/B112	Task BIII: Length 3	0.789	0.596	57	0.781	0.625	64

Table 4
Concept of invariance:
Solution probabilities at age seven
by social class (SES) in two categories: low (SES 1-3) vs high (SES 4-6)
Urban sample

Socio-Economic Status		low			high		
Task		Judgment	Justification	N	Judgment	Justification	N
INA/B101	Task A: Two Dimensional Space	0.810	0.556	63	0.931	0.741	58
INA/B102	Task B: Number	0.921	0.825	63	0.914	0.897	58
INA/B103	Task C: Substance	0.698	0.571	63	0.879	0.672	58
INA/B104	Task D: Continuous Quantity	0.635	0.524	63	0.862	0.638	58
INA/B105	Task E: Weight	0.603	0.540	63	0.845	0.690	58
INA/B106	Task F: Discontinuous Quantity	0.762	0.651	63	0.914	0.776	58
INA/B107	Task AI: Area 1	0.825	0.762	63	0.897	0.879	58
INA/B108	Task AII: Area 2	0.683	0.635	63	0.741	0.690	58
INA/B109	Task AIII: Area 3	0.603	0.540	63	0.655	0.638	58
INA/B110	Task BI: Length 1	0.635	0.587	63	0.776	0.621	58
INA/B111	Task BII: Length 2	0.603	0.571	63	0.776	0.603	58
INA/B112	Task BIII: Length 3	0.714	0.540	63	0.862	0.690	58

Table 5
Concept of invariance:
Solution probabilities at age seven
by social class in six categories
Urban sample

Socio-economic Status		low/low (SES 1)			low/high (SES 2)		
Task		Judgment	Justification	N	Judgment	Justification	N
INA/B101	Task A: Two Dimensional Space	0.611	0.389	18	0.926	0.593	27
INA/B102	Task B: Number	0.889	0.833	18	0.963	0.852	27
INA/B103	Task C: Substance	0.667	0.611	18	0.778	0.593	27
INA/B104	Task D: Continuous Quantity	0.611	0.556	18	0.630	0.519	27
INA/B105	Task E: Weight	0.444	0.389	18	0.667	0.593	27
INA/B106	Task F: Discontinuous Quantity	0.667	0.556	18	0.778	0.704	27
INA/B107	Task AI: Area 1	0.833	0.722	18	0.778	0.741	27
INA/B108	Task AII: Area 2	0.611	0.611	18	0.630	0.556	27
INA/B109	Task AIII: Area 3	0.500	0.444	18	0.556	0.519	27
INA/B110	Task BI: Length 1	0.500	0.500	18	0.704	0.630	27
INA/B111	Task BII: Length 2	0.444	0.444	18	0.667	0.630	27
INA/B112	Task BIII: Length 3	0.667	0.444	18	0.741	0.593	27

Socio-Economic Status		middle/low (SES 3)			middle/high (SES 4)		
Task		Judgment	Justification	N	Judgment	Justification	N
INA/B101	Task A: Two Dimensional Space	0.833	0.667	18	0.950	0.750	20
INA/B102	Task B: Number	0.889	0.778	18	0.900	0.900	20
INA/B103	Task C: Substance	0.611	0.500	18	0.900	0.650	20
INA/B104	Task D: Continuous Quantity	0.667	0.500	18	0.850	0.650	20
INA/B105	Task E: Weight	0.667	0.611	18	0.850	0.700	20
INA/B106	Task F: Discontinuous Quantity	0.833	0.667	18	0.900	0.800	20
INA/B107	Task AI: Area 1	0.889	0.833	18	0.900	0.900	20
INA/B108	Task AII: Area 2	0.833	0.778	18	0.700	0.650	20
INA/B109	Task AIII: Area 3	0.778	0.667	18	0.600	0.600	20
INA/B110	Task BI: Length 1	0.667	0.611	18	0.900	0.750	20
INA/B111	Task BII: Length 2	0.667	0.611	18	0.900	0.700	20
INA/B112	Task BIII: Length 3	0.722	0.556	18	0.850	0.800	20

Table 5
continued

Socio-Economic Status		high/low (SES 5)			high/high (SES 6)		
		Judgment	Justification	N	Judgment	Justification	N
INA/B101	Task A: Two Dimensional Space	0.857	0.667	21	1.000	0.824	17
INA/B102	Task B: Number	0.905	0.857	21	0.941	0.941	17
INA/B103	Task C: Substance	0.857	0.667	21	0.882	0.706	17
INA/B104	Task D: Continuous Quantity	0.905	0.667	21	0.824	0.588	17
INA/B105	Task E: Weight	0.857	0.762	21	0.824	0.588	17
INA/B106	Task F: Discontinuous Quantity	0.905	0.762	21	0.941	0.765	17
INA/B107	Task AI: Area 1	0.857	0.857	21	0.941	0.882	17
INA/B108	Task AII: Area 2	0.762	0.714	21	0.765	0.706	17
INA/B109	Task AIII: Area 3	0.667	0.667	21	0.706	0.647	17
INA/B110	Task BI: Length 1	0.714	0.571	21	0.706	0.529	17
INA/B111	Task BII: Length 2	0.714	0.571	21	0.706	0.529	17
INA/B112	Task BIII: Length 3	0.857	0.619	21	0.882	0.647	17

Rural sample

Table 6
Concept of invariance:
Solution probabilities at age seven
Rural sample

Task	Judgment	Justification	N
INA/B101 Task A: Two Dimensional Space	0.703	0.609	64
INA/B102 Task B: Number	0.859	0.828	64
INA/B103 Task C: Substance	0.766	0.719	64
INA/B104 Task D: Continuous Quantity	0.688	0.656	64
INA/B105 Task E: Weight	0.719	0.688	64
INA/B106 Task F: Discontinuous Quantity	0.766	0.734	64
INA/B107 Task AI: Area 1	0.859	0.797	64
INA/B108 Task AII: Area 2	0.734	0.703	64
INA/B109 Task AIII: Area 3	0.641	0.625	64
INA/B110 Task BI: Length 1	0.797	0.750	64
INA/B111 Task BII: Length 2	0.813	0.781	64
INA/B112 Task BIII: Length 3	0.859	0.797	64

Table 7
Concept of invariance:
Solution probabilities at age seven
by gender
Rural sample

Sex		male			female		
Task		Judgment	Justification	N	Judgment	Justification	N
INA/B101	Task A: Two Dimensional Space	0.714	0.571	35	0.690	0.655	29
INA/B102	Task B: Number	0.886	0.857	35	0.828	0.793	29
INA/B103	Task C: Substance	0.771	0.714	35	0.759	0.724	29
INA/B104	Task D: Continuous Quantity	0.743	0.714	35	0.621	0.586	29
INA/B105	Task E: Weight	0.771	0.743	35	0.655	0.621	29
INA/B106	Task F: Discontinuous Quantity	0.800	0.800	35	0.724	0.655	29
INA/B107	Task AI: Area 1	0.857	0.829	35	0.862	0.759	29
INA/B108	Task AII: Area 2	0.714	0.686	35	0.759	0.724	29
INA/B109	Task AIII: Area 3	0.657	0.657	35	0.621	0.586	29
INA/B110	Task BI: Length 1	0.886	0.829	35	0.690	0.655	29
INA/B111	Task BII: Length 2	0.914	0.886	35	0.690	0.655	29
INA/B112	Task BIII: Length 3	0.886	0.886	35	0.828	0.690	29

Table 8
Concept of invariance:
Solution probabilities at age seven
by region
Rural sample

Community		North			South		
Task		Judgment	Justification	N	Judgment	Justification	N
INA/B101	Task A: Two Dimensional Space	0.842	0.789	19	0.640	0.520	25
INA/B102	Task B: Number	0.947	0.947	19	0.840	0.800	25
INA/B103	Task C: Substance	0.737	0.737	19	0.800	0.680	25
INA/B104	Task D: Continuous Quantity	0.684	0.684	19	0.720	0.680	25
INA/B105	Task E: Weight	0.789	0.789	19	0.720	0.720	25
INA/B106	Task F: Discontinuous Quantity	0.895	0.895	19	0.760	0.720	25
INA/B107	Task AI: Area 1	0.842	0.737	19	0.880	0.880	25
INA/B108	Task AII: Area 2	0.789	0.737	19	0.760	0.760	25
INA/B109	Task AIII: Area 3	0.737	0.737	19	0.640	0.600	25
INA/B110	Task BI: Length 1	0.895	0.895	19	0.800	0.800	25
INA/B111	Task BII: Length 2	0.947	0.947	19	0.800	0.800	25
INA/B112	Task BIII: Length 3	0.895	0.895	19	0.880	0.800	25

Table 8
continued

Community		West		
Task		Judgment	Justification	N
INA/B101	Task A: Two Dimensional Space	0.650	0.550	20
INA/B102	Task B: Number	0.800	0.750	20
INA/B103	Task C: Substance	0.750	0.750	20
INA/B104	Task D: Continuous Quantity	0.650	0.600	20
INA/B105	Task E: Weight	0.650	0.550	20
INA/B106	Task F: Discontinuous Quantity	0.650	0.600	20
INA/B107	Task AI: Area 1	0.850	0.750	20
INA/B108	Task AII: Area 2	0.650	0.600	20
INA/B109	Task AIII: Area 3	0.550	0.550	20
INA/B110	Task BI: Length 1	0.700	0.550	20
INA/B111	Task BII: Length 2	0.700	0.600	20
INA/B112	Task BIII: Length 3	0.800	0.700	20

1.8. Assessment of the eight-year old children

Urban sample

Table 9
Concept of invariance:
Solution probabilities at age eight
Urban sample

Total Score

Task	Judgment	Justification	N
INA/B201 Task A: Two Dimensional Space	0.915	0.881	59
INA/B202 Task B: Number	0.932	0.915	59
INA/B203 Task C: Substance	0.881	0.864	59
INA/B204 Task D: Continuous Quantity	0.983	0.966	59
INA/B205 Task E: Weight	0.746	0.729	59
INA/B206 Task F: Discontinuous Quantity	0.915	0.898	59
INA/B207 Task AI: Area 1	0.966	0.949	59
INA/B208 Task AII: Area 2	0.831	0.831	59
INA/B209 Task AIII: Area 3	0.712	0.712	59
INA/B210 Task BI: Length 1	0.898	0.881	59
INA/B211 Task BII: Length 2	0.898	0.864	59
INA/B212 Task BIII: Length 3	0.898	0.864	59

Table 10
Concept of invariance:
Solution probabilities at age eight
by teacher rating
Urban sample

Teacher rating		low			high		
		Judgment	Justification	N	Judgment	Justification	N
INA/B201	Task A: Two Dimensional Space	0.898	0.857	49	1.000	0.850	10
INA/B202	Task B: Number	0.918	0.898	49	0.983	0.983	10
INA/B203	Task C: Substance	0.857	0.857	49	0.933	0.867	10
INA/B204	Task D: Continuous Quantity	0.980	0.959	49	0.883	0.750	10
INA/B205	Task E: Weight	0.694	0.673	49	0.950	0.850	10
INA/B206	Task F: Discontinuous Quantity	0.898	0.878	49	1.000	0.917	10
INA/B207	Task AI: Area 1	0.959	0.939	49	0.967	0.950	10
INA/B208	Task AII: Area 2	0.816	0.816	49	0.917	0.900	10
INA/B209	Task AIII: Area 3	0.673	0.673	49	0.850	0.833	10
INA/B210	Task BI: Length 1	0.878	0.857	49	0.917	0.867	10
INA/B211	Task BII: Length 2	0.878	0.837	49	0.917	0.867	10
INA/B212	Task BIII: Length 3	0.878	0.837	49	0.950	0.867	10

Table 11
Concept of invariance:
Solution probabilities at age eight
by gender
Urban sample

Sex		female			male		
		Judgment	Justification	N	Judgment	Justification	N
INA/B201	Task A: Two Dimensional Space	0.926	0.889	27	0.906	0.875	32
INA/B202	Task B: Number	0.889	0.852	27	0.969	0.969	32
INA/B203	Task C: Substance	0.926	0.926	27	0.844	0.813	32
INA/B204	Task D: Continuous Quantity	1.000	0.963	27	0.969	0.969	32
INA/B205	Task E: Weight	0.704	0.704	27	0.781	0.750	32
INA/B206	Task F: Discontinuous Quantity	0.889	0.889	27	0.938	0.906	32
INA/B207	Task AI: Area 1	1.000	0.963	27	0.938	0.938	32
INA/B208	Task AII: Area 2	0.815	0.815	27	0.844	0.844	32
INA/B209	Task AIII: Area 3	0.667	0.667	27	0.750	0.750	32
INA/B210	Task BI: Length 1	0.889	0.889	27	0.906	0.875	32
INA/B211	Task BII: Length 2	0.889	0.852	27	0.906	0.875	32
INA/B212	Task BIII: Length 3	0.889	0.852	27	0.906	0.875	32

Table 12
Concept of invariance:
Solution probabilities at age eight
by social class in two categories
Urban sample

Socio-Economic Status		low			high		
		Judgment	Justification	N	Judgment	Justification	N
INA/B201	Task A: Two Dimensional Space	0.867	0.833	49	0.966	0.931	29
INA/B202	Task B: Number	0.867	0.833	49	1.000	1.000	29
INA/B203	Task C: Substance	0.767	0.733	49	1.000	1.000	29
INA/B204	Task D: Continuous Quantity	0.967	0.933	49	1.000	1.000	29
INA/B205	Task E: Weight	0.667	0.633	49	0.828	0.828	29
INA/B206	Task F: Discontinuous Quantity	0.833	0.800	49	1.000	1.000	29
INA/B207	Task AI: Area 1	0.933	0.900	49	1.000	1.000	29
INA/B208	Task AII: Area 2	0.767	0.767	49	0.897	0.897	29
INA/B209	Task AIII: Area 3	0.667	0.667	49	0.759	0.759	29
INA/B210	Task BI: Length 1	0.800	0.767	49	1.000	1.000	29
INA/B211	Task BII: Length 2	0.800	0.733	49	1.000	1.000	29
INA/B212	Task BIII: Length 3	0.900	0.833	49	0.897	0.897	29

Table 13
Concept of invariance:
Solution probabilities at age eight
by social class in six categories
Urban sample

Socio-Economic Status		low/low			low/high		
		Judgment	Justification	N	Judgment	Justification	N
INA/B201	Task A: Two Dimensional Space	0.778	0.667	9	0.917	0.917	12
INA/B202	Task B: Number	0.778	0.667	9	0.917	0.917	12
INA/B203	Task C: Substance	0.778	0.778	9	0.833	0.833	12
INA/B204	Task D: Continuous Quantity	1.000	0.889	9	1.000	1.000	12
INA/B205	Task E: Weight	0.667	0.667	9	0.500	0.417	12
INA/B206	Task F: Discontinuous Quantity	0.778	0.778	9	0.917	0.833	12
INA/B207	Task AI: Area 1	0.889	0.778	9	0.917	0.917	12
INA/B208	Task AII: Area 2	0.556	0.556	9	0.750	0.750	12
INA/B209	Task AIII: Area 3	0.333	0.333	9	0.750	0.750	12
INA/B210	Task BI: Length 1	0.889	0.889	9	0.833	0.750	12
INA/B211	Task BII: Length 2	0.889	0.778	9	0.833	0.750	12
INA/B212	Task BIII: Length 3	0.778	0.667	9	0.917	0.833	12

Table 10
Concept of invariance:
Solution probabilities at age eight
by teacher rating
Urban sample

Teacher rating		low			high		
		Judgment	Justification	N	Judgment	Justification	N
INA/B201	Task A: Two Dimensional Space	0.898	0.857	49	1.000	0.850	10
INA/B202	Task B: Number	0.918	0.898	49	0.983	0.983	10
INA/B203	Task C: Substance	0.857	0.857	49	0.933	0.867	10
INA/B204	Task D: Continuous Quantity	0.980	0.959	49	0.883	0.750	10
INA/B205	Task E: Weight	0.694	0.673	49	0.950	0.850	10
INA/B206	Task F: Discontinuous Quantity	0.898	0.878	49	1.000	0.917	10
INA/B207	Task AI: Area 1	0.959	0.939	49	0.967	0.950	10
INA/B208	Task AII: Area 2	0.816	0.816	49	0.917	0.900	10
INA/B209	Task AIII: Area 3	0.673	0.673	49	0.850	0.833	10
INA/B210	Task BI: Length 1	0.878	0.857	49	0.917	0.867	10
INA/B211	Task BII: Length 2	0.878	0.837	49	0.917	0.867	10
INA/B212	Task BIII: Length 3	0.878	0.837	49	0.950	0.867	10

Table 11
Concept of invariance:
Solution probabilities at age eight
by gender
Urban sample

