Is it Instruction or Feedback: A Replication Study of Wood et al (1978) about Adaptive Instruction for 3-Year-Olds

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Abstract

Since the article of Wood et al. (1978) stated that adaptive instruction seems most effective, compared to other instruction types, adaptive instruction has been accepted as a key element for effective instruction. Therefore, Smit et al. (2021) have initiated an exact replication study. Looking at the design of both studies, feedback could be present in the instructional phase. Since feedback is considered a powerful influence on learning and performance, this could influence the participants performance. Using the data of Smit, this study examined if adaptive instruction is as effective as Wood found, or if the effect of instruction on the performance of three-year-old children, can be explained by the received amount of feedback. The instruction phase videos of 80 three-year-old children, that were randomly assigned to four types of instruction, were observed while building a pyramid with blocks. There was no significant effect of instruction on performance. Mediation analyses revealed a significant effect of instruction type on amount of feedback, but no significant effect of amount of feedback on performance. Therefore, feedback did not mediate the effect of instruction on performance. Although this is but one study that contradicts the findings of Wood, more empirical research is needed.

Keywords: adaptive instruction, amount of feedback, task performance, preschoolers

Is it Instruction or Feedback: A Replication Study of Wood et al (1978) about Adaptive Instruction for 3-Year-Olds

Due to the heterogeneity of learning groups in education, many academics suggest that it is essential for teachers to adapt their instruction to the individual student (Bransford et al., 2000; Hardy et al., 2019; Parsons et al., 2018). In this adaptive instruction approach, the teacher accommodates to the needs and abilities of different students (Lee & Park, 2008; Parsons et al., 2018). Because adaptive instruction is widely accepted as a key element to effective instruction, even the Dutch Inspectorate of Education stresses the importance of this instruction and evaluates the extent to which it is provided by teachers (Inspectie van het onderwijs, 2019).

One of the first researchers who have demonstrated the positive effect of adaptive instruction is Wood et al. (1978), whose study is often cited in research regarding adaptive instruction as supporting evidence for its effectiveness (Smit et al., 2021). However, other influences on performance besides instruction type (which will be discussed in detail later) were given little attention by Wood and colleagues. As a result, the original article leaves some variances within or between the different instruction types undiscussed, which may affect the relationship between the instructional types and their results. To help verify the credibility of this much cited article and to find out if the research of Wood and colleagues actually indicates that adaptive instruction is the most effective form of instruction, it is important to replicate their research.

Original research of Wood et al. (1978)

Based on mother-child interactions, Wood et al. (1978) identified five levels of intervention that could be applied when a child encounters a problem: 1) general verbal encouragement; 2) specific verbal information; 3) selection; 4) prepared material; 5) demonstration. In their research, Wood and colleagues proposed that these levels of

intervention occurred in patterns, which resulted in four different teaching strategies. Subsequently, Wood and colleagues examined the effectiveness of these different teaching strategies, among three-year-old children who needed to master a difficult construction task with blocks (see Appendix 1 for more information regarding the task). The four strategies were;

1) *Demonstration*: the instructor shows the child how to stack all the blocks from start to finish (all actions are at level 5).
2) *Verbal*: the child is guided verbally while building the construction task, without physical interference of the instructor (all actions are at levels 1 and 2).
3) *Swing*: the instructor alternates between verbal directions (level 1) and demonstration (level 5), while the child is building the construction task.
4) *Contingent*: the instructor makes use of all five levels and alternates guidance depending on the guideline "*If the child succeeds, when next intervening offer less help, if the child fails, when next intervening take over more control*" (Wood et al., 1978, p. 133).

The Contingent strategy represents adaptive instruction because less specific instruction is provided when the child does well, but when the child does not succeed in solving the problem, the instructor provides more specific instruction. To test which teaching strategy was more effective, children in the study of Wood et al. (1978) were first assigned to four distinct groups each taught by one of the four teaching strategies and then immediately tested in a post-test. In this post-test, the child was asked to perform the construction task by themselves. At the end of the post-test, an outcome score was calculated by counting how many blocks were in the correct place and an efficiency score was calculated by dividing the outcome score by the total number of operations (i.e. actions) a child performed.

In short, results showed that children scored significantly better in the Contingent strategy group in terms of the outcome and efficiency score. But more interestingly, results

showed that children assigned to the Demonstration strategy group had an significantly lower efficiency score compared to the three other instruction types. This means more actions were needed but with fewer blocks in the correct place. However, a possible explanation for this big difference is not clearly argued in the study by Woods et al. (1978).

One possible explanation for the large difference in efficiency could be found in the methodological approach of the study. For example, the children who were assigned to the strategy Demonstration, were not allowed to work with the blocks before entering the post-test, while children who were assigned to the strategies Verbal, Swing and Contingent, were allowed to do so. Since these three teaching strategies involve guiding the child during the construction task, the child could be corrected for incorrect actions and rewarded for correct actions before the child enters the post-test. Since the child has already performed actions in this instructional phase, that are judged to be correct or incorrect, the child may avoid the incorrect action and immediately perform the correct action in the post-test (Mory, 2004). This would mean that the child has learned from the received feedback, provided by the instructor, on task performance and might therefore get a higher outcome or efficiency score in the post-test. The higher efficiency scores on the strategies Verbal, Swing and Contingent opposed to Demonstration, is exactly what can be found in the results.

Another explanation could be found in the levels of intervention that are used in each teaching strategy. Since all levels of instruction are offered by the instructor in the Contingent strategy, opposed to the other strategies that offer levels to a lesser extent, the Contingent strategy has more opportunities to provide feedback to children. This could explain the highest outcome and efficiency scores in this strategy.

On top of that, the study of Wood et al. (1978) does not show what the distribution of outcome scores was of children within a strategy. Despite the fact that the verbal strategy had on average only 6.2 blocks correct, the best performance was still 20 correct blocks. Thus,

there seems to be variation between the scores of children. However, a possible explanation for this is again not discussed by Wood. This variation could also be explained by differences in amount of feedback between sessions or children (Sullivan et al., 2008). In total, both arguments raise the question; did Wood examine the effect of instruction or can feedback explain the differences?

Feedback

Feedback is considered one of the most powerful influences on learning and performance (Hattie & Timperley, 2007). Qualitatively high quality feedback is information from an agent (e.g. peers, parents, experience), in this case an instructor, about the learner's previous performance or current actions with the objective of encouraging positive and desired development (Archer, 2010). Information is provided by the agent to bridge the gap between the current level of performance and the desired level, so that the learner is able to understand strengths and weaknesses of their performance (Hattie & Timperley, 2007; Ramprasad, 1983; Sadler, 2010). Feedback can be used for correcting inaccurate strategies or actions and appears most influential when it is specific (Shute, 2008).

