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Combining bimodal presentation schemes and buzz groups improves clinical reasoning and learning at morning report

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Abstract

Morning reports offer opportunities for intensive work-based learning. In this controlled study, we measured learning processes and outcomes with the report of paediatric emergency room patients. Twelve specialists and 12 residents were randomised into four groups and discussed the same two paediatric cases. The groups differed in their presentation modality (verbal only vs. verbal + text) and the use of buzz groups (with vs. without). The verbal interactions were analysed for clinical reasoning processes. Perceptions of learning and judgment of learning were reported in a questionnaire. Diagnostic accuracy was assessed by a 20-item multiple-choice test. Combined bimodal presentation and buzz groups increased the odds ratio of clinical reasoning to occur in the discussion of cases by a factor of 1.90 ($p = 0.013$), indicating superior reasoning for buzz groups working with bimodal materials. For specialists, a positive effect of bimodal presentation was found on perceptions of learning ($p < 0.05$), and for residents, a positive effect of buzz groups was found on judgment of learning ($p < 0.005$). A positive effect of bimodal presentation on diagnostic accuracy was noted in the specialists ($p < 0.05$). Combined bimodal presentation and buzz group discussion of emergency cases improves clinicians' clinical reasoning and learning.

Background

Admissions to clinical departments are often reported at morning report, a major educational and patient care-related activity in teaching hospitals (Gross et al. 1999; Amin et al. 2000; Hougtalen et al. 2002; Klaber & Macdougall 2009; Walton & Steinert 2010; McNeill et al. 2013). Morning report is a decision-dense, work-based learning environment, diagnostic uncertainty is common, and opportunities to practice and compare clinical reasoning are frequent. As an educational tool, however, morning report is challenging to define, and its outcomes are difficult to measure (McNeill et al. 2013). Learning needs among the participating clinicians are diverse, as they range in experience from novices (medical students) to intermediates (residents) and experts (specialists). When defining a learning theory framework for teaching and learning at morning report, the concept of cognitive apprenticeship is relevant (Collins 2006; Schumacher 2013). Cognitive apprenticeship emphasises a number of teaching and learning methods, including modelling, coaching and scaffolding. Inherently, interaction between learners and teachers is important and has the greatest impact when learners have adequate time and the curriculum permits continuity and sequenced challenges. Although morning report may indeed offer opportunities for intensive, interactive, work-based and sequenced learning from authentic cases, these learning opportunities are often neglected or unused (Walton & Steinert 2010). We suggest that this is at least partly because little empiric research has been done on the teaching and learning involved at morning report (Walton & Steinert 2010; McNeill et al. 2013).

Practice points

- Structure of morning report is important for the quality of clinical reasoning and learning.
- Bimodal presentation of selected cases combined with activation of all the participants in buzz groups increases the quality of clinical reasoning at morning report.
- Continued focus on residents' self-directed learning, coaching and modelling by specialists is required.

Morning report and elaboration and guidance of clinical reasoning

According to the cognitive apprenticeship learning theory, such research should include a focus not only on learning outcomes but also on the processes of learning (Collins 2006). Therefore, an emphasis on development of medical expertise is highly relevant. We know that medical expertise develops by integration of knowledge into illness scripts, i.e.

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cognitive entities containing clinically relevant information (Schmidt & Rikers 2007). This integration occurs with extensive and repeated application of knowledge during exposure to real patient problems (Schmidt & Rikers 2007). Knowledge about pathophysiology is gradually encapsulated within the script, and the number of scripts grows with experience. Much time should therefore be spent on having learners reflect and elaborate on patients (Schmidt & Rikers 2007). Time spent at morning report talking over cases is a valuable investment that can enhance encapsulation, illness script formation and diagnostic accuracy. In addition, research should take into account cognitive load theory (van Merriënboer & Sweller 2005), as inappropriate presentation of patients or just too many complex patients may overload working memory and hamper performance and learning. With the addition of a written presentation scheme, a simple intervention like bimodal presentation could help learners counteract this problem by using two channels, i.e. verbal and visual, instead of verbal only (van Merriënboer & Sweller 2005).