Sex		female			male		
		Judgment	Justification	N	Judgment	Justification	N
INA/B201	Task A: Two Dimensional Space	0.926	0.889	27	0.906	0.875	32
INA/B202	Task B: Number	0.889	0.852	27	0.969	0.969	32
INA/B203	Task C: Substance	0.926	0.926	27	0.844	0.813	32
INA/B204	Task D: Continuous Quantity	1.000	0.963	27	0.969	0.969	32
INA/B205	Task E: Weight	0.704	0.704	27	0.781	0.750	32
INA/B206	Task F: Discontinuous Quantity	0.889	0.889	27	0.938	0.906	32
INA/B207	Task AI: Area 1	1.000	0.963	27	0.938	0.938	32
INA/B208	Task AII: Area 2	0.815	0.815	27	0.844	0.844	32
INA/B209	Task AIII: Area 3	0.667	0.667	27	0.750	0.750	32
INA/B210	Task BI: Length 1	0.889	0.889	27	0.906	0.875	32
INA/B211	Task BII: Length 2	0.889	0.852	27	0.906	0.875	32
INA/B212	Task BIII: Length 3	0.889	0.852	27	0.906	0.875	32

Table 12
Concept of invariance:
Solution probabilities at age eight
by social class in two categories
Urban sample

Socio-Economic Status		low			high		
		Judgment	Justification	N	Judgment	Justification	N
INA/B201	Task A: Two Dimensional Space	0.867	0.833	49	0.966	0.931	29
INA/B202	Task B: Number	0.867	0.833	49	1.000	1.000	29
INA/B203	Task C: Substance	0.767	0.733	49	1.000	1.000	29
INA/B204	Task D: Continuous Quantity	0.967	0.933	49	1.000	1.000	29
INA/B205	Task E: Weight	0.667	0.633	49	0.828	0.828	29
INA/B206	Task F: Discontinuous Quantity	0.833	0.800	49	1.000	1.000	29
INA/B207	Task AI: Area 1	0.933	0.900	49	1.000	1.000	29
INA/B208	Task AII: Area 2	0.767	0.767	49	0.897	0.897	29
INA/B209	Task AIII: Area 3	0.667	0.667	49	0.759	0.759	29
INA/B210	Task BI: Length 1	0.800	0.767	49	1.000	1.000	29
INA/B211	Task BII: Length 2	0.800	0.733	49	1.000	1.000	29
INA/B212	Task BIII: Length 3	0.900	0.833	49	0.897	0.897	29

Table 13
Concept of invariance:
Solution probabilities at age eight
by social class in six categories
Urban sample

Socio-Economic Status		low/low			low/high		
		Judgment	Justification	N	Judgment	Justification	N
INA/B201	Task A: Two Dimensional Space	0.778	0.667	9	0.917	0.917	12
INA/B202	Task B: Number	0.778	0.667	9	0.917	0.917	12
INA/B203	Task C: Substance	0.778	0.778	9	0.833	0.833	12
INA/B204	Task D: Continuous Quantity	1.000	0.889	9	1.000	1.000	12
INA/B205	Task E: Weight	0.667	0.667	9	0.500	0.417	12
INA/B206	Task F: Discontinuous Quantity	0.778	0.778	9	0.917	0.833	12
INA/B207	Task AI: Area 1	0.889	0.778	9	0.917	0.917	12
INA/B208	Task AII: Area 2	0.556	0.556	9	0.750	0.750	12
INA/B209	Task AIII: Area 3	0.333	0.333	9	0.750	0.750	12
INA/B210	Task BI: Length 1	0.889	0.889	9	0.833	0.750	12
INA/B211	Task BII: Length 2	0.889	0.778	9	0.833	0.750	12
INA/B212	Task BIII: Length 3	0.778	0.667	9	0.917	0.833	12

Table 13

continued

Socio-Economic Status		middle/low			middle/high		
Task		Judgment	Justification	N	Judgment	Justification	N
INA/B201	Task A: Two Dimensional Space	0.889	0.889	9	1.000	1.000	11
INA/B202	Task B: Number	0.889	0.889	9	1.000	1.000	11
INA/B203	Task C: Substance	0.667	0.556	9	1.000	1.000	11
INA/B204	Task D: Continuous Quantity	0.889	0.889	9	1.000	1.000	11
INA/B205	Task E: Weight	0.889	0.889	9	0.727	0.727	11
INA/B206	Task F: Discontinuous Quantity	0.778	0.778	9	1.000	1.000	11
INA/B207	Task AI: Area 1	1.000	1.000	9	1.000	1.000	11
INA/B208	Task AII: Area 2	1.000	1.000	9	0.818	0.818	11
INA/B209	Task AIII: Area 3	0.889	0.889	9	0.818	0.818	11
INA/B210	Task BI: Length 1	0.667	0.667	9	1.000	1.000	11
INA/B211	Task BII: Length 2	0.667	0.667	9	1.000	1.000	11
INA/B212	Task BIII: Length 3	1.000	1.000	9	1.000	1.000	11

Socio-Economic Status		high/low			high/high		
Task		Judgment	Justification	N	Judgment	Justification	N
INA/B201	Task A: Two Dimensional Space	0.909	0.818	11	1.000	1.000	7
INA/B202	Task B: Number	1.000	1.000	11	1.000	1.000	7
INA/B203	Task C: Substance	1.000	1.000	11	1.000	1.000	7
INA/B204	Task D: Continuous Quantity	1.000	1.000	11	1.000	1.000	7
INA/B205	Task E: Weight	0.818	0.818	11	1.000	1.000	7
INA/B206	Task F: Discontinuous Quantity	1.000	1.000	11	1.000	1.000	7
INA/B207	Task AI: Area 1	1.000	1.000	11	1.000	1.000	7
INA/B208	Task AII: Area 2	0.909	0.909	11	1.000	1.000	7
INA/B209	Task AIII: Area 3	0.636	0.636	11	0.857	0.857	7
INA/B210	Task BI: Length 1	1.000	1.000	11	1.000	1.000	7
INA/B211	Task BII: Length 2	1.000	1.000	11	1.000	1.000	7
INA/B212	Task BIII: Length 3	0.909	0.909	11	0.714	0.714	7

1.9. Missings

Table 14
Number of Missings in the concept of invariance

Tasks	7 years	8 years¹	Sample
ALL	0	-	Rural
ALL	0	62	Urban

¹ At age eight, only the children with low competence level were assessed.

2. Class inclusion and addition of classes

2.1. Description of the concept

Class inclusion refers to the relation between classes of objects that are ordered according to a hierarchical organization of attributes. The superordinate class corresponds to the most general attribute within this hierarchy and it can be constituted by an addition of subclasses.

According to the Piagetian model of the acquisition of class inclusion, possession of the class inclusion concept requires the ability to compare quantitatively the extensions of the subordinate and superordinate classes (Piaget & Inhelder 1973a, b, Piaget & Szeminska 1975). Subordinate and superordinate classes are designated as included or including classes.

In hierarchical classification, the secondary class appears as complement to the included class (primary class). Composition creates an overarching superordinate class by adding the primary and secondary classes through the operation of class inclusion, as long as one or both classes are not empty. This superordinate class combines the attributes of the objects in an overarching level of classification. The acquisition of class inclusion corresponds to grouping operation 1 in Flavell's taxonomy (1963).

The logical operator of composition is logical addition. In its formalized expression, it becomes clear that both subclasses are added into one superordinate class: $A + A' = B$ (for example, the subclass of oranges and the complementary class of other fruits constitute the superordinate class fruit). Given that the secondary amount is not an empty amount, it follows that $B > A$ expresses the extensions of the primary- and superordinate classes. The addition of classes, the principle underlying the operation, means that one can manipulate the mathematical term to infer that B is always larger than A, because B always contains A and A'. The acquisition of class inclusion can be assessed by eliciting the children's reasons for judging the question whether there is more A or more B. Adequate responses will refer to this class additive composition, either in the form "B contains A and A'" or "There is still A' contained in B."

In agreement with Hoppe-Graff (1982), Kofsky (1963, 1966), and Piaget and Inhelder (1973a, b), we can determine the following partial achievements which together constitute a classificatory conclusion:

- 1) distinction and coordination of the included and including classes;
- 2) conservation of class characteristics across changes in classification levels (an orange-colored, round object still remains an orange even when classified as fruit); and
- 3) coordination from comprehension (intension or quality of the attribute) and class extension in the sense that based on the operation of class addition the extension of subordinate and superordinate classes can be determined and compared. Class inclusion competence is usually taken as evidence for consolidated concrete-operational structures.

Data on the concept of classification and class inclusion were collected in two ways: First, the children were presented with concrete materials (i.e. plastic geometrical chips) from which to create class hierarchies; second, the children were to construct class hierarchies within a verbal presentation.

2.2. Class inclusion with concrete objects

2.2.1. Description of the measures: equipment and materials

To assess classification of concrete materials, this investigation drew on the tasks developed by Smedslund (1964). The tasks examine the child's ability to classify according to hierarchy and to quantify the extensions of the included and including class in a comparative way. The requisite for the achievement of this test is the ability to add classes.

The materials consisted of 13 red plastic chips (10 round and 3 square chips) and 6 white plastic chips (3 round and 3 square). Within this arrangement, different hierarchical classes could be created according to color or form. A second task used the same materials, except that colors and forms were reversed.

2.2.2. Investigation procedures and instructions

The child is first presented with the entire collection of unordered plastic chips. I asks preparatory questions, and repeats them in case the child has not understood the presentation of the task. I continues to repeat the questions until it is clear that the child has grasped the details of how the class inclusion should be completed.

I points to a red round chip and ascertains the child's comprehension:

- "What color is this chip?" and "What form does this chip have?".

I points to a white square chip and asks again:

- "What color is this chip?" and "What form does this chip have?"

Then the child is asked to put all the white chips off to the side so that only the red chips remain.

- "Are all these chips red?"
- "In this set, are there more round chips or more square chips?"

The last question is meant to encourage the child to compare the extensions of both subclasses and to quantify them in comparison to one another. The collection is then covered and the questions are repeated:

- "Are all these chips red?"
- "In this arrangement, are there more round or more square chips?"

Following the preparatory question sequence and assuming that the child could follow the investigator's statements to this point, the actual test questions are asked. They refer to the collection "red round chips and red square chips" that is still covered:

- "In this arrangement, are there now more red chips or more round chips?" (I points to the covered set of chips).
- "How do you know that?"

Then the collection is uncovered again with the question:

- "Now, look over here. Are there more red chips or more round chips?" (I points to the uncovered set of chips).
- "How do you know that?"

2.2.3. Scoring instructions and coding rules

The children's responses were recorded in the following way: 1) a so-called judgment score was assigned to correspond to the child's judgment of the test question ("There are more round ones" or "There are more red ones"), and 2) the children's reasons for their classification judgments were noted. The type (1) responses were then coded as to whether classification was adequately demonstrated or not. The children's explanations of the given judgment were termed adequate when they presented one of the following arguments:

- "There are more red ones because they are all red";
- "There are more red ones, because the round ones and the square ones together are more than the round ones alone";
- "There are more red ones, because the square chips are in there too";

The following types of judgments and reasons were seen as inappropriate:

- "There are more red ones, because there are only three square ones and a lot more round ones" or
- "I don't really know for sure."

The experimental class inclusion tasks were administered at the age of seven, eight and nine years.

2.2.4. List of Variables

2.2.4.1. Variables including data of the seven-year-old children

CIA101	Adequacy of Judgment / red chips / uncovered
CIA102	Adequacy of Judgment / red chips / covered
CIA103	Adequacy of Judgment / white chips / uncovered
CIA104	Adequacy of Judgment / white chips / covered
CIB101	Adequacy of Justification / red chips / uncovered
CIB102	Adequacy of Justification / red chips / covered
CIB103	Adequacy of Justification / white chips / uncovered
CIB104	Adequacy of Justification / white chips / covered

2.2.4.2. Variables including information of the eight-year-old children

CIA201	Adequacy of Judgment / red chips / uncovered
CIA202	Adequacy of Judgment / red chips / covered
CIA203	Adequacy of Judgment / white chips / uncovered
CIA204	Adequacy of Judgment / white chips / covered
CIB201	Adequacy of Justification / red chips / uncovered
CIB202	Adequacy of Justification / red chips / covered
CIB203	Adequacy of Justification / white chips / uncovered
CIB204	Adequacy of Justification / white chips / covered

2.2.4.2. Variables including information of the nine-year-old children

CIA301	Adequacy of Judgment / red chips / uncovered
CIA302	Adequacy of Judgment / red chips / covered
CIA303	Adequacy of Judgment / white chips / uncovered
CIA304	Adequacy of Judgment / white chips / covered
CIB301	Adequacy of Justification / red chips / uncovered
CIB302	Adequacy of Justification / red chips / covered
CIB303	Adequacy of Justification / white chips / uncovered
CIB304	Adequacy of Justification / white chips / covered

2.2.5. References

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2.2.6. Assessment of the seven-year-old children

Urban sample

Table 1
Concept of class inclusion:
Solution probabilities at age seven
Urban sample

Task	Judgment	Justification	N
CIA/B101 Red chips/ uncovered	0.298	0.273	121
CIA/B102 Red chips/ covered	0.306	0.231	121
CIA/B103 White chips/ uncovered	0.298	0.281	121
CIA/B104 White chips/ covered	0.322	0.231	121

Table 2
Concept of class inclusion:
Solution probabilities at age seven
by teacher rating
Urban sample

Task	low			high		
	Judgment	Justification	N	Judgment	Justification	N
CIA/B101 Red chips/ uncovered	0.164	0.131	61	0.433	0.417	60
CIA/B102 Red chips/ covered	0.197	0.098	61	0.417	0.367	60
CIA/B103 White chips/ uncovered	0.164	0.131	61	0.433	0.433	60
CIA/B104 white chips/ covered	0.180	0.082	61	0.467	0.383	60

Table 3
Concept of class inclusion:
Solution probabilities at age seven
by gender
Urban sample

Task	female			male		
	Judgment	Justification	N	Judgment	Justification	N
CIA/B101 Red chips/ uncovered	0.316	0.298	57	0.316	0.298	64
CIA/B102 Red chips/ covered	0.281	0.246	57	0.281	0.246	64
CIA/B103 White chips/ uncovered	0.333	0.316	57	0.333	0.316	64
CIA/B104 White chips/ covered	0.368	0.246	57	0.368	0.246	64

Table 4
Concept of class inclusion:
Solution probabilities at age seven
by social class in two categories: low (SES 1-3) high (SES 4-6)
Urban sample

SES		low			high		
Task		Judgment	Justification	N	Judgment	Justification	N
CIA/B101	Red chips/ uncovered	0.333	0.286	63	0.836	0.836	58
CIA/B102	Red chips/ covered	0.333	0.254	63	0.852	0.852	58
CIA/B103	White chips/ uncovered	0.333	0.317	63	0.869	0.869	58
CIA/B104	White chips/ covered	0.333	0.238	63	0.836	0.820	58

Table 5
Concept of class inclusion:
Solution probabilities at age seven
by social class in six categories
Urban sample

SES		low/low (SES 1)			low/high (SES 2)		
Task		Judgment	Justification	N	Judgment	Justification	N
CIA/B101	Red chips/ uncovered	0.278	0.222	18	0.316	0.407	27
CIA/B102	Red chips/ covered	0.222	0.167	18	0.281	0.370	27
CIA/B103	White chips/ uncovered	0.222	0.222	18	0.481	0.444	27
CIA/B104	White chips/ covered	0.222	0.222	18	0.481	0.296	27

SES		middle/low (SES 3)			middle/high (SES 4)		
Task		Judgment	Justification	N	Judgment	Justification	N
CIA/B101	Red chips/ uncovered	0.278	0.167	18	0.150	0.150	20
CIA/B102	Red chips/ covered	0.278	0.167	18	0.200	0.150	20
CIA/B103	White chips/ uncovered	0.222	0.222	18	0.150	0.150	20
CIA/B104	White chips/ covered	0.222	0.167	18	0.200	0.150	20

SES		high/low (SES 5)			high/high (SES 6)		
Task		Judgment	Justification	N	Judgment	Justification	N
CIA/B101	Red chips/ uncovered	0.238	0.238	21	0.412	0.412	17
CIA/B102	Red chips/ covered	0.286	0.190	21	0.353	0.294	17
CIA/B103	White chips/ uncovered	0.286	0.238	21	0.353	0.353	17
CIA/B104	White chips/ covered	0.286	0.190	21	0.471	0.353	17

Rural sample

Table 6
Concept of class inclusion:
Solution probabilities at age seven
Rural sample

Task	Judgment	Justification	N
CIA/B101 Red chips/ uncovered	0.250	0.203	64
CIA/B102 Red chips/ covered	0.219	0.203	64
CIA/B103 White chips/ uncovered	0.250	0.234	64
CIA/B104 White chips/ covered	0.344	0.219	64

Table 7
Concept of class inclusion:
Solution probabilities at age seven
by gender
Rural sample

Sex	female			male		
	Task	Judgment	Justification	N	Judgment	Justification
CIA/B301 Red chips/ uncovered	0.310	0.276	29	0.200	0.143	35
CIA/B302 Red chips/ covered	0.276	0.241	29	0.171	0.171	35
CIA/B303 White chips/ uncovered	0.310	0.276	29	0.200	0.200	35
CIA/B304 White chips/ covered	0.276	0.276	29	0.400	0.171	35