Corrective feedback

However, feedback is a complex construct that can take many different forms (Wisniewski et al., 2020). Taking the meta-analysis of Hattie and Timperley (2007) as a guide, they state that feedback about the task tells the learner how well a task is performed, for example by distinguishing incorrect from correct actions, which is also called corrective feedback. Corrective feedback is a response to errors of learners (Li, 2018) to indicate implicitly or more explicitly that there is an error (Li & Vuono, 2019; Nassaji & Kartchava, 2017). This is seen as highly effective for learning new skills (Hattie & Timperley, 2007; Wisniewski et al., 2020). Corrective feedback can then, also consist in other forms (Lyster &

Ranta, 1997; Tedick & Gortari, 1998), with suggestive feedback and elicitation fitting within the current research design.

Suggestive feedback. In the study by Blatt and colleagues (2008), feedback was categorised and it appeared that the majority indicated neutral feedback, which consisted mainly of explanations or suggestions for improvement. These suggestions for improvement were seen as suggestive feedback, which are comments that suggest doing something different or encourage you to discover this yourself. In essence, these are remarks that alert the learner that there is a problem or an error, without saying exactly what it is (Paas & Van Merrienboer, 2007; Tedick & Gortari, 1998).

Elicitation. In addition, suggestions for improvement can also be provided by asking questions, which evokes the student to reflect on their answer and repair their mistakes (Panova & Lyster, 2002). Feedback elicitation can be done by pausing after asking the question, allowing the student to complete the teachers utterance. Thus, giving feedback by giving a clue to the learner about what the teacher misses. In addition, this form of interaction between teacher and learner helps with engagement and prompts the learner to self-correct by evaluating alternative methods (Panova & Lyster, 2002; van Zee & Minstrell, 1997). Through describing (suggestive feedback) or asking (elicitation) about the alternative action, the displayed action can be corrected (Tedick & Gortari, 1998), hence the link to corrective feedback. But since corrective feedback is often followed by naming the expected correct action, these two forms seem slightly different.

Positive feedback

Besides corrective feedback, there are other types of feedback that contribute to increasing performance. Although Hattie and Timperley's (2007) meta-analyses showed that praise was the least effective form of feedback for improving performance, letting the learner know their action was correct did have positive effects. This is in line with the idea that

positive feedback can help maintain correct actions (Butler et al., 2008), which lead to behavioural adaptation (Eppinger et al., 2008) and provide an explicit association between action and outcome (Shute, 2008), thus have a positive effect on learning.

Amount of feedback

Besides other important factors such as timing, specificity of the information and task complexity (Lam et al., 2011; Wisniewski et al., 2020), several studies showed indications of a positive relation between the amount of feedback and performance (Mory, 2004; Salmoni et al., 1984). Subsequently, many studies mention to offer 'the right amount' of feedback (Lam et al., 2011; Mory, 2004; Sidaway et al., 2012; Thomas & Arnold, 2011). On top of that, Sullivan and colleagues (2008) found similar relations in which children who received feedback were more accurate during a retention task, then children who received a reduced amount of feedback. So, although each beforementioned forms of feedback have a different impact on learning, they all provide important learning opportunities (Gielen et al., 2010).

The present study

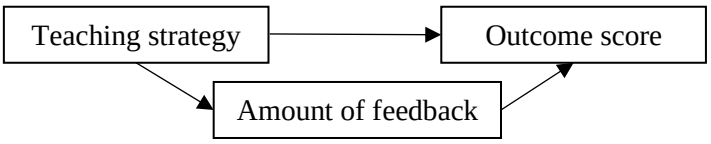
The purpose of this study is to find out if adaptive instruction is as effective as Wood et al. (1978) found, or if the effect of instruction on the performance of three-year-old children, can be explained by the received amount of feedback. Insights in this could help educators find the right balance between providing a certain instruction and giving feedback.

Accordingly, the first thing to examine is whether the effect of instruction on performance can also be found in this exact replication study. APA defines an exact replication as: "*a researcher uses procedures that are identical to the original experiment or duplicated as closely as possible*" (APA Dictionary of Psychology, n.d.). As Wood has found that the children taught by the Contingent strategy (which provides adaptive instruction) performed better on the post-test than the children in the other groups, the first hypothesis is that there is an effect of teaching strategy on the performance of the children. Subsequently, it

will be explored whether the effect of the teaching strategy on performance was mediated by the amount of feedback a child has received in the instructional phase. First, it is possible that teaching strategy has an effect on the amount of feedback an instructor can give, since an instructor uses different levels of instruction in each strategy. Since the instructor can use all five levels in the Contingent strategy, it is expected that children assigned to this strategy, will receive more feedback than the three other strategies. Then, it is expected that the more feedback a child has received, the better the performance, since beforementioned research has found indications for this. When both paths are found to be statistically significant, there may be a mediation. The second hypothesis thus states that the type of instruction has an indirect effect on performance through amount of feedback, see figure 1. Since Wood found that adaptive instruction resulted in significantly better results than the three other strategies, the current study chose the Contingent strategy as the reference group to compare with the other strategies.

Figure 1

General Mediation Model



Method

The current study uses the video data of the replication study by Smit et al. (2021) on the study by Wood et al. (1978). Both the present study and the study of Smit et al. (2021) have been approved by the ethical committee of the university.

Participants

The participants in the replication study by Smit et al. (2021) were Dutch-speaking children that were recruited by approaching parents via social media. A total of 256 children, received a pseudonym (i.e. number), and were allocated to one of the four teaching strategies

(per strategy n = 64), by stratified randomization controlled for gender (boy or girl), age (< 3,5 year old and > 3,5) and location (lab or day-care). The pseudonyms with consent forms (which were not accessible for master students) and the video data were safely stored in separate locations on Utrecht University's YODA platform. Students were only allowed to use the video data on University's laptops after signing a non-disclosure agreement.

Current study calculated by means of a power analyses (Faul et al., 2009), that with a large expected effect size of 0.4 (Cohen, 2013; Wisniewski et al., 2020) and a significance level of .05, this study would need a minimum sample size of 76 participants to have proper power of 0.80. The participants (n = 80) were distributed across four experimental groups, each assigned with a different teaching strategy (n = 20), using stratified randomization controlled for gender (boys N = 39, girls N = 41), instructor and location (lab N = 28, day-care with various locations N = 52,) to get the most representative sample.

Instrument

The replication study used a nearly identical wooden construction puzzle, as was used by Wood et al. (1978), shaped like a pyramid with 17 blocks. The four different teaching strategy groups were guided by instructors, who were trained in delivering the different kinds of instructions. Videos were recorded during the instructional phase and the post-test.