Recent research suggests that in contextual, authentic learning there is a need to guide not only clinical reasoning, but also visual search and attention (Jarodzka et al. 2012). Knowledge on visual skills is now available from eye-tracking studies performed in radiology and paediatrics, (Krupinski et al. 2006; Kok et al. 2012; Balslev et al. 2012) and it appears that viewing behaviour of newcomers in a specialty is strongly determined by stimulus characteristics. Viewing behaviour steered by salience of stimuli is called bottom-up behaviour (Itti & Koch 2001). When cognitive relevance guides visual search, as is the case with experts, this is called top-down behaviour (Yarbus 1967; DeAngulus & Pelz 2009). This line of research also supports the use of a scheme for presentation of cases to help learners attend to and process key aspects of the case.

From the problem-solving literature, it is well known that novice learners characteristically work backwards from a goal. That is, they focus on the goal and try to find means that could help them to reach this goal, a phenomenon that is also found in visual domains (van Meeuwen et al. 2014). In contrast, experts, who possess useful schemes or scripts, typically work forward from relevant, activated illness scripts towards the goal (van Meeuwen et al. 2014). There are thus a large number of lines of research to support the use of a scheme for presentation of cases to help learners attend to and process key aspects of the case. To help learners work more like experts by deliberately practicing a top-down, forward approach to cases, a bimodal presentation scheme for stepwise, daily presentation of single emergency cases was developed in paediatric departments in Denmark. The presentation scheme, named "Today's Case" (TDC), is thus designed to help the reporting residents extract the most important information from the case and present it in an organised way. TDC is also designed to enhance elaboration of clinical reasoning processes, and in this way help learners create new scripts. Although TDC may also include authentic clinical pictures or video recordings, such imaging is not tested in the present study.

Improving clinical reasoning and learning by bimodal presentation schemes and buzz groups

Clinical reasoning is the argumentation clinicians use while diagnosing clinical cases and we are very interested in this type of expertise as a process marker of learning. The aim of our research was to measure how different types of support affect participants' quality of clinical reasoning.

Clinical reasoning can be improved by scaffolding. Scaffolding offers the learner opportunities to practice while the teacher gradually fades his/her support (Puntambekar & Hübscher 2005; Morris & Blaney 2010; Belland 2014). We thus believe that the provision of a simple scheme with oral and written information, i.e. bimodal presentation, which is revealed with a stepwise, top-down and forward approach, will help learners deal with key aspects of a clinical case. Scaffolding can also be related to the interaction among participants that is involved in sharing of cognition (Lebeau 1998; Balslev et al. 2009), an essential feature of collaborative learning from clinical encounters. A large group can be divided into smaller groups for a short period of time to increase interaction (Cantillon 2003; Jaques 2003). These are named buzz-groups after the sound they produce when pairs actively exchange arguments (Jaques 2003). In buzz-group pairs, scaffolding can be instantaneously adapted to the levels of expertise and prior knowledge of the two clinicians (Puntambekar & Hübscher 2005). The interaction of bimodal presentation with "buzzing" is particularly interesting. Instead of having to hold all the verbal information in working memory, participants in the buzz groups are helped by the visually available, written information (van Merriënboer & Sweller 2005).

Diagnostic accuracy can be used as a dependent variable for learning outcome, because diagnostic accuracy is a marker for expertise. Self-assessment of learning on the other hand, is a complicated, multipurpose and a context-dependent phenomenon (Eva & Regehr 2005; Bjork et al. 2013). In the context of morning report, we believe that two perspectives are important: how much participants think they learned from an activity (perception of learning), and their prediction of how well they will perform in a diagnostic accuracy test afterwards: judgment of learning.