Table 8
Concept of class inclusion:
Solution probabilities at age seven
by community
Rural sample

Region	North			South		
	Task	Judgment	Justification	N	Judgment	Justification
CIA/B301 Red chips/ uncovered	0.263	0.211	19	0.280	0.280	25
CIA/B302 Red chips/ covered	0.211	0.211	19	0.280	0.240	25
CIA/B303 White chips/ uncovered	0.316	0.316	19	0.320	0.280	25
CIA/B304 White chips/ covered	0.474	0.263	19	0.320	0.280	25

Region	West		
Task	Judgment	Justification	N
CIA/B101 Red chips/ uncovered	0.200	0.100	20
CIA/B102 Red chips/ covered	0.150	0.150	20
CIA/B103 White chips/ uncovered	0.100	0.100	20
CIA/B104 White chips/ covered	0.250	0.100	20

2.2.7. Assessment of the eight-year-old children

Urban sample

Table 9
Concept of class inclusion:
Solution probabilities at age eight
Urban sample

Task	Judgment	Justification	N
CIA/B201 Red chips/ uncovered	0.458	0.424	59
CIA/B202 Red chips/ covered	0.407	0.390	59
CIA/B203 White chips/ uncovered	0.407	0.390	59
CIA/B204 White chips/ covered	0.424	0.390	59

Table 10
Concept of class inclusion:
Solution probabilities at age eight
by teacher rating
Urban sample

Task	low			high		
	Judgment	Justification	N	Judgment	Justification	N
CIA/B201 Red chips/ uncovered	0.408	0.367	49	0.700	0.700	10
CIA/B202 Red chips/ covered	0.347	0.327	49	0.700	0.700	10
CIA/B203 White chips/ uncovered	0.347	0.327	49	0.700	0.700	10
CIA/B204 White chips/ covered	0.367	0.327	49	0.700	0.700	18

Table 11
Concept of class inclusion:
Solution probabilities at age eight
by gender
Urban sample

Task	female			male		
	Judgment	Justification	N	Judgment	Justification	N
CIA/B201 Red chips/ uncovered	0.481	0.407	27	0.438	0.438	32
CIA/B202 Red chips/ covered	0.370	0.370	27	0.438	0.406	32
CIA/B203 White chips/ uncovered	0.444	0.407	27	0.375	0.375	32
CIA/B204 White chips/ covered	0.370	0.370	27	0.469	0.406	32

Table 12
Concept of class inclusion:
Solution probabilities at age eight
by social class in two categories
Urban sample

SES		low			high		
Task		Judgment	Justification	N	Judgment	Justification	N
CIA/B201	Red chips/ uncovered	0.333	0.300	30	0.586	0.250	29
CIA/B202	Red chips/ covered	0.267	0.233	30	0.552	0.167	29
CIA/B203	White chips/ uncovered	0.233	0.200	30	0.586	0.167	29
CIA/B204	White chips/ covered	0.333	0.267	30	0.517	0.250	29

Table 13
Concept of class inclusion:
Solution probabilities at age seven
by social class in six categories
Urban sample

SES		low/low			low/high		
Task		Judgment	Justification	N	Judgment	Justification	N
CIA/B201	Red chips/ uncovered	0.444	0.333	9	0.250	0.250	12
CIA/B202	Red chips/ covered	0.222	0.222	9	0.167	0.167	12
CIA/B203	White chips/ uncovered	0.222	0.111	9	0.167	0.167	12
CIA/B204	White chips/ covered	0.222	0.222	9	0.333	0.250	12

SES		middle/low			middle/high		
Task		Judgment	Justification	N	Judgment	Justification	N
CIA/B201	Red chips/ uncovered	0.333	0.333	9	0.455	0.455	11
CIA/B202	Red chips/ covered	0.444	0.333	9	0.545	0.545	11
CIA/B203	White chips/ uncovered	0.333	0.333	9	0.545	0.545	11
CIA/B204	White chips/ covered	0.444	0.333	9	0.455	0.455	11

SES		high/low			high/high		
Task		Judgment	Justification	N	Judgment	Justification	N
CIA/B201	Red chips/ uncovered	0.727	0.636	11	0.571	0.571	7
CIA/B202	Red chips/ covered	0.545	0.545	11	0.571	0.571	7
CIA/B203	White chips/ uncovered	0.636	0.636	11	0.571	0.571	7
CIA/B204	White chips/ covered	0.636	0.636	11	0.429	0.429	7

2.2.8. Assessment of the nine-year-old children

Urban sample

Table 14
Concept of class inclusion:
Solution probabilities at age nine
Urban sample

Task	Judgment	Justification	N
CIA/B301 Red chips/ uncovered	0.868	0.842	114
CIA/B302 Red chips/ covered	0.842	0.825	114
CIA/B303 White chips/ uncovered	0.842	0.842	114
CIA/B304 White chips/ covered	0.833	0.807	114

Table 15
Concept of class inclusion:
Solution probabilities at age nine
by teacher rating
Urban sample

Task	low			high		
	Judgment	Justification	N	Judgment	Justification	N
CIA/B301 Red chips/ uncovered	0.797	0.746	59	0.945	0.945	55
CIA/B302 Red chips/ covered	0.780	0.746	59	0.909	0.909	55
CIA/B303 White chips/ uncovered	0.729	0.729	59	0.964	0.964	55
CIA/B304 White chips/ covered	0.767	0.717	59	0.945	0.972	55

Table 16
Concept of class inclusion:
Solution probabilities at age nine
by gender
Urban sample

Task	female			male		
	Judgment	Justification	N	Judgment	Justification	N
CIA/B301 Red chips/ uncovered	0.906	0.849	53	0.836	0.836	61
CIA/B302 Red chips/ covered	0.830	0.792	53	0.852	0.852	61
CIA/B303 White chips/ uncovered	0.811	0.811	53	0.869	0.869	61
CIA/B304 White chips/ covered	0.830	0.792	53	0.836	0.820	61

Table 17
Concept of class inclusion:
Solution probabilities at age nine
by social class in two categories
Urban sample

SES		low			high		
Task		Judgment	Justification	N	Judgment	Justification	N
CIA/B301	Red chips/ uncovered	0.817	0.783	60	0.926	0.907	54
CIA/B302	Red chips/ covered	0.800	0.767	60	0.889	0.889	54
CIA/B303	White chips/ uncovered	0.800	0.800	60	0.889	0.889	54
CIA/B304	White chips/ covered	0.767	0.717	60	0.907	0.907	54

Table 18
Concept of class inclusion:
Solution probabilities at age nine
by social class in six categories
Urban sample

SES		low/low			low/high		
Task		Judgment	Justification	N	Judgment	Justification	N
CIA/B301	Red chips/ uncovered	0.750	0.688	16	0.769	0.731	26
CIA/B302	Red chips/ covered	0.688	0.688	16	0.846	0.769	26
CIA/B303	White chips/ uncovered	0.688	0.688	16	0.808	0.808	26
CIA/B304	White chips/ covered	0.688	0.563	16	0.769	0.731	26

SES		middle/low			middle/high		
Task		Judgment	Justification	N	Judgment	Justification	N
CIA/B301	Red chips/ uncovered	0.944	0.944	18	0.895	0.895	19
CIA/B302	Red chips/ covered	0.833	0.833	18	0.842	0.842	19
CIA/B303	White chips/ uncovered	0.889	0.889	18	0.895	0.895	19
CIA/B304	White chips/ covered	0.833	0.833	18	0.895	0.895	19

SES		high/low			high/high		
Task		Judgment	Justification	N	Judgment	Justification	N
CIA/B301	Red chips/ uncovered	1.000	1.000	20	0.867	0.907	15
CIA/B302	Red chips/ covered	0.950	0.950	20	0.867	0.889	15
CIA/B303	White chips/ uncovered	0.950	0.950	20	0.889	0.889	15
CIA/B304	White chips/ covered	1.000	1.000	20	0.907	0.907	15

Rural Sample

Table 19
Concept of class inclusion:
Solution probabilities at age nine
Rural sample

Total Score

Task	Judgment	Justification	N
CIA/B101 Red chips/ uncovered	0.677	0.661	62
CIA/B102 Red chips/ covered	0.694	0.661	62
CIA/B103 White chips/ uncovered	0.710	0.661	62
CIA/B104 White chips/ covered	0.710	0.645	62

Table 20
Concept of class inclusion:
Solution probabilities at age nine
by gender
Rural sample

Gender	female			male		
	Task	Judgment	Justification	N	Judgment	Justification
CIA/B301 Red chips/ uncovered	0.686	0.630	27	0.667	0.686	35
CIA/B302 Red chips/ covered	0.741	0.667	27	0.657	0.657	35
CIA/B303 White chips/ uncovered	0.771	0.630	27	0.630	0.686	35
CIA/B304 White chips/ covered	0.741	0.667	27	0.686	0.629	35

Table 21
Concept of class inclusion:
Solution probabilities at age nine
by community
Rural sample

Region	North			South		
	Task	Judgment	Justification	N	Judgment	Justification
CIA/B301 Red chips/ uncovered	0.778	0.778	18	0.750	0.708	24
CIA/B302 Red chips/ covered	0.778	0.778	18	0.833	0.750	24
CIA/B303 White chips/ uncovered	0.722	0.722	18	0.750	0.750	24
CIA/B304 White chips/ covered	0.833	0.778	18	0.750	0.708	24

Region

West

Task	Judgment	Justification	N
CIA/B301 Red chips/ uncovered	0.500	0.500	20
CIA/B302 Red chips/ covered	0.450	0.450	20
CIA/B303 White chips/ uncovered	0.650	0.500	20
CIA/B304 White chips/ covered	0.550	0.450	20

2.2.9. Missings

Table 22

Number of Missings in the concept of class inclusion

Tasks	7 years	8 years	9 years	Sample
ALL	0	-	2	Rural
ALL	0	62	7	Urban

2.3. Verbal classification

2.3.1. Description of the measure: Semantic classes

To measure verbal classification, this investigation drew on the tasks from Piaget and Inhelder (1973a, b) and new items were also designed to draw on experiences from the children's own lifeworld: The tasks assessed the children's ability to classify verbal categories hierarchically, and to compare the extensions of the subordinate and superordinate classes. The concept of verbal classification was tested with the following categories:

- 1) cat/animals
- 2) duck/birds
- 3) buttercup/flowers
- 4) orange/fruits (fruit)
- 5) Volkswagen/cars
- 6) boys or girls/children
- 7) fishing boats/ships
- 8) lego blocks/toys
- 9) white sheep/sheep
- 10) black sheep/sheep
- 11) dress or pants/clothes
- 12) hard candies/sweets
- 13) people from Reykjavik/people from Iceland

2.3.2. Investigation procedures and instructions

All 13 tasks were presented verbally. The interviewer read the questions and waited for each answer. After each answer, the interviewer asked for a reason. The following example of task 5 (Volkswagen/cars) demonstrates the procedure.

- "What do you think? Are there more Volkswagens or are there more cars?"

The interviewer records the subject's response.

- "How do you know that? Can you tell me how you know that?"

Again, the interviewer records the subject's reason.

The items were presented in the following order:

5, 6, 7, 1, 8, 9, 10, 11, 2, 12, 3, 13, 4

2.3.3. Scoring instructions and coding rules

The children's responses were coded in the following way: 1) a so-called judgment score was assigned to the children's judgment of the test question ("There are more Volkswagens" or "There are more cars") and 2) the children's reasons for their classification judgments were noted.

The type (1) responses were then coded as to whether classification was adequately demonstrated. The children's explanations of the judgment were termed adequate when they presented one of the following arguments demonstrating the acquisition of class inclusion:

- "There are more cars, because they are all cars."
- "There are more cars, because cars don't come only from Volkswagen, but from companies like Ford too."
- "There are more cars, because there are a lot more cars than just Volkswagen cars."

The following types of judgments and reasons were seen as inappropriate:

- "There are more Volkswagens, because there are so many Volkswagens here."
- "I'm not really sure."

2.3.4. Additional tasks and pictorial classification

2.3.4.1. Description of the measures

The nine-year-old children had to solve two further variations of the verbal classifications tasks: In the first one, the superordinate class term was replaced by a collection term and in the second one, pictures of the designated entities were presented in addition to the standard question.

The collection tasks were tested in five domains:

- I)
 - A) duck/birds
 - B) people from Reykjavik / people from Iceland
 - C) Lego blocks / pile
 - D) buttercups / garden
 - E) cats / zoo

The wording of the class inclusion questions with collection terms is depicted in table A.

Table A**Items used in the collection task I)**

- A) Are there more ducks or more birds ?
- B). Are there more people from Reykjavik or more people from Iceland ?
- C). Let us imagine that all the toys in Reykjavik were collected in one pile. Who would have more toys, the one who gets the pile or the one who gets all the legoblocks ? Why ?
- D). Let us imagine a flower collector, who collects all the flowers in Iceland one summer and plants them in a garden. Who would get more flowers, the one who gets all the buttercups in Iceland or the one who gets the garden ?
- E). Let us imagine that all animals in Iceland were put in one zoo. Who would have more animals, the one who gets all the cats in Iceland or the one who gets the zoo ?
-

The pictorial classification tasks were tested in three domains under two different conditions: The items of section II included collection terms while in the tasks of section III countable terms were used to designate the superordinate class.

II)

- A) boys and girls / class
- B) trawlers / fleet
- C) black sheep / flock

III)

- A) boys and girls / children
- B) trawlers / fleet
- C) black sheep / flock

The wording of the class inclusion questions used in the pictorial preseted tasks is depicted in table B.

Table B**Items used in the pictorial presented task**

II) collection terms	III) countable superordinate class terms
A). Here we see a picture of children in school. These are the boys and these are the girls and this is the class. Who would have a bigger birthday party, the one who invites the boys or the one who invites the class ?	A). Here we see a picture of children in school. These are the boys and these are the girls. Now the teacher asks the children to order up in a long queue. Which would be a longer queue, a queue of the boys in the picture or a queue of the children ?
B). Here we see a picture from the sea. These ships are trawlers and these are cargoships and this is the fleet. Who would need a bigger harbour, the one who owns the fleet or the one who owns the trawlers ?	B). Here we see a picture from the sea. These ships are trawlers and these are cargoships. Who would have more vessels, the one who owns the ships or the one who owns the trawlers ?
C). Here we see the sheep owned by some farmer. These are the white sheep and these are different colours and this is the flock. Who would need a bigger sheepfold, the one who gets the white sheep or the one who gets the flock ?	C). Here we see a picture of the sheep owned by a farmer. These are white and these are different colours. Who would get more meat, the one who slaughters the white sheep or the one who slaughters the sheep ?

2.3.4.2. Investigation procedures and instructions

1. The tasks I) A-E are verbal classification tasks, in which the superordinate class term has been replaced by a collection term.

The interviewer read the questions, waited for the answer and asked the subjects to give a reason for their judgment.

The following example of task I) E demonstrates the procedure.

- "Imagine that all the animals in Iceland were put into a zoo. What do you think ? Who would have more animals - the one who gets all the cats in Iceland or the one who gets the whole zoo ?"

The interviewer records the subject's response.

- "How do you know that? Can you tell me how you know that?"

Again the interviewer records the subject's reason.

2. Tasks II) A-C and III) A-C were presented pictorially. The interviewer read the questions while showing the pictures. Having answered the questions, the children were asked to justify their judgment. The following example of task II) A demonstrates the procedure.

- "Here we can see a picture of school children / pupils. These are the boys (show) and these are the girls and here you can see the whole class (show). What do you think ? Who would have a bigger birthday party, the one who invites the boys or the one who invites the whole class ?"

The interviewer records the subject's response.

- "How do you know that? Can you tell me how you know that?"

Again, the interviewer records the subject's reason.

The coding of the subject' s answers proceeded as described in 2.3.3.

Verbal classification was measured at the age of seven, eight and nine. At the age of twelve, only a selection of two verbal classification and two collection tasks were presented to the subjects.