Outcome scores

To assess performance of the participants, the videos of the post-test were used to count the total correct operations of the participant at the end of the post-test. The total task consisted of 20 operations, summarized as; making of a pair, making a layer and stacking a layer onto a previous layer (see Appendix 1 for a more elaborate list of operations). This leads to obtaining a minimum score of 0 and a maximum score of 20 on the variable outcome score. The end of the post-test was defined as when; the participant finishes the puzzle, the participant refuses to continue or the instructor (verbally or physically) intervenes.

This is identical to the methods Wood et al. (1978) used, however, there was no further validity information available. Regarding reliability, two researchers scored the same videos independently, while using the list of operations and cut-off rules. This interrater reliability resulted in a perfect agreement with a Cohen's Kappa of 1, $p < .001$ (Landis & Koch, 1977). This pilot contained eight videos, which is 10% of the total videos, controlled for gender (boys $N = 4$, girls $N = 4$), instructor, teaching strategy (Demonstration $N = 2$, Verbal $N = 2$, Swing $N = 2$ and Contingent $N = 2$) and location (lab $N = 4$, day-care $N = 4$).

Feedback

To be able to conduct a quantitative analyses, non-numerical data (video material) was coded into numerical data. By using a deductive approach, a priori codes were derived from literature, which were not modified or supplemented during the observation process. The video data was coded by the method of coding and counting, which based on Chi (1997) would imply eight steps. So, to assess the amount of feedback a participant received, the researcher observed the videos of the instructional phase via the programme Mediacoder (Bos & Steenbeek, 2017). With a continuous sampling method from start to finish, the researcher was able to mark the type of verbalisations of the instructors with codes, which are listed in Table 1. After an initial look at the videos, the four forms of feedback seemed clearly prevalent. Through expert validation with the lead researcher of the replication study, face validity of the instrument was ensured and through careful consideration of the literature, content validity was ensured. On top of that, the controlled research conditions of the replication study, helped with the internal validity of the overall research. A distinction had to be made between information that is feedback and information that is purely instruction. As Wood et al. (1978) described, instructions can be verbal "Pick up the four largest blocks" or through demonstration. As Table 1 shows, this research identifies instruction as providing new, specific information that is scripted beforehand, either verbal or through demonstration.

Table 1

Coding scheme of verbalisations of instructors towards participants

Code	Definition	Examples	Literature
1. Instruction *Feedback*	Providing new, specific information that is scripted beforehand.	*Grab the four largest blocks; Grab a block with a stick; Put the stick in the hole; *Presents action**.	Smit et al. (2021)
2. Positive	Comments that let the learner know that their action was correct.	*Well done; Great job; Yes that one; You saw that correctly!*	Butler et al., (2008); Eppinger et al., 2008); Shute, (2008)
3. Corrective	Comments that lets the child know their action was incorrect (explicit or implicit) and provides them with specific information towards the correct action.	*You don't need those now; Turn them, then it will fit; Look, you need this one *presents block*; Try that one *points**.	Wisniewski et al. (2020); Hattie and Timperley (2007); Nassaji & Kartchava (2017); Li (2018).
4. Suggestive	Comments that alert the learner that there is a problem or an error, that suggest doing something different or to continue, without saying exactly what it is.	*Maybe try something else; Maybe take these two; Try putting them together. Try a different one;*	Blatt et al. (2008); Paas & Van Merrienboer (2007); Tedick & Gortari (1998)
5. Elicitation	A question that emphasises an incorrect action, by giving a clue to the learner about what the teacher misses and leave room for the student to self-correct.	*What can you do with those blocks? Can you try anything else? Is that the right block?*	Panova & Lyster (2002); van Zee & Minstrell (1997); Tedick & Gortari (1998)

To segment the verbalisations of the instructor, a timestamp with the corresponding code was administered when the instructor responded to an action of the child. As long as the content of the response remained similar and the child did not take action in between, it remained the same code. As soon as the content changed, or the child performed an action, a new code should be assigned. An example of two codes in one sentence is: “well done, now grab the other block”, which is first coded as positive feedback (code 2), then as instruction (code 1). The observation instrument with more examples (in Dutch) and further detailed explanations are presented in Appendix 2.

Because beforementioned literature indicated that different types of feedback, have varying effects on performance, three different variables were derived from the coded data.

The first aspect of feedback is positive feedback (i.e. code 2); the second is corrective feedback total (i.e., codes 3, 4, and 5 combined); the third is feedback total (i.e., codes 2 till 5 are combined). The three variables were created by summing the amount of codes received. Therefore, the measurement level was considered as continuous, positive feedback ranged from 0 to 26; corrective feedback from 0 to 28, and the amount of total feedback ranged from 0 to 50. After watching a couple of videos from the teaching strategy 'Demonstration', only instruction (code 1) could be assigned. Since all other codes did not occur, it was decided that this teaching strategy did not contain feedback, eliminating the need to watch the other videos. Subsequently, the 'amount of feedback' was set on zero in this group.

To ensure reliability, two researchers scored the same videos independently, while using the coding scheme of table 1. This interrater reliability resulted in a Cohen's Kappa of .86, $p < .001$, that is considered as "almost perfect" (Landis & Koch, 1977). This pilot contained six videos, which is 10% of the total videos (minus Demonstration), controlled for gender (boys $N = 3$, girls $N = 3$), instructor, teaching strategy (Verbal $N = 2$, Swing $N = 2$ and Contingent $N = 2$) and location (lab $N = 3$, day-care $N = 3$). To further assess whether the instrument is consistent, the main researcher scored the first watched video again, after scoring all videos. This test-retest reliability resulted in a Cohen's Kappa of .71, $p < .001$, which is considered as "substantial" (Landis & Koch, 1977).

Procedure replication research

Active informed consent was sought from the parents prior to the assessment via a questionnaire, after receiving an information letter (see Appendix 3), as the participant was a minor. Because visual footage is used, parents had the option of choosing degrees of anonymity (i.e. blurred face). After randomly assigning the participants to one of the four teaching strategies, they were seen individually and their entire instruction session and post-test was recorded with two camera's on tripods. Even though there were different locations of

the sessions, circumstances were kept as similar as possible (e.g. avoid distraction from toys or other children, position and distance of camera's and puzzling while sitting on the ground).

Upon entry, the participant was allowed to play freely with some simple toys while the researcher interacted with the child's caregiver. When they both seemed relaxed, a questionnaire was given to the caregiver and the participant was introduced to the construction task. This was followed by the instructional phase. The total time of the instructional phase depended on the strategy in which the participant was assigned. In the demonstration strategy, the participant merely watched while the instructor showed how to build the pyramid, which took approximately 3 minutes (M = 03.09, SD = 00.07). In the other three teaching strategy groups, the instructor let the child build the pyramid while they gave instructions. These three groups generally needed more time in the instruction phase; contingent (M = 14.52, SD = 03.26), swing (M = 11.57, SD = 03.33) and verbal (M = 13.24, SD = 04.54). When the researcher and the participant had built the entire pyramid or when the researcher had demonstrated the entire process, the pyramid was taken apart and the post-test began. Here the child was asked to now build the pyramid by themselves, without help. To ensure that the child would continue to work on the task in the post-test for as long as possible, the researcher was allowed to slightly intervene in a few circumstances; 1) when the child specifically asked for help, 2) when the child wanted to leave the situation, 3) when the child showed obvious frustration. After the post-test, a 'thank you gift' was given to the child as reward and the parents received a €20 gift card.