Development of hypotheses

Compared to a standard situation with oral presentation of a case without planned interaction, we added: (1) bimodal presentation of Today's Case, or (2) buzz groups with one-to-one interactive, collaborative analysis. Above all, we expected that clinical reasoning would improve with the combination of bimodal presentation with buzz group, as the interaction in the buzz groups would be greatly helped by the written information available throughout the discussion. We also anticipated that the perception of learning might improve with use of a bimodal presentation scheme and buzz groups. We expected judgment of learning, i.e. the predicted future performance, to be better with residents working in buzz groups due to the saliency of the cognitive apprenticeship model in one-to-one buzz group discussions. We expected that the diagnostic accuracy would be enhanced if a written case was available and work was done with the help of buzz groups.

We hypothesised:

(1) The combination of a bimodal presentation scheme and buzz groups yield positive interaction effects on the quality of clinical reasoning.
(2) The perception of learning improves with use of a bimodal presentation scheme and buzz groups.
(3) The judgment of learning improves with use of a bimodal presentation scheme and buzz groups.
(4) Diagnostic accuracy improves with use of a bimodal presentation scheme and buzz groups.

Methods

Setting and participants

For this study, a small scale version of morning report with controlled research circumstances was developed. A total of 24 clinicians, i.e. 12 specialists (mean duration of paediatric experience: 18.1 years) and 12 residents (mean duration of paediatric experience: 1.3 years) from 5 paediatric departments participated.

Today's case

We designed a presentation scheme for the reporting of selected single emergency room patients, TDC; see Figure 1. TDC was deliberately designed to help participants deal with key aspects of the history first, i.e. to apply a top-down, forward approach.

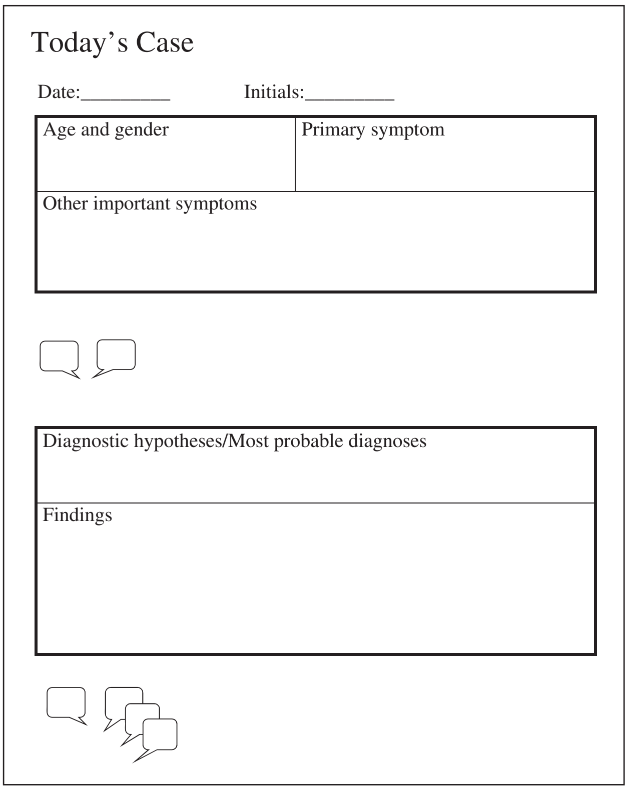

Figure 1. Today's case.

In section A, visual information such as age, gender, primary symptom and other important symptoms were presented in writing and mentioned verbally, whereas section B was not revealed until later. The case selected should possess some diagnostic ambiguity so that extensive clinical reasoning processes might be stimulated. The resident asked for collaborative clinical reasoning in pairs ("buzz groups"). When discussion came to an end, the resident asked for comments from a few participants. In section B, the findings were revealed. A group discussion of findings and most probable diagnosis (after examination) then took place. Finally, one or two of the specialists commented on the case. Icons in the scheme indicated the formats of the discussion.