2.3.5. List of variables

2.3.5.1. Variables including data of the seven-year-old children

CVA101	Adequacy of Judgment / Verbal Classification / Animals/Cats
CVA102	Adequacy of Judgment / Verbal Classification / Birds/Ducks
CVA103	Adequacy of Judgment / Verbal Classification / Flowers/Buttercups
CVA104	Adequacy of Judgment / Verbal Classification / Fruit/Oranges
CVA105	Adequacy of Judgment / Verbal Classification / Cars/Volkswagens
CVA106	Adequacy of Judgment / Verbal Classification / Children/Boys / Girls
CVA107	Adequacy of Judgment / Verbal Classification / Ships/Trawlers
CVA108	Adequacy of Judgment / Verbal Classification / Toys/Lego
CVA109	Adequacy of Judgment / Verbal Classification / Sheep/White Sheep
CVA110	Adequacy of Judgment / Verbal Classification / Sheep/Black Sheep
CVA111	Adequacy of Judgment / Verbal Classification / Clothes/Dresses
CVA112	Adequacy of Judgment / Verbal Classification / Candy/sweets
CVA113	Adequacy of Judgment / Verbal Classification /Icelanders/People from Reykjavik
CVB101	Adequacy of Justification / Verbal Classification /Animals/Cats
CVB102	Adequacy of Justification / Verbal Classification /Birds/Ducks
CVB103	Adequacy of Justification / Verbal Classification /Flowers/Buttercups
CVB104	Adequacy of Justification / Verbal Classification /Fruit/Oranges
CVB105	Adequacy of Justification / Verbal Classification /Cars/Volkswagens
CVB106	Adequacy of Justification / Verbal Classification /Children/Boys / Girls
CVB107	Adequacy of Justification / Verbal Classification /Ships/Trawlers
CVB108	Adequacy of Justification / Verbal Classification /Toys/Lego
CVB109	Adequacy of Justification / Verbal Classification /Sheep/White Sheep
CVB110	Adequacy of Justification / Verbal Classification /Sheep/Black Sheep
CVB111	Adequacy of Justification / Verbal Classification /Clothes/Dresses
CVB112	Adequacy of Justification / Verbal Classification /Candy/sweets
CVB113	Adequacy of Justification / Verbal Classification /Icelanders/People from Reykjavik

2.3.5.2. Variables including data of the nine/year/old children

CVA301	Adequacy of Judgment / Verbal Classification /Animals/Cats
CVA302	Adequacy of Judgment / Verbal Classification /Birds/Ducks
CVA303	Adequacy of Judgment / Verbal Classification /Flowers/Buttercups
CVA304	Adequacy of Judgment / Verbal Classification /Fruit/Oranges
CVA305	Adequacy of Judgment / Verbal Classification /Cars/Volkswagen
CVA306	Adequacy of Judgment / Verbal Classification /Children/Boys / Girls
CVA307	Adequacy of Judgment / Verbal Classification /Ships/Trawlers
CVA308	Adequacy of Judgment / Verbal Classification /Toys/Lego
CVA309	Adequacy of Judgment / Verbal Classification /Sheep/White Sheep
CVA310	Adequacy of Judgment / Verbal Classification /Sheep/Black Sheep
CVA311	Adequacy of Judgment / Verbal Classification /Clothes/Dresses
CVA312	Adequacy of Judgment / Verbal Classification /Candy/sweets
CVA313	Adequacy of Judgment / Verbal Classification /Icelanders/People from Reykjavik
CVB301	Adequacy of Justification / Verbal Classification /Animals/Cats
CVB302	Adequacy of Justification / Verbal Classification /Birds/Ducks
CVB303	Adequacy of Justification / Verbal Classification /Flowers/Buttercups
CVB304	Adequacy of Justification / Verbal Classification /Fruit/Oranges
CVB305	Adequacy of Justification / Verbal Classification /Cars/Volkswagens
CVB306	Adequacy of Justification / Verbal Classification /Children/Boys / Girls
CVB307	Adequacy of Justification / Verbal Classification /Ships/Trawlers
CVB308	Adequacy of Justification / Verbal Classification /Toys/Lego
CVB309	Adequacy of Justification / Verbal Classification /Sheep/White Sheep
CVB310	Adequacy of Justification / Verbal Classification /Sheep/Black Sheep
CVB311	Adequacy of Justification / Verbal Classification /Clothes/Dresses
CVB312	Adequacy of Justification / Verbal Classification /Candy/sweets
CVB313	Adequacy of Justification / Verbal Classification /Icelanders/People from Reykjavik
CPA301	Adequacy of Judgment / Pictorial Classification / Birds/Ducks
CPA302	Adequacy of Judgment / Pictorial Classification / Icelanders/People from Reykjavik
CPA303	Adequacy of Judgment / Pictorial Classification / Legoblocks/Pile
CPA304	Adequacy of Judgment / Pictorial Classification / Buttercups/ Garden
CPA305	Adequacy of Judgment / Pictorial Classification / Cats/ Zoo
CPA306	Adequacy of Judgment / Pictorial Classification / Boys-Girls/ Class
CPA307	Adequacy of Judgment / Pictorial Classification / Trawlers/Fleet
CPA308	Adequacy of Judgment / Pictorial Classification /Herd/White Sheep

CPA309	Adequacy of Judgment / Pictorial Classification / Children/Boys Girls
CPA310	Adequacy of Judgment / Pictorial Classification / Ships/ Trawlers
CPA311	Adequacy of Judgment / Pictorial Classification / Sheep/White Sheep
CPB301	Adequacy of Justification / Pictorial Classification / Birds/Ducks
CPB302	Adequacy of Justification / Pictorial Classification / Icelanders/People from Reykjavik
CPB303	Adequacy of Justification / Pictorial Classification / Legoblocks/Pile
CPB304	Adequacy of Justification / Pictorial Classification / Buttercups/ Garden
CPB305	Adequacy of Justification / Pictorial Classification / Cats/ Zoo
CPB306	Adequacy of Justification / Pictorial Classification / Boys-Girls/ Class
CPB307	Adequacy of Justification / Pictorial Classification / Trawlers/Fleet
CPB308	Adequacy of Justification / Pictorial Classification / Herd/White Sheep
CPB309	Adequacy of Justification / Pictorial Classification / Children/Boys Girls
CPB310	Adequacy of Justification / Pictorial Classification / Ships/ Trawlers
CPB311	Adequacy of Justification / Pictorial Classification / Sheep/White Sheep
CPC301	Type of Justification / Pictorial Classification / Birds/Ducks
CPC302	Type of Justification / Pictorial Classification / Icelanders/People from Reykjavik
CPC303	Type of Justification / Pictorial Classification / Legoblocks/Pile
CPC304	Type of Justification / Pictorial Classification / Buttercups/ Garden
CPC305	Type of Justification / Pictorial Classification / Cats/ Zoo
CPC306	Type of Justification / Pictorial Classification / Boys-Girls/ Class
CPC307	Type of Justification / Pictorial Classification / Trawlers/Fleet
CPC308	Type of Justification / Pictorial Classification / White Sheep/Herd
CPC309	Type of Justification / Pictorial Classification / Children/Boys Girls
CPC310	Type of Justification / Pictorial Classification / Ships/Trawlers
CPC311	Type of Justification / Pictorial Classification / Sheep/White Sheep

2.3.5.2. Variables including data of the twelve-year-old children

CFA410	Adequacy of Judgment / Verbal Classification / Buttercups / Flowers
CFB410	Adequacy of Justification / Verbal Classification / Buttercups / Flowers
CSA406	Adequacy of Judgment / Verbal Classification / White Sheep / Sheep
CSB406	Adequacy of Justification / Verbal Classification / White Sheep / Sheep
KFA410	Adequacy of Judgment / Collection task / Buttercups / Garden
KFB410	Adequacy of Justification / Collection task / Buttercups / Garden
KTA403	Adequacy of Judgment / Collection task / Trawlers / Fleet
KTB403	Adequacy of Justification / Collection task / Trawlers / Fleet

2.3.6. References

Piaget, J. & Inhelder, B. (1973a): Die Entwicklung der elementaren logischen Strukturen:
Teil I. Düsseldorf: Schwann Verlag.

Piaget, J. & Inhelder, B. (1973b): Die Entwicklung der elementaren logischen Strukturen:
Teil II. Düsseldorf: Schwann Verlag.

2.3.7. Assessment of the seven-year old children

Urban sample

Table 1
Verbal classification:
Solution probabilities at age seven
Urban sample

Task		Judgment	Justification	N
CVA/B101	Animals / Cats	0.959	0.322	121
CVA/B102	Birds / Ducks	00.81	0.273	121
CVA/B103	Flowers / Buttercups	0.917	0.306	121
CVA/B104	Fruits / Oranges	0.868	0.331	121
CVA/B105	Cars / Volkswagen	0.909	0.289	121
CVA/B106	Children / Boys/Girls	0.694	0.372	121
CVA/B107	Ships / Trawlers	0.702	0.248	121
CVA/B108	Toys / Lego-Blocks	0.785	0.240	121
CVA/B109	Sheep / White Sheep	0.719	0.339	121
CVA/B110	Sheep / Black Sheep	0.835	0.331	121
CVA/B111	Clothes / Dresses- Pants	0.835	0.364	121
CVA/B112	Sweets / Candy	0.884	0.331	121
CVA/B113	Icelanders / Reykjavikers	0.744	0.339	121

Table 2
Verbal classification:
Solution probabilities at age seven
by teacher rating
Urban sample

Teacher rating		low			high		
		Judgment	Justification	N	Judgment	Justification	N
CVA/B101	Animals / Cats	0.934	0.115	61	0.983	0.533	60
CVA/B102	Birds / Ducks	0.721	0.033	61	0.900	0.517	60
CVA/B103	Flowers / Buttercups	0.869	0.098	61	0.967	0.517	60
CVA/B104	Fruits / Oranges	0.803	0.082	61	0.933	0.583	60
CVA/B105	Cars / Volkswagen	0.852	0.016	61	0.967	0.567	60
CVA/B106	Children / Boys/Girls	0.475	0.115	61	0.917	0.633	60
CVA/B107	Ships / Trawlers	0.607	0.066	61	0.800	0.433	60
CVA/B108	Toys / Lego-Blocks	0.705	0.082	61	0.867	0.400	60
CVA/B109	Sheep / White Sheep	0.639	0.082	61	0.800	0.600	60
CVA/B110	Sheep / Black Sheep	0.738	0.082	61	0.933	0.583	60
CVA/B111	Clothes / Dresses/ Pants	0.705	0.131	61	0.967	0.600	60
CVA/B112	Sweets / Candy	0.820	0.098	61	0.950	0.567	60
CVA/B113	Icelanders / Reykjavikers	0.574	0.049	61	0.917	0.633	60

Table 3
Verbal classification:
Solution probabilities at age seven
by gender
Urban sample

Gender		female			male		
		Judgment	Justification	N	Judgment	Justification	N
CVA/B101	Animals / Cats	0.982	0.263	57	1.000	0.491	64
CVA/B102	Birds / Ducks	0.772	0.298	57	0.982	0.473	64
CVA/B103	Flowers / Buttercups	0.930	0.316	57	0.945	0.455	64
CVA/B104	Fruits / Oranges	0.842	0.351	57	0.945	0.418	64
CVA/B105	Cars / Volkswagen	0.877	0.246	57	0.982	0.418	64
CVA/B106	Children / Boys/Girls	0.789	0.333	57	0.982	0.782	64
CVA/B107	Ships / Trawlers	0.702	0.158	57	0.909	0.491	64
CVA/B108	Toys / Lego-Blocks	0.860	0.228	57	0.873	0.436	64
CVA/B109	Sheep / White Sheep	0.772	0.351	57	0.709	0.527	64
CVA/B110	Sheep / Black Sheep	0.842	0.368	57	1.000	0.455	64
CVA/B111	Clothes / Dresses/ Pants	0.930	0.368	57	0.982	0.400	64
CVA/B112	Sweets / Candy	0.912	0.351	57	0.982	0.436	64
CVA/B113	Icelanders / Reykjavikers	0.807	0.333	57	0.927	0.436	64

Table 4
Verbal classification:
Solution probabilities at age seven
by social class in two categories: low (SES 1-3) high (SES 4-6)
Urban sample

SES	Task	low			high		
		Judgment	Justification	N	Judgment	Justification	N
CVA/B101	Animals / Cats	0.952	0.302	63	0.984	0.426	58
CVA/B102	Birds / Ducks	0.746	0.270	63	1.000	0.410	58
CVA/B103	Flowers / Buttercups	0.889	0.270	63	0.918	0.377	58
CVA/B104	Fruits / Oranges	0.841	0.317	63	0.951	0.393	58
CVA/B105	Cars / Volkswagen	0.857	0.270	63	1.000	0.344	58
CVA/B106	Children / Boys/Girls	0.635	0.333	63	0.984	0.705	58
CVA/B107	Ships / Trawlers	0.667	0.190	63	0.902	0.426	58
CVA/B108	Toys / Lego-Blocks	0.794	0.238	63	0.885	0.393	58
CVA/B109	Sheep / White Sheep	0.762	0.333	63	0.721	0.459	58
CVA/B110	Sheep / Black Sheep	0.778	0.302	63	0.951	0.377	58
CVA/B111	Clothes / Dresses/ Pants	0.794	0.349	63	0.951	0.344	58
CVA/B112	Sweets / Candy	0.873	0.302	63	1.000	0.361	58
CVA/B113	Icelanders / Reykjavikers	0.730	0.286	63	0.836	0.393	58

Table 5
Verbal classification:
Solution probabilities at age seven
by social class in six categories
Urban sample

SES	Task	low/low (SES 1)			low/high (SES 2)		
		Judgment	Justification	N	Judgment	Justification	N
CVA/B101	Animals / Cats	1.000	0.222	18	1.000	0.407	27
CVA/B102	Birds / Ducks	0.778	0.222	18	0.741	0.333	27
CVA/B103	Flowers / Buttercups	0.833	0.278	18	0.963	0.259	27
CVA/B104	Fruits / Oranges	0.833	0.278	18	0.852	0.370	27
CVA/B105	Cars / Volkswagen	0.778	0.167	18	0.926	0.333	27
CVA/B106	Children / Boys/Girls	0.667	0.222	18	0.630	0.407	27
CVA/B107	Ships / Trawlers	0.556	0.167	18	0.741	0.333	27
CVA/B108	Toys / Lego-Blocks	0.778	0.111	18	0.815	0.407	27
CVA/B109	Sheep / White Sheep	0.833	0.222	18	0.778	0.407	27
CVA/B110	Sheep / Black Sheep	0.667	0.222	18	0.815	0.333	27
CVA/B111	Clothes / Dresses/ Pants	0.833	0.278	18	0.852	0.370	27
CVA/B112	Sweets / Candy	0.889	0.278	18	0.889	0.370	27
CVA/B113	Icelanders / Reykjavikers	0.722	0.222	18	0.667	0.370	27

Table 5

continued

SES		middle/low (SES 3)			middle/high (SES 4)		
Task		Judgment	Justification	N	Judgment	Justification	N
CVA/B101	Animals / Cats	0.833	0.222	18	0.900	0.200	20
CVA/B102	Birds / Ducks	0.722	0.222	18	0.850	0.150	20
CVA/B103	Flowers / Buttercups	0.833	0.278	18	0.850	0.250	20
CVA/B104	Fruits / Oranges	0.833	0.278	18	0.900	0.350	20
CVA/B105	Cars / Volkswagen	0.833	0.278	18	0.950	0.250	20
CVA/B106	Children / Boys/Girls	0.611	0.333	18	0.600	0.250	20
CVA/B107	Ships / Trawlers	0.667	0.000	18	0.650	0.200	20
CVA/B108	Toys / Lego-Blocks	0.778	0.111	18	0.800	0.200	20
CVA/B109	Sheep / White Sheep	0.667	0.333	18	0.650	0.300	20
CVA/B110	Sheep / Black Sheep	0.833	0.333	18	0.850	0.300	20
CVA/B111	Clothes / Dresses/ Pants	0.667	0.389	18	0.850	0.300	20
CVA/B112	Sweets / Candy	0.833	0.222	18	0.900	0.300	20
CVA/B113	Icelanders / Reykjavikers	0.833	0.222	18	0.600	0.350	20

SES		high/low (SES 5)			high/high (SES 6)		
Task		Judgment	Justification	N	Judgment	Justification	N
CVA/B101	Animals / Cats	1.000	0.429	21	1.000	0.412	17
CVA/B102	Birds / Ducks	0.952	0.381	21	0.824	0.294	17
CVA/B103	Flowers / Buttercups	1.000	0.476	21	1.000	0.294	17
CVA/B104	Fruits / Oranges	0.905	0.333	21	0.882	0.353	17
CVA/B105	Cars / Volkswagen	0.952	0.333	21	1.000	0.353	17
CVA/B106	Children / Boys/Girls	0.810	0.476	21	0.882	0.529	17
CVA/B107	Ships / Trawlers	0.857	0.429	21	0.706	0.294	17
CVA/B108	Toys / Lego-Blocks	0.667	0.238	21	0.882	0.294	17
CVA/B109	Sheep / White Sheep	0.667	0.381	21	0.706	0.353	17
CVA/B110	Sheep / Black Sheep	0.952	0.381	21	0.882	0.412	17
CVA/B111	Clothes / Dresses/ Pants	0.905	0.381	21	0.882	0.471	17
CVA/B112	Sweets / Candy	0.810	0.429	21	1.000	0.353	17
CVA/B113	Icelanders / Reykjavikers	0.857	0.381	21	0.824	0.471	17