Data analyses

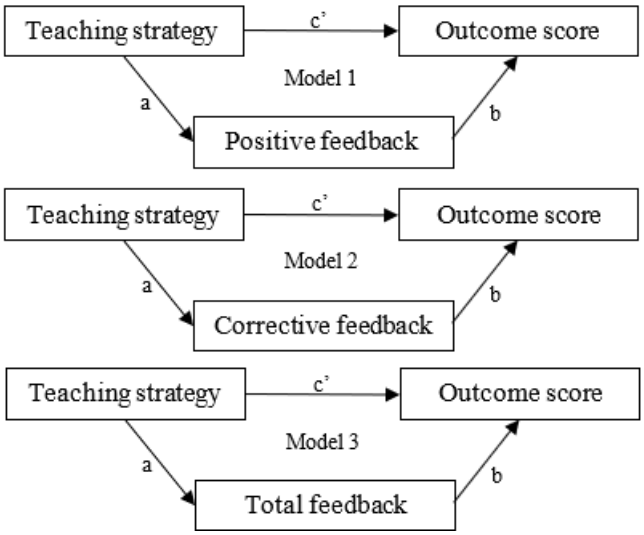
Regarding the first hypothesis, a one-way ANOVA, was conducted in SPSS with the independent categorical variable 'teaching strategy' and the dependent continuous variable 'outcome scores', to determine if there is a significant total effect of type of instruction on performance. Post hoc analyses were run with Tukey, since the number of participants in each

group is equal. The assumption of homogeneity of variance indicated no violation, $F(3,76) = 0.71$, $p = .92$. The Shapiro-Wilk test indicated that the outcome scores were not normally distributed in all teaching strategy groups , $W(20) = .75$, $p < .001$. Although ANOVA is robust to the violation of normality (Blanca et al., 2017), a nonparametric test of Kruskal- Wallis, was run since this test does not assume normality (Kruskal Wallis, 1952).

Regarding the mediation in the second hypothesis, a regression analysis was conducted in SPSS using PROCESS 3.5.3 by Andrew F. Hayes. Via PROCESS, three dummy variables were created for 'teaching strategy' to make pair-wise comparisons with the reference group, resulting in; X1- contingent versus swing; X2- contingent versus verbal; X3- contingent versus demonstration. The mediator was divided in three types of feedback; positive feedback, corrective feedback total and feedback total, which were all at a continuous measurement level. For each mediator, a different regression was conducted, see Figure 2 for the three different models. The assumptions of linearity; no outliers; multicollinearity; homoscedasticity; and normal distribution were checked in advance, and aside from normality, all assumptions were met.

Figure 2

Mediation Models



Note. Path a and path c' are each tested through three dummy variables.

Results

Descriptives

Considering the means in the descriptive statistics in Table 2, it seems that the performance of the children taught by the contingent strategy, was not higher than the other strategies. When looking at these descriptive statistics, the swing strategy group seems to have achieved the highest outcome scores. It is striking that children taught in the verbal strategy show lower performance than the other strategies - but show a higher amount of positive feedback. The following steps will test whether these differences between strategies are significant. As mentioned earlier, the assumption of normal distribution was violated. This is also reflected in the descriptive statistics, since the standard deviation is higher than the mean in the groups; contingent, verbal and demonstration. The descriptive statistics also show variance of amount of instruction amongst the four teaching strategies, showing that the children in the contingent and swing group, received much less instruction than the children in the verbal and demonstration group[1].

Table 2

Descriptive statistics for Outcome Score, Amount of Instruction and Amounts of Feedback, Allocated to the four Teaching Strategies.

	Contingent		Swing		Verbal		Demo		Total			
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*Min*	*Max*
Outcome	8.4	8.8	10.6	8.9	6.65	8.71	7.7	9.1	8.33	8.81	0	20
Instruction	10.10	3.46	8.95	2.39	22.55	6.22	25	25	16.65	8.12	4	35
Positive FB	5.85	3.76	4.75	2.88	14.65	4.67	0	0	6.31	6.25	0	26
Corrective FB	11.15	5.02	6.0	3.4	13.5	6.18	0	0	7.66	6.73	0	28
Total FB	17	5.59	10.75	4.76	28.15	7.58	0	0	13.97	11.49	0	50

Note. FB = Feedback, demo = demonstration, min/max for outcome score is equal over all teaching strategies.

[1] It has to be noted that this study is only one analysis of the video data, with 80 participants chosen from a group of 256. Other master students, with other selected participants, confirm the variation in teachers' behaviour.

Table 3 shows the computed Pearson's correlation coefficients of the variables. Significant positive correlations were found between total feedback and the other two feedback types, which is logical since total feedback is the total sum. There were no correlations amongst the other variables.

Table 3

Correlations between variables

	1.	2.	3.	4.
1. Outcome				
2. Instruction	-.12			
3. Positive feedback	-.10	.14		
4. Corrective feedback	-.14	-.14	.57**	
5. Total feedback	-.14	-.01	.88**	.89**

Note. **Correlation is significant at p <.001

Teaching Strategy and Performance (RQ1)

A one-way ANOVA was run to examine the impact of teaching strategy on outcome scores. The ANOVA analyses shows there is no significant main effect between teaching strategy & outcome score, $F(3.76) = .717$; $p = .545$. The Kruskal- Wallis test also showed no significant effect $p = .396$. Post hoc analyses also showed no significant differences, despite the means of the swing group seemed higher in the descriptive statistics.

Teaching Strategy, Amount of Feedback and Performance (RQ2)

To investigate the second hypothesis regarding the mediating effect of amount of feedback on performance, a mediation analysis was performed using PROCESS. The results will first discuss 'Path *a*' of the mediation for all three models, then 'path *b*' and lastly overall conclusions regarding the mediation effect.