Two authentic cases were presented verbally. Case 1 had respiratory problems due to a haemangioma in the trachea. Case 2 had seizures signalling benign autonomic epilepsy (Panayiotopoulos syndrome). The cases were expected to be diagnostically challenging to the residents, while the specialists were expected to be able to recognise the key information and to make a correct diagnosis. Case 1 was presented first and analysed, then case 2. To ensure that the content of the discussion was similar, each group analysed the same two cases. To prevent dissemination of content, groups worked on the same day.

Instruments and measures

The clinical reasoning processes in the entire verbal interaction during analysis of cases were assessed by a coding system (Hassebrock & Prietula 1992) adapted by de Grave et al. (1996). The system provides an instrument for the categorisation of cognitive processes appearing during problem analysis by groups. As this study focuses on the development of expertise by improved development of illness scripts, then enhanced theory building, theory evaluation and metareasoning are desirable (Balslev et al. 2012). On the other hand, we know that data exploration is used less with increased duration of postgraduate expertise. All verbal clauses were scored as data exploration, building of hypotheses, evaluation of hypotheses and metareasoning (Table 1) and reported in frequency tables.

The quality of clinical reasoning was assumed to be indicated by an increase of the relative frequency of clauses labelled as "building of hypotheses", "evaluation of hypotheses" or "metareasoning" versus clauses labelled as "data exploration". Hence, for the analysis regarding hypothesis 1 the categorization of clauses was transformed into a binary scheme: clinical reasoning clauses versus other clauses.

Learning outcomes were evaluated by a questionnaire and by a diagnostic accuracy test. One item tested perception of learning from the session on a 10-point Likert scale, (0: I did not learn anything new; 9: I learned very much new). One item tested prediction of performance on the subsequent diagnostic accuracy test (judgment of learning) (Bjork et al. 2013): We simply asked "As a test, you will receive 20 cases that must be diagnosed. How many of them do you expect to diagnose correctly?" The diagnostic accuracy was tested by a 20-item MCQ test. The test was constructed by a specialist in

Table 1. Coding system for clauses in the protocols of verbal interaction during problem analysis.

Task level
2.1 Data exploration: problem definition; reference to the information in the case; identification; structuring; integrating and initial interpretation of information; signalling lacking data *''When did it start?''* *''How old is he?''* *''He has two haemangiomas on the skin''*
2.2 Theory building: causal reasoning; hypothesis; associations' specification; generalisation. *''It could be asthma''* *''I think he has a haemangioma in the trachea''*
2.3 Theory evaluation: confirming evaluation; non-confirming evaluation, evaluation about certainty. *''Yes, you are right''* *''No, he is too old to have laryngomalacia''*
2.4 Metareasoning: reflecting on prior knowledge, reflecting on the learning process, reflecting on strategy of thinking *''This is how I think''* *''There may be different views on that''*

Representative examples are presented in italics.

paediatrics (TB) and two trainees (ABR and TS). It was designed to test diagnostic accuracy in airway obstruction in infants (case 1) and in seizures in children (case 2). Correct diagnoses were established beforehand by two expert paediatricians. The test results were scored by two researchers. The diagnostic accuracy test score was the frequency of correctly diagnosed cases.

Procedures

This was a randomised controlled study with post-test only. We provided an identical verbal stepwise presentation of patient cases to all four conditions.

We applied bimodal presentation, because human working memory has a visual as well as an auditory component that are largely independent of each other. Using both components would increase working memory capacity, with positive effects on learning. TDC ensures participants' bimodal presentation, as the participants are always able to listen to the verbal presentation, and they have a written version available. The scheme was projected onto a screen visible to the participants. Thus, participants were always able to re-read and re-evaluate information given a few seconds before. We applied buzz groups to increase the interaction among the participants. We used the ideal scaffolding modality: one-to-one scaffolding. One-to-one scaffolding occurs in buzz groups, and mechanisms include questioning, feedback, indication of important problem elements and expert modelling (Belland 2014). Bimodal presentation and buzz groups were combined in a full factorial design (Figure 2).