Rural sample

Table 6
Verbal classification:
Solution probabilities at age seven
Rural sample

Task		Judgment	Justification	N
CVA/B101	Animals / Cats	0.953	0.125	64
CVA/B102	Birds / Ducks	0.859	0.094	64
CVA/B103	Flowers / Buttercups	0.719	0.078	64
CVA/B104	Fruits / Oranges	0.594	0.109	64
CVA/B105	Cars / Volkswagen	0.844	0.094	64
CVA/B106	Children / Boys/Girls	0.656	0.281	64
CVA/B107	Ships / Trawlers	0.500	0.078	64
CVA/B108	Toys / Lego-Blocks	0.766	0.063	64
CVA/B109	Sheep / White Sheep	0.484	0.156	64
CVA/B110	Sheep / Black Sheep	0.766	0.188	64
CVA/B111	Clothes / Dresses/ Pants	0.781	0.156	64
CVA/B112	Sweets / Candy	0.813	0.078	64
CVA/B113	Icelanders / Reykjavikers	0.547	0.125	64

Table 7
Verbal classification:
Solution probabilities at age seven
by gender
Rural sample

Task		female			male		
		Judgment	Justification	N	Judgment	Justification	N
CVA/B101	Animals / Cats	0.931	0.207	29	0.971	0.057	35
CVA/B102	Birds / Ducks	0.828	0.069	29	0.886	0.114	35
CVA/B103	Flowers / Buttercups	0.759	0.138	29	0.686	0.029	35
CVA/B104	Fruits / Oranges	0.655	0.138	29	0.543	0.086	35
CVA/B105	Cars / Volkswagen	0.862	0.138	29	0.829	0.057	35
CVA/B106	Children / Boys/Girls	0.759	0.345	29	0.571	0.229	35
CVA/B107	Ships / Trawlers	0.379	0.069	29	0.600	0.086	35
CVA/B108	Toys / Lego-Blocks	0.793	0.069	29	0.743	0.057	35
CVA/B109	Sheep / White Sheep	0.655	0.241	29	0.343	0.086	35
CVA/B110	Sheep / Black Sheep	0.724	0.241	29	0.800	0.143	35
CVA/B111	Clothes / Dresses/ Pants	0.862	0.207	29	0.714	0.114	35
CVA/B112	Sweets / Candy	0.828	0.138	29	0.800	0.029	35
CVA/B113	Icelanders / Reykjavikers	0.655	0.138	29	0.457	0.114	35

Table 8
Verbal classification:
Solution probabilities at age seven
by community
Rural sample

Region		North			South		
Task		Judgment	Justification	N	Judgment	Justification	N
CVA/B101	Animals / Cats	1.000	0.105	19	0.960	0.160	25
CVA/B102	Birds / Ducks	0.895	0.053	19	0.920	0.160	25
CVA/B103	Flowers / Buttercups	0.737	0.053	19	0.840	0.080	25
CVA/B104	Fruits / Oranges	0.684	0.105	19	0.720	0.160	25
CVA/B105	Cars / Volkswagen	0.947	0.105	19	0.760	0.120	25
CVA/B106	Children / Boys/Girls	0.789	0.316	19	0.800	0.280	25
CVA/B107	Ships / Trawlers	0.421	0.105	19	0.680	0.080	25
CVA/B108	Toys / Lego-Blocks	0.842	0.053	19	0.680	0.080	25
CVA/B109	Sheep / White Sheep	0.421	0.158	19	0.560	0.200	25
CVA/B110	Sheep / Black Sheep	0.947	0.158	19	0.760	0.280	25
CVA/B111	Clothes / Dresses/ Pants	0.947	0.105	19	0.840	0.240	25
CVA/B112	Sweets / Candy	0.947	0.105	19	0.840	0.080	25
CVA/B113	Icelanders / Reykjavikers	0.789	0.158	19	0.600	0.120	25

Region		West			
Task		Judgment	Justification	N	
CVA/B101	Animals / Cats	0.900	0.100	20	
CVA/B102	Birds / Ducks	0.750	0.050	20	
CVA/B103	Flowers / Buttercups	0.550	0.100	20	
CVA/B104	Fruits / Oranges	0.350	0.050	20	
CVA/B105	Cars / Volkswagen	0.850	0.050	20	
CVA/B106	Children / Boys/Girls	0.350	0.250	20	
CVA/B107	Ships / Trawlers	0.350	0.050	20	
CVA/B108	Toys / Lego-Blocks	0.800	0.050	20	
CVA/B109	Sheep / White Sheep	0.450	0.100	20	
CVA/B110	Sheep / Black Sheep	0.600	0.100	20	
CVA/B111	Clothes / Dresses/ Pants	0.550	0.100	20	
CVA/B112	Sweets / Candy	0.650	0.050	20	
CVA/B113	Icelanders / Reykjavikers	0.250	0.100	20	

2.3.8. Assessment of the eight-year old children

Urban sample

Table 9
Verbal classification:
Solution probabilities at age eight
Urban sample

Total Score				
Task		Judgment	Justification	N
CVA/B201	Animals / Cats	0.949	0.288	59
CVA/B202	Birds / Ducks	0.847	0.153	59
CVA/B203	Flowers / Buttercups	0.797	0.254	59
CVA/B204	Fruits / Oranges	0.949	0.373	59
CVA/B205	Cars / Volkswagen	0.966	0.119	59
CVA/B206	Children / Boys/Girls	0.847	0.508	59
CVA/B207	Ships / Trawlers	0.712	0.220	59
CVA/B208	Toys / Lego-Blocks	0.814	0.254	59
CVA/B209	Sheep / White Sheep	0.729	0.441	59
CVA/B210	Sheep / Black Sheep	0.864	0.441	59
CVA/B211	Clothes / Dresses/ Pants	0.881	0.305	59
CVA/B212	Sweets / Candy	0.966	0.305	59
CVA/B213	Icelanders / Reykjavikers	0.763	0.254	59

Table 10
Verbal classification:
Solution probabilities at age eight
by teacher rating
Urban sample

Teacher rating		low			high		
Task		Judgment	Justification	N	Judgment	Just	N
CVA/B201	Animals / Cats	0.959	0.265	49	0.900	0.400	10
CVA/B202	Birds / Ducks	0.816	0.102	49	1.000	0.400	10
CVA/B203	Flowers / Buttercups	0.755	0.184	49	1.000	0.600	10
CVA/B204	Fruits / Oranges	0.939	0.306	49	1.000	0.700	10
CVA/B205	Cars / Volkswagen	0.980	0.082	49	0.900	0.300	10
CVA/B206	Children / Boys/Girls	0.837	0.429	49	0.900	0.900	10
CVA/B207	Ships / Trawlers	0.714	0.163	49	0.700	0.500	10
CVA/B208	Toys / Lego-Blocks	0.796	0.204	49	0.900	0.500	10
CVA/B209	Sheep / White Sheep	0.694	0.347	49	0.900	0.900	10
CVA/B210	Sheep / Black Sheep	0.857	0.367	49	0.900	0.800	10
CVA/B211	Clothes / Dresses/ Pants	0.857	0.224	49	1.000	0.700	10
CVA/B212	Sweets / Candy	0.959	0.265	49	1.000	0.500	10
CVA/B213	Icelanders / Reykjavikers	0.714	0.184	49	1.000	0.600	10

Table 11
Verbal classification
Solution probabilities at age eight
by gender
Urban sample

Gender		female			male		
Task		Judgment	Justification	N	Judgment	Justification	N
CVA/B201	Animals / Cats	0.963	0.259	27	0.938	0.313	32
CVA/B202	Birds / Ducks	0.852	0.148	27	0.844	0.156	32
CVA/B203	Flowers / Buttercups	0.815	0.222	27	0.781	0.281	32
CVA/B204	Fruits / Oranges	0.963	0.370	27	0.938	0.375	32
CVA/B205	Cars / Volkswagen	0.926	0.074	27	1.000	0.156	32
CVA/B206	Children / Boys/Girls	0.889	0.481	27	0.813	0.531	32
CVA/B207	Ships / Trawlers	0.704	0.148	27	0.719	0.281	32
CVA/B208	Toys / Lego-Blocks	0.815	0.222	27	0.813	0.281	32
CVA/B209	Sheep / White Sheep	0.704	0.407	27	0.750	0.469	32
CVA/B210	Sheep / Black Sheep	0.815	0.407	27	0.906	0.469	32
CVA/B211	Clothes / Dresses/ Pants	0.926	0.222	27	0.844	0.375	32
CVA/B212	Sweets / Candy	0.963	0.185	27	0.969	0.406	32
CVA/B213	Icelanders / Reykjavikers	0.741	0.185	27	0.781	0.313	32

Table 12
Verbal classification:
Solution probabilities at age eight
by social class in two categories: low (SES 1-3) high (4-6)
Urban sample

SES		low			high		
Task		Judgment	Justification	N	Judgment	Justification	N
CVA/B201	Animals / Cats	0.933	0.167	30	0.966	0.414	29
CVA/B202	Birds / Ducks	0.733	0.000	30	0.966	0.310	29
CVA/B203	Flowers / Buttercups	0.733	0.133	30	0.862	0.379	29
CVA/B204	Fruits / Oranges	0.900	0.200	30	1.000	0.552	29
CVA/B205	Cars / Volkswagen	0.967	0.067	30	0.966	0.172	29
CVA/B206	Children / Boys/Girls	0.800	0.400	30	0.897	0.621	29
CVA/B207	Ships / Trawlers	0.567	0.100	30	0.862	0.345	29
CVA/B208	Toys / Lego-Blocks	0.733	0.167	30	0.897	0.345	29
CVA/B209	Sheep / White Sheep	0.667	0.233	30	0.793	0.655	29
CVA/B210	Sheep / Black Sheep	0.800	0.233	30	0.931	0.655	29
CVA/B211	Clothes / Dresses/ Pants	0.833	0.167	30	0.931	0.448	29
CVA/B212	Sweets / Candy	0.933	0.167	30	1.000	0.448	29
CVA/B213	Icelanders / Reykjavikers	0.667	0.200	30	0.862	0.310	29

Table 13
Verbal classification:
Solution probabilities at age eight
by social class in six categories
Urban sample

SES		low/low (SES 1)			low/high (SES 2)		
Task		Judgment	Justification	N	Judgment	Justification	N
CVA/B201	Animals / Cats	1.000	0.111	9	0.833	0.250	12
CVA/B202	Birds / Ducks	0.556	0.000	9	0.833	0.000	12
CVA/B203	Flowers / Buttercups	0.778	0.222	9	0.750	0.083	12
CVA/B204	Fruits / Oranges	0.889	0.444	9	0.833	0.083	12
CVA/B205	Cars / Volkswagen	0.889	0.000	9	1.000	0.083	12
CVA/B206	Children / Boys/Girls	0.778	0.556	9	0.833	0.250	12
CVA/B207	Ships / Trawlers	0.333	0.000	9	0.667	0.167	12
CVA/B208	Toys / Lego-Blocks	0.667	0.111	9	0.750	0.250	12
CVA/B209	Sheep / White Sheep	0.444	0.222	9	0.750	0.167	12
CVA/B210	Sheep / Black Sheep	0.778	0.222	9	0.917	0.167	12
CVA/B211	Clothes / Dresses/ Pants	0.667	0.111	9	0.833	0.167	12
CVA/B212	Sweets / Candy	0.889	0.111	9	0.917	0.167	12
CVA/B213	Icelanders / Reykjavikers	0.667	0.222	9	0.583	0.167	12

Table 13
continued

SES		middle/low (SES 3)			middle/high (SES 4)		
Task		Judgment	Justification	N	Judgment	Just	N
CVA/B201	Animals / Cats	1.000	0.111	9	1.000	0.182	11
CVA/B202	Birds / Ducks	0.778	0.000	9	1.000	0.273	11
CVA/B203	Flowers / Buttercups	0.667	0.111	9	0.818	0.364	11
CVA/B204	Fruits / Oranges	1.000	0.111	9	1.000	0.545	11
CVA/B205	Cars / Volkswagen	1.000	0.111	9	1.000	0.182	11
CVA/B206	Children / Boys/Girls	0.778	0.444	9	0.909	0.455	11
CVA/B207	Ships / Trawlers	0.667	0.111	9	0.818	0.182	11
CVA/B208	Toys / Lego-Blocks	0.778	0.111	9	1.000	0.364	11
CVA/B209	Sheep / White Sheep	0.778	0.333	9	0.727	0.545	11
CVA/B210	Sheep / Black Sheep	0.667	0.333	9	1.000	0.545	11
CVA/B211	Clothes / Dresses/ Pants	1.000	0.222	9	0.909	0.364	11
CVA/B212	Sweets / Candy	1.000	0.222	9	1.000	0.273	11
CVA/B213	Icelanders / Reykjavikers	0.778	0.222	9	0.727	0.182	11

SES		high/low (SES 5)			high/high (SES 6)		
Task		Judgment	Justification	N	Judgment	Justification	N
CVA/B201	Animals / Cats	0.909	0.455	11	1.000	0.714	7
CVA/B202	Birds / Ducks	1.000	0.364	11	0.857	0.286	7
CVA/B203	Flowers / Buttercups	0.818	0.364	11	1.000	0.429	7
CVA/B204	Fruits / Oranges	1.000	0.545	11	1.000	0.571	7
CVA/B205	Cars / Volkswagen	0.909	0.091	11	1.000	0.286	7
CVA/B206	Children / Boys/Girls	0.818	0.545	11	1.000	1.000	7
CVA/B207	Ships / Trawlers	0.909	0.455	11	0.857	0.429	7
CVA/B208	Toys / Lego-Blocks	0.909	0.182	11	0.714	0.571	7
CVA/B209	Sheep / White Sheep	0.818	0.636	11	0.857	0.857	7
CVA/B210	Sheep / Black Sheep	0.818	0.727	11	1.000	0.714	7
CVA/B211	Clothes / Dresses/ Pants	1.000	0.455	11	0.857	0.571	7
CVA/B212	Sweets / Candy	1.000	0.545	11	1.000	0.571	7
CVA/B213	Icelanders / Reykjavikers	1.000	0.364	11	0.857	0.429	7

2.3.9. Assessment of the nine-year-old children

Urban sample

Table 14
Verbal classification:
Solution probabilities at age nine
Urban sample

Total Score				
Task		Judgment	Justification	N
CVA/B301	Animals / Cats	0.991	0.354	113
CVA/B302	Birds / Ducks	0.973	0.345	113
CVA/B303	Flowers / Buttercups	0.920	0.336	113
CVA/B304	Fruits / Oranges	0.938	0.319	113
CVA/B305	Cars / Volkswagen	0.991	0.292	113
CVA/B306	Children / Boys/Girls	0.973	0.664	113
CVA/B307	Ships / Trawlers	0.858	0.354	113
CVA/B308	Toys / Lego-Blocks	0.867	0.310	113
CVA/B309	Sheep / White Sheep	0.708	0.398	113
CVA/B310	Sheep / Black Sheep	0.947	0.345	113
CVA/B311	Clothes / Dresses/ Pants	0.956	0.265	113
CVA/B312	Sweets / Candy	0.982	0.319	113
CVA/B313	Icelanders / Reykjavikers	0.894	0.327	113

Table 15
Verbal classification:
Solution probabilities at age nine
by teacher rating
Urban sample

Teacher rating		low			high		
Task		Judgment	Justification	N	Judgment	Justification	N
CVA/B301	Animals / Cats	0.983	0.224	58	1.000	0.491	55
CVA/B302	Birds / Ducks	0.966	0.224	58	0.982	0.473	55
CVA/B303	Flowers / Buttercups	0.897	0.224	58	0.945	0.455	55
CVA/B304	Fruits / Oranges	0.931	0.224	58	0.945	0.418	55
CVA/B305	Cars / Volkswagen	1.000	0.172	58	0.982	0.418	55
CVA/B306	Children / Boys/Girls	0.966	0.552	58	0.982	0.782	55
CVA/B307	Ships / Trawlers	0.810	0.224	58	0.909	0.491	55
CVA/B308	Toys / Lego-Blocks	0.862	0.190	58	0.873	0.436	55
CVA/B309	Sheep / White Sheep	0.707	0.276	58	0.709	0.527	55
CVA/B310	Sheep / Black Sheep	0.897	0.241	58	1.000	0.455	55
CVA/B311	Clothes / Dresses/ Pants	0.931	0.138	58	0.982	0.400	55
CVA/B312	Sweets / Candy	0.983	0.207	58	0.982	0.436	55
CVA/B313	Icelanders / Reykjavikers	0.862	0.224	58	0.927	0.436	55

Table 16
Verbal classification:
Solution probabilities at age nine
by gender
Urban sample