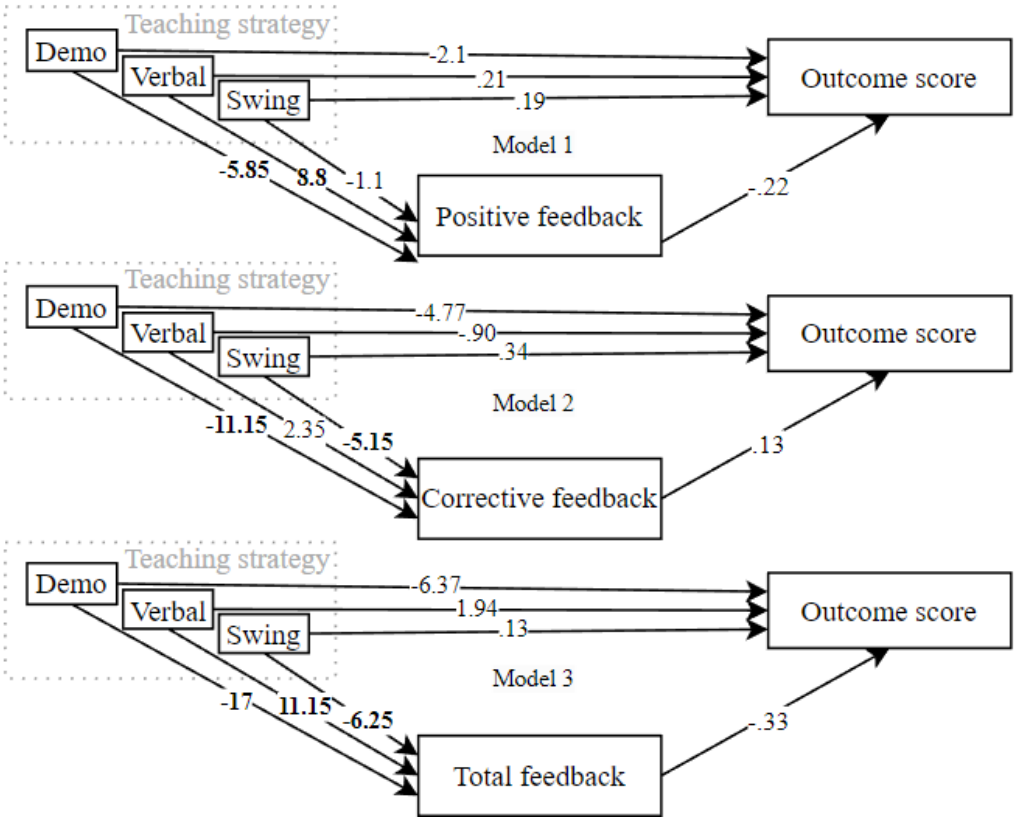
Path *a* of the mediation model shows whether there are significant differences in amount of feedback depending on teaching strategy. For all three models, the differences

highlighted in the descriptive statistics, between the reference group and the other teaching strategies in amount of feedback, were confirmed as significant, as can be seen in figure 3.

Path *b* of the mediation model looks at whether the amount of feedback had an effect on performance. As can be seen in figure 3, there is no statistically significant effect for each of the three models. Model 3 regarding total amount of feedback, was marginally significant (p <.10) b = -.33, $t(75)$ = -1.74, p = .086, which can be interpreted as a marginally significant indirect effect, with the responding bootstrap confidence intervals; 95% CI[0.06, 5.18], CI[-8.05, -.12] and CI[.19,12.30]. Model 1 and 2 did not reveal significant indirect effects.

Figure 3

Results for model 1- positive feedback, model 2-corrective feedback and model 3- total amount of feedback



Note. Reported are the regression coefficients, those in bold are statistically significant *p*-values at $p < .05$. Reference group is contingent.

Discussion

The purpose of this study was to find out if adaptive instruction is as effective as Wood et al. (1978) found, or if the effect of instruction on the performance of three-year-old children could be explained by the received amount of feedback. The first aim was to examine whether there is an effect of teaching strategy on the performance of the children. The second aim was to find out to what extent this effect is mediated by the amount of feedback a child had received in the instructional phase.

Woods claim on adaptive instruction: confirmed?

The first research question examined the effect of instruction on performance. Contrary to previous research of Wood et al. (1978), there was no effect of teaching strategy on the performance of the children. This indicates that adaptive instruction (the contingent strategy) was not found to be more effective than the other instruction types. This is an unexpected outcome as many other studies have also shown the positive effect adaptive instruction (Alwadei et al., 2020; Murphy & Messer, 2000).

Since present study is but one study that does not confirm the effectiveness of adaptive instruction, a possible explanation for the lack of effect could be found in the quality of the delivered instruction. As Wood et al. (1978) mention in their study, it's very hard for instructors to respond appropriately from a 'script' while still fostering a gentle climate, especially in the contingent and swing strategy conditions. Since the instructors in the study of Wood and colleagues were reported to have followed the instructions 70 percent of the time, the instructors of this study probably also showed some deviances. The variation in amount of instruction between strategies, could be an indication of these deviations. This aligns with the unexpected observation, where it seemed that some instructors allowed the children to learn in a more exploratory manner in the contingent group[2]. This means that the instructors gave the

[2] This informal observation was also noticed by all other master students affiliated with this study.

children several attempts to succeed before intervening with instruction or correction. Since this counts as failure of providing the adaptive instruction (according to Wood), this could have hampered the effect of instruction on performance in this study. Which is in line with Neitzel and Stright (2004), who argue that higher levels of adaptiveness is associated with higher performance outcomes, whereas lower levels have less impact on performance. For the ongoing replication research of Smit et al. (2021), a manipulation check will be desirable in order to provide more information about the frequencies of these deviations and their impact on the results.

However, the idea that these deviances in adaptive instruction had such an effect on performance of the children, would make it difficult for teachers who want to apply adaptive instruction in their teaching. Since teachers also have to take into account many other things during instruction (more children, with less 1-on-1 time, more distractions, etc), it would become very difficult to apply adaptive instruction in such a way that it has a proper effect on performance. Altogether, this might call for more research about the effectiveness of adaptive instruction (Hardy et al., 2019; Van de Pol et al., 2010) and the effect of deviances of adaptive instruction, since Dutch teachers are encouraged to used adaptive instruction in classrooms (Inspectie van het onderwijs, 2019).

The role of Feedback on performance

The second research question examined to what extent the effect of instruction on performance could be explained by the amount of feedback. Firstly, it was expected that the teaching strategy would have an effect on the amount of feedback an instructor can give during the instruction phase. For all three models this effect could be confirmed, however, contrary to expectations, children in the contingent strategy did not receive the highest amount of feedback. The children in the verbal strategy, received the most.

The subsequent expectation that the amount of feedback would have a positive effect on performance proved not to be the case. For all three different amounts of feedback, the assumption could not be confirmed. This is an unexpected outcome as many studies have found strong effects of feedback on learning outcomes (Mory, 2004; Sidaway et al., 2012; Sullivan et al., 2008; Thomas & Arnold, 2011). However, as Wisniewski et al. (2020) already mentioned, feedback is a complex construct that includes many aspects. It is possible that one of these aspects influenced the effectiveness of the provided feedback, which could explain the lacking effect of feedback in this study.