Specialists and residents were allocated randomly to basic, buzz, bimodal or the buzz + bimodal groups. The groups consisting of three experts and three non-experts showed no significant differences in terms of duration of paediatric experience. In groups buzz and buzz + bimodal, pairs of one specialist and one resident were randomly formed and discussed cases prior to the discussion in the larger group.

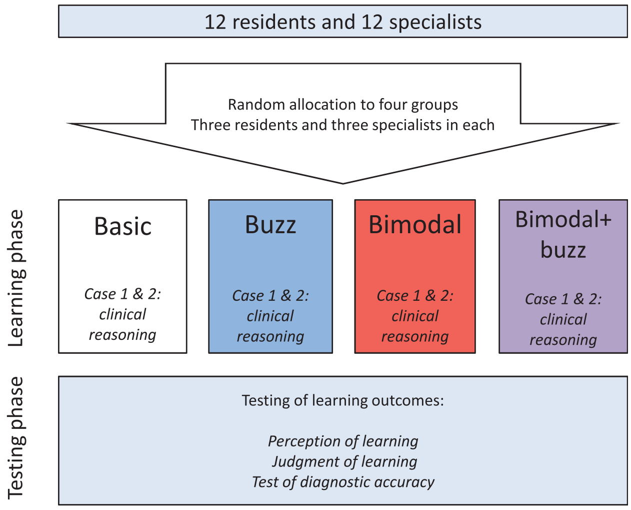

Figure 2. This flow diagram summarizes the one-day study process.

In groups basic and bimodal, buzz group discussion was omitted. Informed, written consent was obtained from all participants. The procedure was verbally and graphically explained to each group to ensure that participants were familiar with the setup. Participants were instructed to discuss information in such a way, that the residents verbalised their thoughts first. Immediately after the learning phase, participants filled in a questionnaire.

Data collection and analysis

The verbal interaction from the beginning to the end of the analysis of cases, including the interactions in buzz group discussions, was recorded on multiple audio recorders to ensure pick-up of all that was said and subsequently transcribed verbatim. When no new hypotheses or diagnoses appeared, audio recording was terminated.

Inter-rater reliability of categorisation of clinical reasoning clauses was determined by generalisability analysis. Four random samples of clauses, one from each of the groups, were independently labelled by two raters. For the pooled set of 189 clauses, 16 % of all clauses, the generalisability coefficient G was calculated as an indicator of the inter-rater reliability (Brennan 2001). The coefficient G is defined

$$G = \frac{\sigma_c^2}{\sigma_c^2 + \frac{\sigma_{c\times r}^2}{n_r}}$$

where σ_c^2 is the variance of the 0–1 label clinical reasoning over clauses (the variance of interest), $\sigma_{c\times r}^2$ the variance of the interaction of clauses and raters (representing the disagreement between the raters), and n_r the number of raters. Variance components σ_c^2, and $\sigma_{c\times r}^2$ were estimated by variance analysis of the data in the sample of clauses labelled by two raters. Then, using the equation above, the expected reliability G could be calculated for any number of raters n_r. For a single rater ($n_r = 1$) coefficient G was found to be equal to 0.77. As this indicates a sufficient level of reliability, (Streiner & Norman 2008) it was decided to use the labelling results obtained with a single rater.

Table 2. Effects of bimodal presentation, buzz groups and their interaction on the odds of a clause in the discussion to be a clinical reasoning clause (analysis: logistic regression, DF = 1).

Independent variables		Odds ratio	Lower[a]	Upper	Significance (one-sided *p*)
Constant		1.40	–	–	–
Main effect	Bimodal presentation	1.23	0.83	1.83	$p = 0.30$ (NS)
Main effect	Buzz groups	0.95	0.65	1.40	$p = 0.80$ (NS)
Interaction	Bimodal presentation + buzz groups	1.90	1.15	3.15	$p < 0.013$

[a]Lower and Upper refer to the boundaries of the 95% confidence interval for the odds ratio.