Gender		female			male		
Task		Judgment	Justification	N	Judgment	Justification	N
CVA/B301	Animals / Cats	1.000	0.269	52	0.984	0.426	61
CVA/B302	Birds / Ducks	0.942	0.269	52	1.000	0.410	61
CVA/B303	Flowers / Buttercups	0.923	0.288	52	0.918	0.377	61
CVA/B304	Fruits / Oranges	0.923	0.231	52	0.951	0.393	61
CVA/B305	Cars / Volkswagen	0.981	0.231	52	1.000	0.344	61
CVA/B306	Children / Boys/Girls	0.962	0.615	52	0.984	0.705	61
CVA/B307	Ships / Trawlers	0.808	0.269	52	0.902	0.426	61
CVA/B308	Toys / Lego-Blocks	0.846	0.212	52	0.885	0.393	61
CVA/B309	Sheep / White Sheep	0.692	0.352	52	0.721	0.459	61
CVA/B310	Sheep / Black Sheep	0.942	0.308	52	0.951	0.377	61
CVA/B311	Clothes / Dresses/ Pants	0.962	0.173	52	0.951	0.344	61
CVA/B312	Sweets / Candy	0.962	0.269	52	1.000	0.361	61
CVA/B313	Icelanders / Reykjavikers	0.962	0.250	52	0.836	0.393	61

Table 17
Verbal classification:
Solution probabilities at age nine
by social class in two categories: low (SES 1-3) high (4-6)
Urban sample
SES

Task		low			high		
		Judgment	Justification	N	Judgment	Justification	N
CVA/B301	Animals / Cats	0.983	0.237	59	0.966	0.414	54
CVA/B302	Birds / Ducks	0.949	0.186	59	0.966	0.310	54
CVA/B303	Flowers / Buttercups	0.898	0.271	59	0.862	0.379	54
CVA/B304	Fruits / Oranges	0.932	0.271	59	1.000	0.552	54
CVA/B305	Cars / Volkswagen	1.000	0.203	59	0.966	0.172	54
CVA/B306	Children / Boys/Girls	0.966	0.593	59	0.897	0.621	54
CVA/B307	Ships / Trawlers	0.797	0.288	59	0.862	0.345	54
CVA/B308	Toys / Lego-Blocks	0.814	0.220	59	0.897	0.345	54
CVA/B309	Sheep / White Sheep	0.593	0.339	59	0.793	0.655	54
CVA/B310	Sheep / Black Sheep	0.949	0.305	59	0.931	0.655	54
CVA/B311	Clothes / Dresses/ Pants	0.915	0.203	59	0.931	0.448	54
CVA/B312	Sweets / Candy	0.983	0.254	59	1.000	0.448	54
CVA/B313	Icelanders / Reykjavikers	0.881	0.288	59	0.862	0.310	54

Table 18
Verbal classification:
Solution probabilities at age nine
by social class in six categories
Urban sample

Task		low/low (SES 1)			low/high (SES 2)		
		Judgment	Justification	N	Judgment	Justification	N
CVA/B301	Animals / Cats	1.000	0.067	15	1.000	0.423	26
CVA/B302	Birds / Ducks	0.933	0.067	15	0.962	0.308	26
CVA/B303	Flowers / Buttercups	0.867	0.067	15	0.962	0.346	26
CVA/B304	Fruits / Oranges	0.867	0.133	15	0.923	0.346	26
CVA/B305	Cars / Volkswagen	1.000	0.200	15	1.000	0.269	26
CVA/B306	Children / Boys/Girls	0.933	0.533	15	1.000	0.615	26
CVA/B307	Ships / Trawlers	0.800	0.133	15	0.808	0.423	26
CVA/B308	Toys / Lego-Blocks	0.600	0.067	15	0.923	0.269	26
CVA/B309	Sheep / White Sheep	0.400	0.200	15	0.769	0.423	26
CVA/B310	Sheep / Black Sheep	0.933	0.200	15	0.923	0.423	26
CVA/B311	Clothes / Dresses/ Pants	0.867	0.067	15	0.962	0.269	26
CVA/B312	Sweets / Candy	1.000	0.133	15	0.962	0.346	26
CVA/B313	Icelanders / Reykjavikers	0.933	0.200	15	0.885	0.308	26

Table 18
continued

SES		middle/low (SES 3)			middle/high (SES 4)		
Task		Judgment	Justification	N	Judgment	Justification	N
CVA/B301	Animals / Cats	0.944	0.111	18	1.000	0.526	19
CVA/B302	Birds / Ducks	0.944	0.111	18	1.000	0.737	19
CVA/B303	Flowers / Buttercups	0.833	0.333	18	1.000	0.368	19
CVA/B304	Fruits / Oranges	1.000	0.278	18	0.895	0.421	19
CVA/B305	Cars / Volkswagen	1.000	0.111	18	0.947	0.421	19
CVA/B306	Children / Boys/Girls	0.944	0.611	18	0.947	0.789	19
CVA/B307	Ships / Trawlers	0.778	0.222	18	0.842	0.474	19
CVA/B308	Toys / Lego-Blocks	0.833	0.278	18	0.947	0.421	19
CVA/B309	Sheep / White Sheep	0.500	0.333	18	1.000	0.474	19
CVA/B310	Sheep / Black Sheep	1.000	0.222	18	0.842	0.421	19
CVA/B311	Clothes / Dresses/ Pants	0.889	0.222	18	1.000	0.474	19
CVA/B312	Sweets / Candy	1.000	0.222	18	0.947	0.368	19
CVA/B313	Icelanders / Reykjavikers	0.833	0.333	18	0.895	0.368	19

SES		high/low (SES 5)			high/high (SES 6)		
Task		Judgment	Justification	N	Judgment	Justification	N
CVA/B301	Animals / Cats	1.000	0.400	20	1.000	0.533	15
CVA/B302	Birds / Ducks	1.000	0.400	20	1.000	0.400	15
CVA/B303	Flowers / Buttercups	0.950	0.500	20	0.867	0.333	15
CVA/B304	Fruits / Oranges	1.000	0.400	20	0.933	0.267	15
CVA/B305	Cars / Volkswagen	1.000	0.400	20	1.000	0.333	15
CVA/B306	Children / Boys/Girls	1.000	0.800	20	1.000	0.600	15
CVA/B307	Ships / Trawlers	1.000	0.400	20	0.933	0.400	15
CVA/B308	Toys / Lego-Blocks	0.950	0.400	20	0.867	0.400	15
CVA/B309	Sheep / White Sheep	0.800	0.450	20	0.667	0.467	15
CVA/B310	Sheep / Black Sheep	1.000	0.350	20	1.000	0.400	15
CVA/B311	Clothes / Dresses/ Pants	1.000	0.250	20	1.000	0.267	15
CVA/B312	Sweets / Candy	1.000	0.400	20	1.000	0.400	15
CVA/B313	Icelanders / Reykjavikers	0.850	0.450	20	1.000	0.267	15

Table 19¹
Verbal classification:
Solution probabilities at age nine
Urban sample

Task		Judgm.	Jst. /Ad	Jst./Sm.	Jst./In.	N
CPA/C301	Birds/Ducks	0.622	0.198	0.234	0.568	111
CPA/C302	Icelanders./Reykjavikers	0.550	0.275	0.229	0.495	109
CPA/C303	Pile/Legoblocks	0.505	0.153	0.207	0.640	111
CPA/C304	Garden/Buttercups	0.355	0.140	0.121	0.738	107
CPA/C305	Zoo/Cats	0.560	0.174	0.275	0.550	109
CPA/C306	Class/Boys Girls	0.506	0.468	0.000	0.532	79
CPA/C307	Fleet/Trawlers	0.436	0.355	0.009	0.636	110
CPA/C308	Herd/White Sheep	0.528	0.453	0.190	0.528	106
CPA/C309	Children/Boys Girls	0.462	0.436	0.130	0.551	78
CPA/C310	Ships/Trawlers	0.312	0.248	0.000	0.752	109
CPA/C311	Sheep/White Sheep	0.481	0.442	0.190	0.538	104

Table 20
Verbal classification:
Solution probabilities at age nine
by teacher rating
Urban sample

Teacher rating		low				
Task		Judgm.	Jst. /Ad	Jst./Sm.	Jst./In	N
CPA/C301	Birds/Ducks	0.754	0.088	0.351	0.561	57
CPA/C302	Icelanders./Reykjavikers	0.618	0.236	0.291	0.473	55
CPA/C303	Pile/Legoblocks	0.594	0.123	0.246	0.632	57
CPA/C304	Garden/Buttercups	0.333	0.074	0.093	0.833	54
CPA/C305	Zoo/Cats	0.673	0.145	0.327	0.527	55
CPA/C306	Class/Boys Girls	0.703	0.622	0.000	0.378	37
CPA/C307	Fleet/Trawlers	0.482	0.321	0.018	0.661	56
CPA/C308	Herd/White Sheep	0.630	0.500	0.037	0.463	54
CPA/C309	Children/Boys Girls	0.622	0.568	0.027	0.405	37
CPA/C310	Ships/Trawlers	0.327	0.236	0.000	0.764	55
CPA/C311	Sheep/White Sheep	0.566	0.491	0.019	0.491	53

¹ Jst./ Ad.: Adequate justification; Jst./Sm.: Semiadequate justification; Jst./In.: Inadequate justification

Table 20

continued

Teacher rating		high				
Task		Judgm.	Jst. /Ad	Jst./Sm.	Jst./In	N
CPA/C301	Birds/Ducks	0.481	0.315	0.111	0.571	54
CPA/C302	Icelanders./Reykjavikers	0.481	0.315	0.167	0.519	54
CPA/C303	Pile/Legoblocks	0.407	0.185	0.167	0.648	54
CPA/C304	Garden/Buttercups	0.377	0.208	0.151	0.642	53
CPA/C305	Zoo/Cats	0.444	0.204	0.222	0.574	54
CPA/C306	Class/Boys Girls	0.333	0.333	0.000	0.667	42
CPA/C307	Fleet/Trawlers	0.389	0.389	0.000	0.611	54
CPA/C308	Herd/White Sheep	0.423	0.405	0.000	0.596	52
CPA/C309	Children/Boys Girls	0.317	0.317	0.000	0.683	41
CPA/C310	Ships/Trawlers	0.296	0.259	0.000	0.741	54
CPA/C311	Sheep/White Sheep	0.392	0.392	0.020	0.588	51

Table 21

**Verbal classification:
Solution probabilities at age nine
by gender
Urban sample**

Gender		male				
Task		Judgm.	Jst. /Ad	Jst./Sm.	Jst./In	N
CPA/C301	Birds/Ducks	0.596	0.211	0.228	0.561	57
CPA/C302	Icelanders./Reykjavikers	0.519	0.259	0.204	0.537	54
CPA/C303	Pile/Legoblocks	0.509	0.158	0.193	0.649	57
CPA/C304	Garden/Buttercups	0.345	0.109	0.145	0.745	55
CPA/C305	Zoo/Cats	0.554	0.161	0.304	0.536	56
CPA/C306	Class/Boys Girls	0.463	0.439	0.000	0.561	41
CPA/C307	Fleet/Trawlers	0.375	0.286	0.000	0.714	56
CPA/C308	Herd/White Sheep	0.509	0.436	0.036	0.527	55
CPA/C309	Children/Boys Girls	0.400	0.400	0.000	0.600	40
CPA/C310	Ships/Trawlers	0.345	0.236	0.000	0.764	55
CPA/C311	Sheep/White Sheep	0.481	0.426	0.019	0.556	54

Table 21
continued

Gender		female				
Task		Judgm.	Jst. /Ad	Jst./Sm.	Jst./In	N
CPA/C301	Birds/Ducks	0.648	0.185	0.241	0.574	54
CPA/C302	Icelanders./Reykjavikers	0.582	0.291	0.255	0.455	55
CPA/C303	Pile/Legoblocks	0.500	0.148	0.222	0.630	54
CPA/C304	Garden/Buttercups	0.365	0.173	0.096	0.731	52
CPA/C305	Zoo/Cats	0.566	0.189	0.245	0.566	53
CPA/C306	Class/Boys Girls	0.553	0.500	0.000	0.500	38
CPA/C307	Fleet/Trawlers	0.500	0.426	0.019	0.556	54
CPA/C308	Herd/White Sheep	0.549	0.471	0.000	0.529	51
CPA/C309	Children/Boys Girls	0.526	0.474	0.026	0.500	38
CPA/C310	Ships/Trawlers	0.278	0.259	0.000	0.741	54
CPA/C311	Sheep/White Sheep	0.480	0.460	0.020	0.520	50

Table 22
Verbal classification:
Solution probabilities at age nine
by social class in six categories
Urban sample

SES	low/low (SES 1)					low/high (SES 2)				
	Judg.	Jst-ad	Jst- sm	Jst-in	N	Judg.	Jst-ad	Jst- sm	Jst-in	N
CPA/C301	0.722	0.167	0.278	0.556	18	0.615	0.077	0.192	0.731	26
CPA/C302	0.563	0.125	0.375	0.500	16	0.556	0.259	0.148	0.593	27
CPA/C303	0.500	0.167	0.165	0.667	18	0.444	0.148	0.185	0.667	27
CPA/C304	0.444	0.167	0.167	0.667	18	0.231	0.038	0.077	0.885	26
CPA/C305	0.667	0.111	0.389	0.500	18	0.542	0.042	0.292	0.667	24
CPA/C306	0.636	0.455	0.000	0.545	11	0.500	0.450	0.000	0.550	20
CPA/C307	0.588	0.471	0.000	0.529	17	0.400	0.240	0.000	0.760	25
CPA/C308	0.625	0.500	0.000	0.500	16	0.480	0.360	0.000	0.640	25
CPA/C309	0.545	0.455	0.000	0.545	11	0.450	0.400	0.050	0.550	20
CPA/C310	0.471	0.353	0.000	0.647	17	0.200	0.080	0.000	0.920	25
CPA/C311	0.563	0.438	0.000	0.563	16	0.360	0.280	0.040	0.680	25

Table 22
continued

SES	middle/low (SES 3)					middle/high (SES 4)				
	Judg.	Jst-ad	Jst- sm	Jst-in	N	Judg.	Jst-ad	Jst- sm	Jst-in	N
CPA/C301	0.824	0.412	0.176	0.412	17	0.429	0.071	0.286	0.643	14
CPA/C302	0.769	0.615	0.154	0.231	13	0.412	0.176	0.235	0.588	17
CPA/C303	0.800	0.267	0.400	0.333	15	0.412	0.059	0.235	0.706	17
CPA/C304	0.643	0.286	0.214	0.500	14	0.176	0.118	0.059	0.824	17
CPA/C305	0.824	0.471	0.294	0.235	17	0.313	0.125	0.188	0.688	16
CPA/C306	0.727	0.727	0.000	0.273	11	0.364	0.364	0.000	0.636	11
CPA/C307	0.563	0.500	0.000	0.500	16	0.294	0.294	0.000	0.706	17
CPA/C308	0.714	0.643	0.000	0.357	14	0.500	0.444	0.056	0.500	18
CPA/C309	0.727	0.727	0.000	0.273	11	0.273	0.273	0.000	0.727	11
CPA/C310	0.500	0.438	0.000	0.563	16	0.235	0.176	0.000	0.824	17
CPA/C311	0.571	0.571	0.000	0.429	14	0.438	0.500	0.000	0.500	16

SES	high/low (SES 5)					high/high (SES 6)				
	Judg.	Jst-ad	Jst- sm	Jst-in	N	Judg.	Jst-ad	Jst- sm	Jst-in	N
CPA/C301	0.632	0.316	0.263	0.421	19	0.471	0.176	0.235	0.588	17
CPA/C302	0.632	0.316	0.316	0.368	19	0.412	0.235	0.176	0.588	17
CPA/C303	0.556	0.167	0.222	0.611	18	0.375	0.125	0.063	0.813	16
CPA/C304	0.467	0.133	0.267	0.600	15	0.294	0.176	0.000	0.824	17
CPA/C305	0.588	0.059	0.412	0.529	17	0.412	0.294	0.059	0.647	17
CPA/C306	0.455	0.455	0.000	0.545	11	0.400	0.400	0.000	0.600	15
CPA/C307	0.500	0.389	0.056	0.556	18	0.294	0.294	0.000	0.706	17
CPA/C308	0.529	0.529	0.000	0.471	17	0.375	0.313	0.063	0.625	16
CPA/C309	0.400	0.400	0.000	0.600	10	0.400	0.400	0.000	0.600	15
CPA/C310	0.278	0.278	0.000	0.722	18	0.250	0.250	0.000	0.750	16
CPA/C311	0.588	0.588	0.000	0.412	17	0.438	0.375	0.063	0.563	16

Rural sample

Table 23
Verbal classification:
Solution probabilities at age nine
Rural sample

Task		Judgment	Justification	N
CVA/B301	Animals / Cats	0.968	0.532	62
CVA/B302	Birds / Ducks	1.000	0.500	62
CVA/B303	Flowers / Buttercups	0.855	0.516	62
CVA/B304	Fruits / Oranges	0.919	0.613	62
CVA/B305	Cars / Volkswagen	0.935	0.452	62
CVA/B306	Children / Boys/Girls	0.935	0.629	62
CVA/B307	Ships / Trawlers	0.629	0.242	62
CVA/B308	Toys / Lego-Blocks	0.823	0.387	62
CVA/B309	Sheep / White Sheep	0.694	0.484	62
CVA/B310	Sheep / Black Sheep	0.952	0.387	62
CVA/B311	Clothes / Dresses/ Pants	0.903	0.581	62
CVA/B312	Sweets / Candy	0.903	0.500	62
CVA/B313	Icelanders / Reykjavikers	0.823	0.452	62