Previous findings in empirical studies suggest that for novices, feedback is most effective when provided immediately after the action (Attali & van der Kleij, 2017; Corbett & Anderson, 2001; Johnson et al., 2017; Shute, 2008). As said before, some instructors allowed the children to learn in a more exploratory manner, giving them more attempts to succeed before intervening. Although this may have contributed to the positive and calm atmosphere they aimed to achieve, it resulted in many uncorrected incorrect actions. This may have made the feedback less effective, since it was not provided immediately after the action. When the feedback would be less effective, this could explain why the amount of feedback didn't have a positive effect on performance. In future research, this could be tackled by informing the instructors about the need of instant feedback. However, it needs to be kept in mind that most studies highlighted multiple influential aspects of feedback, so future research should also benefit from including aspects as; timing, specificity of the information and task complexity (Lam et al., 2011; Johnson et al., 2017; Shute, 2008; Wisniewski et al., 2020).

Limitations and future research

It has to be noted that the present study has several limitations. First of all, it could have been that the task chosen by Wood et al. (1978) might not have given a clear indication about the degree of effectiveness of instruction types. Since there is no increasing difficulty in

the task, children who understood it were likely to complete the whole task successfully but the children who did not understand quite so well often stagnated during the first layer. This was noticeable through the absence of normal distribution of outcome scores, where the scores seemed almost dichotomous; not succeeded versus succeeded. As a result, there is no middle ground, so 'somewhat effective instruction' is not an option with this task. Since, there was also no information about the validity of this task (and so its outcome scores), it would therefore be desirable to perform a conceptual replication, with a different (construction) task.

Secondly, as Wood et al. (1978) already pointed out, this study was done in a controlled setting. When the timing or commitment to the instruction is altered (i.e. learning in a noisy classroom), the different instruction types are likely to have different effects. Therefore, for these results to be more generalisable, and for possible other influences to be tested, more experimental studies should be done in different circumstances.

Thirdly, despite that the researcher of the present study conducted a lot of research on feedback prior to the development of the instrument, it is possible that the way feedback was operationalised may have had an effect on its findings. For instance, there is a lot of information on different types of feedback, all of which seem to have a different impact on effectiveness (Hattie & Timperley, 2007; Wisniewski et al., 2020). Future research could perhaps test whether different operationalisation of feedback, show different results.

Lastly, the present study did not examine whether the manipulations of the instruction types were correctly applied by the instructors. Thus, as indicated earlier, a manipulation check would have been desirable to check to what extent the instructors adhered to their script. Information about possible deviances, will allow for more information about the validity of the results.

Implications

As this is only one (master's thesis) study, the practical implications for the research field are not vastly substantial. However, this study did give an indication that, contrary to the findings of Wood et al. (1978), that teaching strategy may not have as much of an effect on performance in three-year-olds as was first suspected[3]. Should other studies in the future also come to this conclusion, this might have implications for teachers dealing with children of this age. This could mean that teachers should not immediately trust that adaptive instruction is always the best option for getting the best results. In addition, it should also be taken into account that the degree of adaptiveness, may have an effect on the effectiveness of adaptive instruction (Neitzel & Stright, 2004). And that teachers who choose adaptive instruction should be very aware of their adjustments to the child's level. Secondly, it is interesting that while there were few differences in performance, instructional time via Demonstration was considerably shorter compared to the other three types of instruction. As Wood et al. (1978) already mentioned, this may also be useful for teachers, who need to achieve results in a shorter time and with a larger audience.

Considering implications about the effect of amount of feedback, this study suggests that the amount of feedback is not the key element that can explain Woods and colleagues (1978) found variances in performance. Despite beforementioned empirical research have shown that children who received more feedback performed better, this could not be found in the present study. Should these results hold in future research, this would be interesting for educational practices as it raises the question, what is then the key-element? For example, should teachers then have to focus much more on other important aspects of feedback, such as timing and content, and thus be more aware of their verbalisations?

[3] The other master's students affiliated with the ongoing replication study of Smit et al. (2021) were also unable to find any effect of instructional types on performance.

Altogether, this study underscores the importance of replication research, as, contrary to expectations, no significant results have emerged. The absence of the impact of adaptive instruction on performance goes against Wood and colleagues' (1978) claims and additional literature on the effectiveness of adaptive instruction. Due to this discrepancy (while keeping in mind the limitations of present study), it is important that future research revisits the effectiveness of adaptive instruction via conceptual replication, as well as the influence of feedback within such instruction. In this way, empirical research can ensure that knowledge on how teachers can deliver instruction most effectively, is expanded.

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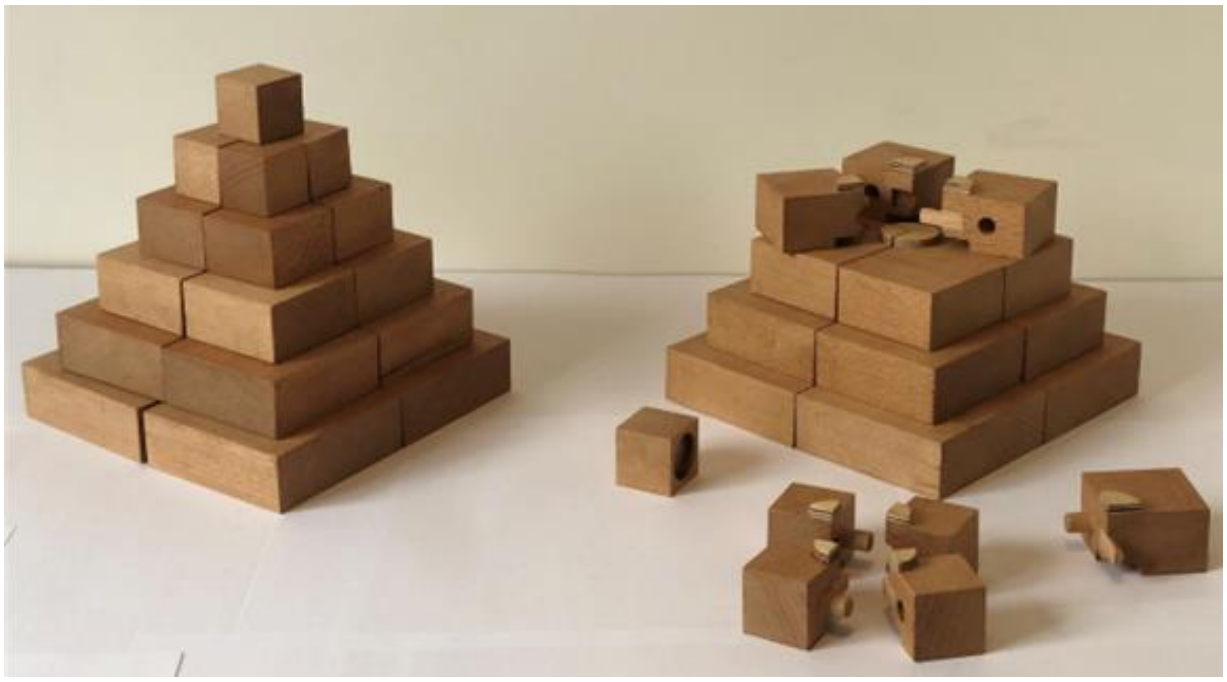
Appendix 1 – Task information