Table 24
Verbal classification:
Solution probabilities at age nine
by Gender
Rural sample

Task		female			male		
		Judgment	Justification	N	Judgment	Justification	N
CVA/B301	Animals / Cats	0.963	0.333	27	0.971	0.686	35
CVA/B302	Birds / Ducks	1.000	0.556	27	1.000	0.457	35
CVA/B303	Flowers / Buttercups	0.815	0.556	27	0.886	0.486	35
CVA/B304	Fruits / Oranges	0.963	0.630	27	0.886	0.600	35
CVA/B305	Cars / Volkswagen	0.852	0.407	27	1.000	0.486	35
CVA/B306	Children / Boys/Girls	0.963	0.593	27	0.914	0.657	35
CVA/B307	Ships / Trawlers	0.630	0.185	27	0.629	0.286	35
CVA/B308	Toys / Lego-Blocks	0.889	0.481	27	0.771	0.314	35
CVA/B309	Sheep / White Sheep	0.741	0.481	27	0.657	0.486	35
CVA/B310	Sheep / Black Sheep	0.963	0.407	27	0.943	0.371	35
CVA/B311	Clothes / Dresses/ Pants	0.889	0.519	27	0.914	0.629	35
CVA/B312	Sweets / Candy	0.963	0.444	27	0.857	0.543	35
CVA/B313	Icelanders / Reykjavikers	0.778	0.370	27	0.857	0.514	35

Table 25
Verbal classification:
Solution probabilities at age nine
by community
Rural sample

Region		North			South		
Task		Judgment	Justification	N	Judgment	Justification	N
CVA/B301	Animals / Cats	1.000	0.444	18	0.958	0.625	24
CVA/B302	Birds / Ducks	1.000	0.611	18	1.000	0.625	24
CVA/B303	Flowers / Buttercups	0.889	0.556	18	0.833	0.583	24
CVA/B304	Fruits / Oranges	1.000	0.611	18	1.000	0.750	24
CVA/B305	Cars / Volkswagen	0.889	0.389	18	1.000	0.542	24
CVA/B306	Children / Boys/Girls	0.944	0.611	18	0.917	0.667	24
CVA/B307	Ships / Trawlers	0.556	0.222	18	0.750	0.375	24
CVA/B308	Toys / Lego-Blocks	0.833	0.444	18	0.708	0.500	24
CVA/B309	Sheep / White Sheep	0.722	0.444	18	0.750	0.542	24
CVA/B310	Sheep / Black Sheep	1.000	0.444	18	0.958	0.375	24
CVA/B311	Clothes / Dresses/ Pants	1.000	0.556	18	0.917	0.625	24
CVA/B312	Sweets / Candy	0.889	0.556	18	0.917	0.625	24
CVA/B313	Icelanders / Reykjavikers	0.833	0.389	18	0.833	0.583	24

Region		West		
Task		Judgment	Justification	N
CVA/B301	Animals / Cats	0.950	0.500	20
CVA/B302	Birds / Ducks	1.000	0.250	20
CVA/B303	Flowers / Buttercups	0.850	0.400	20
CVA/B304	Fruits / Oranges	0.750	0.450	20
CVA/B305	Cars / Volkswagen	0.900	0.400	20
CVA/B306	Children / Boys/Girls	0.950	0.600	20
CVA/B307	Ships / Trawlers	0.550	0.100	20
CVA/B308	Toys / Lego-Blocks	0.950	0.200	20
CVA/B309	Sheep / White Sheep	0.600	0.450	20
CVA/B310	Sheep / Black Sheep	0.900	0.350	20
CVA/B311	Clothes / Dresses/ Pants	0.800	0.550	20
CVA/B312	Sweets / Candy	0.900	0.300	20
CVA/B313	Icelanders / Reykjavikers	0.800	0.350	20

2.3.10. Assessment of the twelve-year old children

Urban sample

Table 26
Verbal classification:
Solution probabilities at age twelve
Urban sample

Task		Judgment	Justification	N
CF410	Flowers / Buttercups	0.909	0.573	110
CS406	Sheeps / White sheeps	0.791	0.691	110
KF410	Garden / Buttercups	0.836	0.400	110
KT403	Fleet / Trawlers	0.809	0.655	110

Table 27
Verbal classification:
Solution probabilities at age twelve
by teacher rating
Urban sample

Teacher rating		low			high		
Task		Judgment	Justification	N	Judgment	Justification	N
CF410	Flowers / Buttercups	0.842	0.386	57	0.981	0.774	60
CS406	Sheeps / White sheeps	0.702	0.509	57	0.887	0.887	60
KF410	Garden / Buttercups	0.754	0.263	57	0.925	0.547	60
KT403	Fleet / Trawlers	0.737	0.509	57	0.887	0.811	60

Table 28
Verbal classification:
Solution probabilities at age twelve
by gender
Urban sample

Gender		female			male		
Task		Judgment	Justification	N	Judgment	Justification	N
CF410	Flowers / Buttercups	0.902	0.569	51	0.915	0.576	59
CS406	Sheeps / White sheeps	0.804	0.647	51	0.780	0.729	59
KF410	Garden / Buttercups	0.824	0.333	51	0.847	0.458	59
KT403	Fleet / Trawlers	0.784	0.667	51	0.831	0.644	59

Table 29
Verbal classification:
Solution probabilities at age eight
by social class in two categories
Urban sample

SES		low			high		
		Judgment	Justification	N	Judgment	Justification	N
CF410	Flowers / Buttercups	0.879	0.466	58	0.942	0.692	52
CS406	Sheeps / White sheeps	0.741	0.603	58	0.846	0.788	52
KF410	Garden / Buttercups	0.810	0.293	58	0.865	0.519	52
KT403	Fleet / Trawlers	0.776	0.603	58	0.846	0.712	52

Table 30
Verbal classification:
Solution probabilities at age twelve
by social class in six categories
Urban sample

SES		low/low (SES 1)			low/high (SES 2)		
		Judgment	Justification	N	Judgment	Justification	N
CF410	Flowers / Buttercups	0.800	0.400	15	0.923	0.462	26
CS406	Sheeps / White sheeps	0.667	0.533	15	0.808	0.654	26
KF410	Garden / Buttercups	0.733	0.200	15	0.808	0.346	26
KT403	Fleet / Trawlers	0.800	0.600	15	0.808	0.654	26

SES		middle/low (SES 3)			middle/high (SES 4)		
		Judgment	Justification	N	Judgment	Justification	N
CF410	Flowers / Buttercups	0.882	0.529	18	1.000	0.737	19
CS406	Sheeps / White sheeps	0.706	0.588	18	0.947	0.947	19
KF410	Garden / Buttercups	0.882	0.294	18	0.947	0.684	19
KT403	Fleet / Trawlers	0.706	0.529	18	0.895	0.789	19

SES		high/low (SES 5)			high/high (SES 6)		
		Judgment	Justification	N	Judgment	Justification	N
CF410	Flowers / Buttercups	0.950	0.700	20	0.846	0.615	13
CS406	Sheeps / White sheeps	0.850	0.700	20	0.692	0.692	13
KF410	Garden / Buttercups	0.850	0.450	20	0.769	0.385	13
KT403	Fleet / Trawlers	0.900	0.800	20	0.692	0.462	13

Rural Sample

Table 31
Verbal classification:
Solution probabilities at age twelve
Rural sample

Task		Judgment	Adequate	Semiad.	Inadequate	N
CF410	Flowers / Buttercups	0.902	0.452	0.145 %	0.403	62
CS406	Sheeps / White sheeps	0.790	0.661	0.048 %	0.290	62
KF410	Garden / Buttercups	0.758	0.371	0.242 %	0.387	62
KT403	Fleet / Trawlers	0.758	0.565	0.016 %	0.419	62

Table 32
Verbal classification:
Solution probabilities at age twelve
by gender
Rural sample

Gender	Task	male			female		
		Judgment	Justification	N	Judgment	Justification	N
CF410	Flowers / Buttercups	0.963	0.333	27	0.971	0.686	35
CS406	Sheeps / White sheeps	1.000	0.556	27	1.000	0.457	35
KF410	Garden / Buttercups	0.815	0.556	27	0.886	0.486	35
KT403	Fleet / Trawlers	0.963	0.630	27	0.886	0.600	35

Table 33
Verbal classification:
Solution probabilities at age twelve
by community
Rural sample

Region	Task	Judg.	Just./Ad.	Just./Sem	Just. /Inc.	N	
North	CF410	Flowers / Buttercups	1.000	0.684	0.526	0.263	18
	CS406	Sheeps / White sheeps	1.000	0.842	0.526	0.105	18
	KF410	Garden / Buttercups	0.889	0.579	0.105	0.316	18
	KT403	Fleet / Trawlers	1.000	0.579	0.000	0.421	18

Table 33
continued

Region		South				
Task		Judg.	Just./Ad.	Just./Sem	Just. /Inc.	N
CF410	Flowers / Buttercups	0.833	0.417	0.833	0.500	24
CS406	Sheeps / White sheeps	0.708	0.583	0.833	0.333	24
KF410	Garden / Buttercups	0.708	0.333	0.167	0.500	24
KT403	Fleet / Trawlers	0.708	0.625	0	0.375	24

Region		West				
Task		Judg.	Just./Ad.	Just./Sem	Just. /Inc.	N
CF410	Flowers / Buttercups	0.944	26.32	31.58	42.11	19
CS406	Sheeps / White sheeps	0.737	57.89	0	42.11	19
KF410	Garden / Buttercups	0.789	21.05	47.37	31.58	19
KT403	Fleet / Trawlers	0.737	47.37	5.26	47.37	19

2.3.11. Missings

Table 34
Number of missings in the concept of verbal classification

Tasks	7 years	8 years	9 years	12 years	Sample
ALL	0	62	8	11	Urban
ALL	0	-	2		Rural
CFA410				3	Rural
CFB410				2	Rural
CSA406				2	Rural
CSB406				2	Rural
KFA410				2	Rural
KFB410				2	Rural
KTA403				2	Rural
KTB403				2	Rural

Table 31
Number of missings in pictorial classification by nine years old
children in addition to the concept of verbal classification

Tasks	9 years
CPA, CPB, CPC301	10
CPA, CPB, CPC302	12
CPA, CPB, CPC303	10
CPA, CPB, CPC304	14
CPA, CPB, CPC305	12
CPA, CPB, CPC306	42
CPA, CPB, CPC307	11
CPA, CPB, CPC308	15
CPA, CPB, CPC309	43
CPA, CPB, CPC310	12
CPA, CPB, CPC311	17

3. Logical Multiplication

3.1. Logical multiplication of classes

3.1.1. Description of the concept

The logical multiplication of classes refers to the classification of objects on two attribute dimensions (Piaget & Inhelder 1973a, b, Piaget & Szeminska 1975). In contrast to the addition of classes, where each element is assigned to one class only, class multiplication demands simultaneous classification according to several attributes found in a single element. Logical multiplication can be conceptualized as a logical operator which forms the product of two attributes, i.e. it isolates exactly those elements which satisfy both attributes. In its formalized expression, this operation is the multiplicative composition of two attributes: $A_1 \times A_2 = A_1A_2$.

Given one matrix combining two different attribute dimensions (such as form and color), acquisition of the logical multiplication of classes consists of the ability to complete this matrix correctly: The objects that are assigned to one of its cells must show the attribute combination that is characteristic for the cell in question.

These tasks are highly complex in that they demand a simultaneous, multiple attribute ascription to the elements to be classified: The object must be represented as concurrently possessing two or more attributes from A_1 and A_2 to A_n . In comparison to class addition, class multiplication demands a multiple (in contrast to unitary) classification level. In Flavell's (1943) taxonomy of grouping types, logical multiplication corresponds to grouping III. Piaget and Inhelder (1977, p. 262 f. and p. 275 f.) indicate in several places that matrix thinking designates the transitional moment or threshold between concrete and formal operations, because conceptually logical multiplication can be grasped and solved as a combinatory task in the sense of formal operations (combinatory system). Thus, compared to the other concrete-operational concepts investigated in this study, logical multiplication presumably places the largest operational demands on the child.

3.1.2 Description of the measures: equipment and materials

To measure the logical multiplication of classes, this study used the tasks developed by Smedslund (1964).

The child is presented with a four-field board with two logical entrances to each field. Three of the four fields are covered, while the fourth field (lower right) remains uncovered and empty. The following figures are hidden under the covered field: three yellow, star-shaped plastic chips in the upper right field; three green, star-shaped chips in the upper left field; and three green, round chips in the lower left field. Next to this four-field board, all possible combinations of the three shapes (stars, squares, and circles) and of the three colors (yellow, green, and blue) are displayed in an irregular arrangement. From this collection, the child has to choose those chips belonging to the empty field in the four-field board.

Task 1: Form × Colour: Completion of the fourth field in a four-field board, uncovered presentation

Task 2: Form × Colour: Completion of the fourth field in a four-field board, covered presentation

3.1.3 Investigation procedures and instructions

The child is presented the arrangement described above. I asks the following preparatory questions, and repeats them in case the child has not understood the presentation of the task. I continues to repeat the questions, until it was clear that the child has grasped the details of how the multiple class inclusion task is to be completed.

I uncovers the upper right field and points with the finger to the objects in the cell.

- "What color are these chips?"

- "What shape are these chips?"

I points to the other collection and asks:

- "Do you see something here that looks like something over there?"

Then, the I covers the upper right field and asks again:

- "Do you see something here that looks like something over there?"

This approach is repeated at least once for each of the three covered objects. The comparison set is reshuffled, again unsystematically, before each repetition. In case the child attempts to assign

the chips incorrectly, I corrects the child by uncovering the corresponding field. Then I asks the following test questions:

- "Now you know all three chips that are found under the cover. But we still don't have a chip for the fourth empty field. Which one of the chips next to the board belongs to this field?"
- "Why do you think this chip belongs to the empty field?"

I then uncovers the three covered fields and again asks the child:

- "Which one of the chips over here belongs to this field?"
- "Why do you think this chip belongs to the empty field?"

3.1.4 Scoring instructions and coding rules

The children's responses are coded in the following way:

1) a so-called judgment score is assigned according to whether or not the child could assign the chip correctly, and 2) the children's reasons for this assignment were noted. The children's explanations are termed adequate when they selected the correct chip and presented one of the following arguments:

- "I chose the yellow round chips because these are green and those there are stars."
- "I chose the yellow round chips because these are yellow and those there are round ones."

The following types of judgments and reasons are seen as inappropriate:

1) Reference to only one classification attribute:

- "The yellow square one, because these are both green and the other two are yellow."

2) Reference to similarities with the objects in single fields:

- "The red suns because they are like the other red round ones."

3) Other reasons and personal preferences.

3.2. Logical multiplication of relations

3.2.1 Description of the concept

The concept of logical multiplication of relations can be seen as analogous to the concept of the multiplication of classes, except that interrelations among the attributes (or characteristics) are combined (Piaget & Inhelder 1973 a, b, Piaget & Szeminska 1975).

3.2.2. Description of the measures: equipment and materials

To measure the logical multiplication of relations, the tasks developed by Smedslund (1964) were used.

The child was presented with a three-field board. Two of the three fields were covered, while the third field (far right) remained uncovered and empty. The following chips were hidden under the covered fields: a light green and a large square chip in the far left field; and a medium green and a medium-sized square chip in the middle field. Next to this three-field board, all possible combinations of the three sizes (small, medium, large) and of three colours (light, medium, dark green) were displayed in an irregular arrangement. From this collection of chips, the child had to choose the chips belonging in the empty field in the three-field board.

3.2.3 Investigation procedures and instructions

The child is presented with the experimental arrangement described above. I asks the following preparatory questions, and repeats them in case the child has not understood the presentation of the task. I continues to repeat the questions, until it is clear that the child has grasped the details of how the creation multiple class relations is to be completed.

I uncovers the far left field and points to the chip in the cell.

- "Which of the chips next to the board looks like this uncovered chip?"

The far left field is covered again, upon which I repeats the question:

- "Which of the chips next to the board looks like the chip I just covered up?"

Then the middle field is uncovered with the question:

- "Which of the chips next to the board looks like this uncovered chip?"

The middle field is again covered, upon which I repeats the question:

- "Which of the chips next to the board looks like the chip I just covered up?"

The comparison set is reshuffled again unsystematically before each repetition. In case the child attempts to assign the chips incorrectly, I corrects the child by uncovering the corresponding field. I then asks the following test questions:

- "Now you know both chips that are found under the cover. But we still don't have a chip for third, empty field. Which one of the chips next to the board belongs to this field?"
- "Why do you think this chip belongs to the empty field?"

I then uncovers the two covered fields and again asks the child:

- "Which one of the chips over here belongs to this empty field?"
- "Why do you think this chip belongs to the empty field?"