First layer:

1. Making a pair
2. Making second pair
3. Making layer

Second layer:

4. Making a pair
5. Making second pair
6. Making layer
7. Stacking layer

Third layer:

8. Making a pair
9. Making second pair
10. Making layer
11. Stacking layer

Forth layer:

12. Making a pair
13. Making second pair
14. Making layer
15. Stacking layer

Fifth layer:

16. Making a pair
17. Making second pair
18. Making layer
19. Stacking layer

Sixth layer:

20. Placing last block

Appendix 2 –Observation Instrument

Code	Definition	Examples
1. Instruction	Providing new, specific information that is scripted beforehand.	*Pak maar een blokje; Pak maar de vier grootste blokken; Pak maar een blokje met een stokje; Doe het stokje in het gaatje; Pak nog een blokje: draai het blokje om (als er nog niet gespeelt is met het blokje); Doe deze blokjes weer aan de andere blokjes; Nu leg je deze blokjes bovenop de toren; Leg deze blokken bovenop de toren; Pak nu alle blokjes met een taartpuntje; Nu pak je het laatste blokje. Dit blokje leg je met het rondje naar beneden bovenop de toren; Je hebt een laag gemaakt; Leg deze laag op die laag; *Doet hele actie voor*.*
Feedback		
2. Positive	Comments that let the learner know that their action was correct.	*Goed gedaan, Knap hoor, Het is gelukt, Top! Wat ga jij goed! Ja, kijk eens aan! Ja die ja; Dat heb jij goed gezien.*
3. Corrective	Comments that lets the child know their action was incorrect (explicit or implicit) and provides them with specific information towards the correct action.	*Leg die blokjes maar even aan kant; Die heb je nu niet nodig; Pak maar een groter blokje dan deze; Dat blokje is nog te klein; Draai ze maar, dan past het wel; Nee niet die; kijk, deze heb je nodig; hee kijk eens *doet voor*; Probeer díe *wijst* eens.*
4. Suggestive	Comments that alert the learner that there is a problem or an error, that suggest doing something different or to continue, without saying exactly what it is.	*Misschien moet je iets anders proberen; Blijf proberen; Misschien zijn die een beetje te klein; Misschien moet je deze twee nemen; Probeer ze samen te voegen. Probeer eens een andere;*
5. Elicitation	A question that emphasises an incorrect action, by giving a clue to the learner about what the teacher misses and leave room for the student to self-correct.	*Wat kun je doen met die blokjes? Heb je ook nog een blokje met een stokje? Heb je ook nog een blokje met een gaatje? Kun je nog iets anders proberen?*

You watch the child's actions. Once the trial leader responds verbally to an action of the child, you determine whether the verbal response is instruction or feedback. You assign the code after the trial leader has conveyed his message, this is usually in one sentence, after which the child engages or responds. If this is a longer explanation, but the content is still about the same and the child has done no action in between, it appears to be the same code. It can also happen that after a correct action of the child, an instructor first compliments (code 2) and then immediately continues with a new instruction (code 1). Since these are then two different messages, two different codes are also assigned.

An instruction (code 1) is often given to a child if the preceding action is correct. After this, the child is given a new instruction. One instruction (code 1) has the same message. With

each new message, a new code is assigned. Examples of instructional phrases that instructors agreed on beforehand are indicated. These are often specific.

A demonstration can also be instruction, when the action provides new information and is not to correct a prior incorrect action is by the child. A test leader may follow the instruction directly with a question. The child has then not shown a new action in between. After asking an instructor, it turned out that she does this to set the child in motion. So we don't see this as an elicitation. In fact, it hardly ever happens that a new instruction is given after an incorrect action, unless the child was so distracted that the instructor felt it necessary to start the explanation all over again. When the child is distracted by something in the environment and the instructor makes comments to direct the child back to the task, is not instruction on the task, but instruction on behaviour, we do not include this.

Feedback can be divided into four groups. First, positive feedback, which follows a correct action by the child. Directions on where the child should sit (and so the positive feedback they get for this) does not count, as these are not on-task.

The other three types of feedback follow after an incorrect action. The main difference between corrective and suggestive, is how the error is corrected. Corrective feedback gives more specific information on how to improve the action, while suggestive feedback actually gives a hint. Corrective feedback can sometimes be given several times in a row because the child does not understand a certain action. If the child doesn’t perform a wrong action in between, this is seen as one correction, example; 'you have to turn the block around, otherwise it won't fit', 'just put the block upright and then that side belongs at the bottom'. In case of: 'no, that's the wrong side, push it the other way', the child has performed a wrong action and is thus a new correction. The biggest difference between suggestive feedback and elicitation is that elicitation always ends with a question mark.

The condition 'Swing' is difficult to code because the verbal instruction the instructors are allowed to give is from level 1. This is quickly worded suggestively by the instructors. The demonstration instruction also quickly appears corrective. So in this condition, it is very important for the coder to consider whether the instruction brings completely new information (instruction code 1) or whether it is a response that is a continuation of a previous action (suggestive or corrective).

The instructors were practised and instructed not to use negative language. So comments like 'you are doing this wrong' should not occur. So there is no code for this. If a comment does not fit one of the 5 codes, there is no need to assign a code to it. This occurs, for example, for small talk.

Appendix 3 – Information letter

Beste ouder/verzorger,

Elk kind is anders. Daarom is het belangrijk dat kinderen de hulp krijgen die ze nodig hebben. In het onderwijs (bijvoorbeeld op de voorschool of de basisschool) maar ook bij het spelen thuis en op het kinderdagverblijf wordt vaak aangenomen dat de hulp die een kind krijgt moet afhangen van het niveau van het kind. Maar of dat echt zo is weten we niet zeker. De Universiteit Utrecht doet hier onderzoek naar, in samenwerking met de Universiteit van Amsterdam.

WAT IS HET DOEL VAN HET ONDERZOEK?

In dit onderzoek kijken we naar het effect van verschillende soorten hulp bij een puzzeltaak. In deze brief willen we u informeren over het onderzoek.

WIE KUNNEN ER MEE DOEN?

Kinderen van **3 jaar**, zonder ontwikkelingsstoornis, waarvan minimaal één van de ouders Nederlands als moedertaal heeft en spreekt met het kind.

WANNEER WORDT HET ONDERZOEK GEDAAN?

Het onderzoek vindt plaats in de periode **oktober 2021- maart 2022.**

WAT HOUDT DEELNAME IN?

U vult een vragenlijst in en uw kind maakt een puzzel. Na afloop krijgt uw kind een klein cadeautje en krijgt u een cadeaubon van 20 euro.

De sessie ziet er als volgt uit:

1. Uw kind gaat eerst even spelen.
2. Daarna maakt uw kind de puzzel samen met een onderzoeker.

Na de instructie probeert uw kind de puzzel nog een keer zelf, zonder hulp. Tijdens het puzzelen worden video- en geluidsopnames gemaakt van uw kind en van de onderzoeker.

WAAR WORDT HET ONDERZOEK GEDAAN?

Er zijn twee mogelijkheden:

1. U komt met uw zoon/dochter naar het Educatie lab van de Universiteit Utrecht (Martinus J. Langeveldgebouw, Heidelberglaan 1. Utrecht) of naar het Family lab van de Universiteit van Amsterdam (Roeterseiland).
2. Het onderzoek vindt plaats op de kinderopvang

In beide gevallen zullen de geldende corona-maatregelen in acht genomen worden.

PRAKTISCHE ZAKEN

- U krijgt voor het meedoen een **cadeaubon van €20**.
- Uw kind krijgt na afloop van de sessie een klein cadeautje.
- Indien nodig/gewenst, ontvangt u reiskostenvergoeding voor de bezoeken aan de universiteit.
- De hierboven genoemde vergoeding worden ook uitgereikt als – om wat voor reden dan ook – het kind of de ouder de sessie niet kan of wil afmaken.

PRIVACY EN VERTROUWELIJKHEID

Tijdens dit onderzoek worden video- en geluidsopnames gemaakt. Voorafgaand aan het onderzoek vult u een digitale vragenlijst in waarin naar een aantal algemene gegevens gevraagd wordt van u en het kind (bv.geboortedatum kind, sekse kind, postcode, taal/talen die thuis gesproken worden, afgeronde opleidingen) en waar u een vragen zult beantwoorden (bv. over het temperament van het kind en het type speelgoed dat u thuis heeft). Dit onderzoek is goedgekeurd door de Ethische Commissie van de Faculteit Sociale Wetenschappen van de Universiteit Utrecht. De privacyverklaring van de UU vindt u hier: https://www.uu.nl/organisatie/praktische-zaken/privacy/privacyverklaring.

U kunt van tevoren keuzes maken m.b.t. het gebruik van de data. **In álle gevallen zullen gegevens die kunnen leiden tot het identificeren van individuen worden verwijderd uit alle data**.

HOE KAN IK WELKE PRIVACY-RECHTEN UITOEFENEN?

U hebt het recht een kopie op te vragen van alle persoonsgegevens die we van uw kind hebben gebruikt voor dit onderzoek en het recht om te verzoeken deze te corrigeren bij onjuistheid. Verder hebt u het recht om bezwaar te maken tegen de verwerking van de gegevens van uw kind en heb u het recht op gegevensoverdraagbaarheid. Daarnaast hebt u ook het recht op gegevenswissing. We zullen uw verzoek altijd serieus nemen, maar niet al deze privacy-rechten gelden voor iedere situatie en voor alle gegevens. We zullen natuurlijk duidelijk communiceren waarom we een verzoek in uw geval wel of niet kunnen uitvoeren.

Verder hebt u ook het recht om uw toestemming voor het verwerken van de persoonsgegevens van uw kind in te trekken. Mocht u de toestemming intrekken, dan zullen we direct stoppen met het verwerken van de persoonsgegevens van uw kind. Analyses die we tot dat moment hebben gemaakt met uw persoonsgegevens zullen we wel blijven gebruiken voor ons onderzoek.

U kunt uw privacy-rechten uitoefenen door contact op te nemen met privacy@uu.nl. Wanneer u algemene vragen -of klachten hebt over dit onderzoek, neem dan ook vooral contact via dit e-mailadres. Mochten we er samen niet uitkomen, dan hebt u altijd de mogelijkheid een klacht in te dienen bij de toezichthoudende autoriteit: klachtenfunctionaris-fetcsocwet@uu.nl.

U ontvangt per mail een link van Gorilla Survey tool met deze brief en de vragen op de volgende bladzijde. Via het digitale formulier geeft u vrijwillig toestemming om de gegevens van uw kind te gebruiken voor ons onderzoek en dat u begrijpt dat u ieder moment kunt stoppen met het onderzoek door te mailen naar puzzeltaak@uu.nl . Als u vragen heeft over het onderzoek kunt u contact opnemen met Nienke Smit (n.smit@uu.nl).

Met vriendelijke groet, namens het onderzoeksteam,

dr. Nienke Smit, onderzoeker Universiteit Utrecht
dr. Janneke van de Pol, universitair hoofddocent Universiteit Utrecht
dr. Renske de Kleijn, universitair docent Universitair Medisch

Centrum Utrecht Prof. dr. Monique Volman, hoogleraar
Universiteit van Amsterdam

GEÏNFORMEERDE TOESTEMMING

Door de vakjes aan te vinken geeft u uitdrukkelijke toestemming:

1. **Audio/Video voor dit onderzoek**

Ik geef toestemming voor het maken van audiovisuele opnames van mijn kind gedurende het onderzoek en ik geef toestemming dat de antwoorden van mijn kind getranscribeerd worden voor het onderzoek. ☐

2. **Vragenlijst gegevens**

Ik geef de onderzoekers die meewerken aan dit project toestemming voor het gebruik van geanonimiseerde algemene gegevens. ☐

3. **Gebruik van data voor overige onderzoeksdoeleinden**

De volgende vraag gaat over het gebruik van uw data voor ander wetenschappelijk onderzoek.
U kunt ook deelnemen als u ervoor kiest om **geen** toestemming te geven voor onderstaande opties. Ik geef toestemming voor...

☐ het gebruik van geanonimiseerde videobeelden en geanonimiseerde algemene gegevens voor andere onderzoeksdoeleinden door andere onderzoekers. De geanonimiseerde data zal worden opgeslagen in een beveiligde database die alleen toegankelijk is voor onderzoekers die werken aan een universiteit

☐ het gebruik van de geanonimiseerde gecodeerde videodata en geanonimiseerde algemene gegevens voor andere onderzoeksdoeleinden door andere onderzoekers. De videobeelden zelf worden niet opgeslagen op de beveiligde database maar wel de codes die we hebben toegekend bij het analyseren van de videobeelden

☐ Ik geef geen toestemming voor overige onderzoeksdoeleinden

Voornaam en achternaam ouder: _____

Voornaam en achternaam kind: _____

Geboortedatum kind: _____

Handtekening ouder: _____

Datum van vandaag: _____

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