Task 3: Hue x Size: Squares in three adjacent fields; completion of the right field;
covered presentation

Task 4: Hue x Size: Squares in three adjacent fields; completion of the right field;
uncovered presentation

3.2.4 Scoring instructions and coding rules

The children's responses are coded in the following way: 1) a so-called judgment score is assigned according to whether or not the child could assign the chip correctly, and 2) the children's reasons for this assignment is noted. The children's explanations are termed adequate when they selected the correct chip and presented one of the following arguments:

- "I chose the smallest and darkest square chip because the others are getting smaller and smaller and darker and darker."

The following types of judgments and reasons are seen as inappropriate:

- 1) Reference to only one distinctive relation:
 - "This one is the smallest one of all."
- 2) Reference to similarities with the objects in single fields:
 - "That one is just like this one here."
- 3) Other reasons and personal preferences.

The logical multiplication tasks were assessed at age seven, eight and nine.

3.3. List of variables

3.3.1. Variables including data of the seven-year old children

LMA101	Adequacy of Judgment / Logical Multiplication of Classes / uncovered
LMA102	Adequacy of Judgment / Logical Multiplication of Classes / covered
LMA103	Adequacy of Judgment / Logical Multiplication of Relations / uncovered
LMA104	Adequacy of Judgment / Logical Multiplication of Relations / covered
LMB101	Adequacy of Justification / Logical Multiplication of Classes / uncovered
LMB102	Adequacy of Justification / Logical Multiplication of Classes / covered
LMB103	Adequacy of Justification / Logical Multiplication of Relations / uncovered
LMB104	Adequacy of Justification / Logical Multiplication of Relations / covered

3.3.2. Variables including data of the eight-year old children

LMA201	Adequacy of Judgment / Logical Multiplication of Classes / uncovered
LMA202	Adequacy of Judgment / Logical Multiplication of Classes / covered
LMA203	Adequacy of Judgment / Logical Multiplication of Relations / uncovered
LMA204	Adequacy of Judgment / Logical Multiplication of Relations / covered
LMB201	Adequacy of Justification / Logical Multiplication of Classes / uncovered
LMB202	Adequacy of Justification / Logical Multiplication of Classes / covered
LMB203	Adequacy of Justification / Logical Multiplication of Relations / uncovered
LMB204	Adequacy of Justification / Logical Multiplication of Relations / covered

3.3.3. Variables including data of the nine-year old children

LMA301	Adequacy of Judgment / Logical Multiplication of Classes / uncovered
LMA302	Adequacy of Judgment / Logical Multiplication of Classes / covered
LMA303	Adequacy of Judgment / Logical Multiplication of Relations / uncovered
LMA304	Adequacy of Judgment / Logical Multiplication of Relations / covered
LMB301	Adequacy of Justification / Logical Multiplication of Classes / uncovered
LMB302	Adequacy of Justification / Logical Multiplication of Classes / covered
LMB303	Adequacy of Justification / Logical Multiplication of Relations / uncovered
LMB304	Adequacy of Justification / Logical Multiplication of Relations / covered

3.4. References

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3.5. Assessment of the seven-year old children

Urban Sample

Table 1
Logical multiplication:
Solution probabilities at age seven
Urban sample

Task		Judgment	Justification	N
LMA/B101	Classes / uncovered	0.562	0.380	121
LMA/B102	Classes / covered	0.455	0.207	121
LMA/B103	Relations / uncovered	0.372	0.322	121
LMA/B104	Relations/ covered	0.207	0.124	121

Table 2
Logical multiplication:
Solution probabilities at age seven
by teacher rating
Urban sample

Task		low			high		
		Judgment	Justification	N	Judgment	Justification	N
LMA/B101	Classes / uncovered	0.393	0.131	61	0.733	0.633	60
LMA/B102	Classes / covered	0.393	0.049	61	0.517	0.357	60
LMA/B103	Relations / uncovered	0.148	0.082	61	0.600	0.357	60
LMA/B104	Relations/ covered	0.098	0.049	61	0.317	0.200	60

Table 3
Logical multiplication:
Solution probabilities at age seven
by gender
Urban sample

Task		female			male		
		Judgment	Justification	N	Judgment	Justification	N
LMA/B101	Classes / uncovered	0.614	0.456	57	0.516	0.313	64
LMA/B102	Classes / covered	0.509	0.246	57	0.406	0.172	64
LMA/B103	Relations / uncovered	0.368	0.298	57	0.375	0.344	64
LMA/B104	Relations/ covered	0.228	0.140	57	0.188	0.109	64

Table 4
Logical multiplication:
Solution probabilities at age seven
by social class in two categories: low (SES 1-3), high (SES 4-6)
Urban sample

SES		high			low		
Task		Judgment	Justification	N	Judgment	Justification	N
LMA/B101	Classes / uncovered	0.603	0.413	63	0.517	0.345	58
LMA/B102	Classes / covered	0.476	0.159	63	0.431	0.259	58
LMA/B103	Relations / uncovered	0.365	0.317	63	0.379	0.328	58
LMA/B104	Relations/ covered	0.206	0.175	63	0.207	0.069	58

Table 5
Logical multiplication:
Solution probabilities at age seven
by social class in six categories
Urban sample

SES		low/low (SES 1)			low/high (SES 2)		
Task		Judgment	Justification	N	Judgment	Justification	N
LMA/B101	Classes / uncovered	0.556	0.444	18	0.630	0.370	27
LMA/B102	Classes / covered	0.389	0.167	18	0.519	0.148	27
LMA/B103	Relations / uncovered	0.278	0.222	18	0.370	0.296	27
LMA/B104	Relations/ covered	0.167	0.111	18	0.148	0.148	27

SES		middle/low (SES 3)			middle/high (SES 4)		
Task		Judgment	Justification	N	Judgment	Justification	N
LMA/B101	Classes / uncovered	0.611	0.444	18	0.650	0.450	20
LMA/B102	Classes / covered	0.500	0.167	18	0.300	0.250	20
LMA/B103	Relations / uncovered	0.444	0.444	18	0.350	0.300	20
LMA/B104	Relations/ covered	0.333	0.278	18	0.200	0.050	20

SES		high/low (SES 5)			high/high (SES 6)		
Task		Judgment	Justification	N	Judgment	Justification	N
LMA/B101	Classes / uncovered	0.476	0.333	21	0.412	0.235	17
LMA/B102	Classes / covered	0.571	0.286	21	0.412	0.235	17
LMA/B103	Relations / uncovered	0.381	0.333	21	0.412	0.353	17
LMA/B104	Relations/ covered	0.190	0.048	21	0.235	0.118	17

Rural Sample

Table 6
Logical multiplication:
Solution probabilities at age seven
Rural sample

Task		Judgment	Justification	N
LMA/B101	Classes / uncovered	0.359	0.141	64
LMA/B102	Classes / covered	0.375	0.094	64
LMA/B103	Relations / uncovered	0.297	0.109	64
LMA/B104	Relations/ covered	0.156	0.063	64

Table 7
Logical multiplication:
Solution probabilities at age seven
by gender
Rural sample

Gender	Task	female			male		
		Judgment	Justification	N	Judgment	Justification	N
LMA/B101	Classes / uncovered	0.483	0.241	29	0.257	0.057	35
LMA/B102	Classes / covered	0.414	0.069	29	0.343	0.114	35
LMA/B103	Relations / uncovered	0.379	0.172	29	0.229	0.057	35
LMA/B104	Relations/ covered	0.207	0.069	29	0.114	0.057	35

Table 8
Logical multiplication:
Solution probabilities at age seven
by community
Rural sample

Region	Task	North			South		
		Judgment	Justification	N	Judgment	Justification	N
LMA/B101	Classes / uncovered	0.368	0.158	19	0.320	0.120	25
LMA/B102	Classes / covered	0.421	0.053	19	0.400	0.120	25
LMA/B103	Relations / uncovered	0.474	0.211	19	0.280	0.080	25
LMA/B104	Relations/ covered	0.211	0.105	19	0.160	0.040	25

Region		West		
Task		Judgment	Justification	N
LMA/B101	Classes / uncovered	0.400	0.150	20
LMA/B102	Classes / covered	0.300	0.100	20
LMA/B103	Relations / uncovered	0.150	0.050	20
LMA/B104	Relations/ covered	0.100	0.050	20

3.6. Assessment of the eight-year old children

Table 9
Logical multiplication:
Solution probabilities at age eight
Urban sample

Task		Judgment	Justification	N
LMA/B201	Classes / uncovered	0.525	0.356	59
LMA/B202	Classes / covered	0.458	0.237	59
LMA/B203	Relations / uncovered	0.458	0.322	59
LMA/B204	Relations / covered	0.288	0.169	59

Table 10
Logical multiplication:
Solution probabilities at age eight
by teacher rating
Urban sample

Teacher rating		low			high		
Task		Judgment	Justification	N	Judgment	Justification	N
LMA/B201	Classes / uncovered	0.469	0.286	49	0.800	0.700	10
LMA/B202	Classes / covered	0.429	0.204	49	0.600	0.400	10
LMA/B203	Relations / uncovered	0.408	0.265	49	0.700	0.600	10
LMA/B204	Relations / covered	0.245	0.122	49	0.500	0.400	10

Table 11
Logical multiplication:
Solution probabilities at age eight
by gender
Urban sample

Gender		female			male		
Task		Judgment	Justification	N	Judgment	Justification	N
LMA/B201	Classes / uncovered	0.556	0.481	27	0.500	0.250	32
LMA/B202	Classes / covered	0.519	0.333	27	0.406	0.156	32
LMA/B203	Relations / uncovered	0.370	0.259	27	0.531	0.375	32
LMA/B204	Relations / covered	0.296	0.148	27	0.281	0.188	32

Table 12
Logical multiplication:
Solution probabilities at age eight
by social class in two categories: low (SES 1-3), high (SES 4-6)
Urban sample

SES		high			low		
		Judgment	Justification	N	Judgment	Justification	N
LMA/B201	Classes / uncovered	0.655	0.448	29	0.400	0.267	30
LMA/B202	Classes / covered	0.586	0.379	29	0.333	0.100	30
LMA/B203	Relations / uncovered	0.552	0.414	29	0.367	0.233	30
LMA/B204	Relations / covered	0.379	0.241	29	0.200	0.100	30

Table 13
Logical multiplication:
Solution probabilities at age eight
by social class in six categories
Urban sample

SES		low/low (SES 1)			low/high (SES 2)		
		Judgment	Justification	N	Judgment	Justification	N
LMA/B201	Classes / uncovered	0.333	0.111	9	0.583	0.417	12
LMA/B202	Classes / covered	0.444	0.222	9	0.417	0.083	12
LMA/B203	Relations / uncovered	0.333	0.222	9	0.500	0.250	12
LMA/B204	Relations / covered	0.222	0.111	9	0.333	0.167	12
SES		middle/low (SES 3)			middle/high (SES 4)		
		Judgment	Justification	N	Judgment	Justification	N
LMA/B201	Classes / uncovered	0.222	0.222	9	0.455	0.364	11
LMA/B202	Classes / covered	0.111	0.000	9	0.727	0.545	11
LMA/B203	Relations / uncovered	0.222	0.222	9	0.455	0.273	11
LMA/B204	Relations / covered	0.000	0.000	9	0.364	0.182	11
SES		high/low (SES 5)			high/high (SES 6)		
		Judgment	Justification	N	Judgment	Justification	N
LMA/B201	Classes / uncovered	0.818	0.455	11	0.714	0.571	7
LMA/B202	Classes / covered	0.455	0.273	11	0.571	0.286	7
LMA/B203	Relations / uncovered	0.545	0.364	11	0.714	0.714	7
LMA/B204	Relations / covered	0.273	0.182	11	0.571	0.429	7

3.7. Assessment of the nine-year old children

Urban Sample

Table 14
Logical multiplication:
Solution probabilities at age nine
Urban sample

Task		Judgment	Justification	N
LMA/B301	Classes / uncovered	0.708	0.496	113
LMA/B302	Classes / covered	0.611	0.319	113
LMA/B303	Relations / uncovered	0.681	0.566	113
LMA/B304	Relations / covered	0.442	0.283	113

Table 15
Logical multiplication:
Solution probabilities at age nine
by teacher rating
Urban sample

Teacher rating		low			high		
Task		Judgment	Justification	N	Judgment	Justification	N
LMA/B201	Classes / uncovered	0.610	0.322	59	0.815	0.685	54
LMA/B202	Classes / covered	0.576	0.203	59	0.648	0.444	54
LMA/B203	Relations / uncovered	0.627	0.458	59	0.741	0.685	54
LMA/B204	Relations / covered	0.339	0.136	59	0.556	0.444	54

Table 16
Logical multiplication:
Solution probabilities at age nine
by gender
Urban sample

Gender		female			male		
Task		Judgment	Justification	N	Judgment	Justification	N
LMA/B301	Classes / uncovered	0.792	0.604	53	0.633	0.400	60
LMA/B302	Classes / covered	0.623	0.358	53	0.600	0.283	60
LMA/B303	Relations / uncovered	0.642	0.509	53	0.717	0.617	60
LMA/B304	Relations / covered	0.434	0.283	53	0.450	0.283	60

Table 17
Logical multiplication:
Solution probabilities at age nine
by social class in two categories: low (SES 1-3), high (SES 4-6)
Urban sample

SES		high			low		
Task		Judgment	Justification	N	Judgment	Justification	N
LMA/B301	Classes / uncovered	0.733	0.450	60	0.679	0.547	53
LMA/B302	Classes / covered	0.600	0.283	60	0.623	0.358	53
LMA/B303	Relations / uncovered	0.600	0.467	60	0.774	0.679	53
LMA/B304	Relations / covered	0.350	0.167	60	0.547	0.415	53

Table 18
Logical multiplication:
Solution probabilities at age nine
by social class in six categories
Urban sample

SES		low/low (SES 1)			low/high (SES 2)		
Task		Judgment	Justification	N	Judgment	Justification	N
LMA/B301	Classes / uncovered	0.688	0.375	16	0.808	0.577	26
LMA/B302	Classes / covered	0.625	0.313	16	0.615	0.385	26
LMA/B303	Relations / uncovered	0.375	0.250	16	0.654	0.500	26
LMA/B304	Relations / covered	0.250	0.063	16	0.423	0.231	26

SES		middle/low (SES 3)			middle/high (SES 4)		
Task		Judgment	Justification	N	Judgment	Justification	N
LMA/B301	Classes / uncovered	0.667	0.333	18	0.632	0.526	19
LMA/B302	Classes / covered	0.556	0.111	18	0.632	0.421	19
LMA/B303	Relations / uncovered	0.722	0.611	18	0.789	0.632	19
LMA/B304	Relations / covered	0.333	0.167	18	0.368	0.211	19

SES		high/low (SES 5)			high/high (SES 6)		
Task		Judgment	Justification	N	Judgment	Justification	N
LMA/B301	Classes / uncovered	0.650	0.450	20	0.786	0.714	14
LMA/B302	Classes / covered	0.650	0.200	20	0.571	0.500	14
LMA/B303	Relations / uncovered	0.700	0.650	20	0.857	0.786	14
LMA/B304	Relations / covered	0.600	0.450	20	0.714	0.643	14

Rural Sample

Table 19
Logical multiplication:
Solution probabilities at age nine
Rural sample

Total Score

Task		Judgment	Justification	N
LMA/B301	Classes / uncovered	0.452	0.242	64
LMA/B302	Classes / covered	0.500	0.177	64
LMA/B303	Relations / uncovered	0.419	0.323	64
LMA/B304	Relations / covered	0.194	0.113	64

Table 20
Logical multiplication:
Solution probabilities at age nine
by gender
Rural sample

Gender		female			male		
Task		Judgment	Justification	N	Judgment	Justification	N
LMA/B301	Classes / uncovered	0.481	0.259	27	0.429	0.229	35
LMA/B302	Classes / covered	0.593	0.148	27	0.429	0.200	35
LMA/B303	Relations / uncovered	0.407	0.222	27	0.429	0.400	35
LMA/B304	Relations / covered	0.296	0.185	27	0.114	0.057	35

Table 21
Logical multiplication:
Solution probabilities at age nine
by community
Rural sample

Region		North			South		
Task		Judgment	Justification	N	Judgment	Justification	N
LMA/B301	Classes / uncovered	0.444	0.333	18	0.583	0.375	24
LMA/B302	Classes / covered	0.667	0.278	18	0.458	0.167	24
LMA/B303	Relations / uncovered	0.556	0.389	18	0.417	0.292	24
LMA/B304	Relations / covered	0.278	0.278	18	0.250	0.083	24

Region		West			
Task		Judgment	Justification	N	
LMA/B301	Classes / uncovered	0.300	0.000	20	
LMA/B302	Classes / covered	0.400	0.100	20	
LMA/B303	Relations / uncovered	0.300	0.300	20	
LMA/B304	Relations / covered	0.050	0.000	20	

3.8. Missings

Table 22
Number of Missings in the concept of logical classification

Tasks	7 years	8 years	9 years	SAMPLE
ALL	0	62	8	Urban
ALL	0	-	2	Rural

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