Analyses

For hypothesis 1, the occurrence of clinical reasoning in the discussions was investigated by analysing the odds of a clause to be a clinical reasoning clause. For such a binary-dependent variable a logistic regression is appropriate to estimate the effects of several factors and their interaction(s). For our set-up this implies that the log odds of clinical reasoning, i.e. log (frequency of clinical reasoning clauses/frequency of other clauses) are explained by the sum of three terms: the main effects of the independent variables bimodal presentation scheme and buzz groups, and their interaction effect. The unit of analysis was clauses in the transcripts.

For hypotheses 2 and 3, a full factorial two-way ANOVA was performed with presentation scheme and buzz groups (and their interaction) as factors for perceived learning, judgment of learning and diagnostic accuracy. Mann–Whitney tests were also done. The unit of analysis was the participants. For all statistical tests, a significance level of 0.05 was used.

Participation was voluntary. Ethical approval was sought through the regional Danish Ethical Committee, and according to Danish regulations, the study was exempted from formal ethical approval. Strategic funds for postgraduate educational activities from the Faculty of Health, Aarhus University.

Results

Age and duration of paediatric training for participants was comparable among basic, buzz, bimodal and buzz-bimodal groups. The mean time for analyses of cases was comparable at 9.1, 10.5, 14.3 and 12.6 min, respectively. Duration of buzz groups was 2.4 min (range 2.2–2.5).

Table 2 shows the results of the logistic regression in terms of the odds of clinical reasoning clauses to occur in the discussions. The constant 1.4 represents the odds for the group without bimodal presentation and buzz groups. For the group with bimodal presentation only the odds changed with a factor 1.23 (resulting odds: 1.4×1.23), and for the group with buzz groups only they changed with 0.95 (resulting odds: 1.4×0.95), however, both effects were found to be non-significant. As expected, the combined use of bimodal presentation and buzz groups caused a significant interaction effect, increasing the odds for the corresponding group by a factor of 1.9 ($p = 0.013$) from 1.4 to 2.7; see Table 2 and Figure 3.

This study shows that a combined bimodal presentation and buzz group discussion of emergency cases improves participants' clinical reasoning during morning report. These results suggest that participants are able to reason like experts if they have a bimodal presentation available when active in buzz groups. This combined approach results in enhanced clinical reasoning. Our first hypothesis was therefore supported.

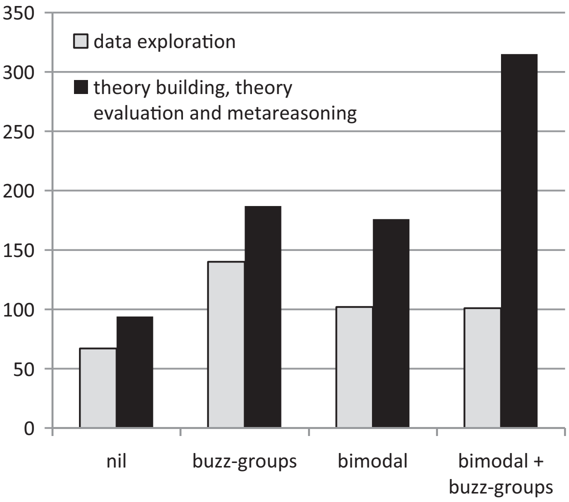

Figure 3. Frequencies of clinical reasoning in the four groups. Combined bimodal presentation and use of buzz groups resulted in much higher frequencies of desirable clinical reasoning processes: theory building, theory evaluation and meta-reasoning, while data exploration was limited.

Not surprisingly, the perceived learning from discussion of cases was generally much lower among specialists than among the residents (Table 3). A main positive effect of bimodal presentation was, however, noted with the specialists with regard to perception of learning (2.5 increase on a 10-point scale, $p < 0.05$). A strong positive effect of buzz groups was found among the residents on judgment of learning, i.e. the prediction of future performance (3.9 increase on a 20-point scale, $p < 0.005$). Our second and third hypotheses were therefore partly supported.

A main positive effect of bimodal presentation was noted among the specialists with regard to diagnostic accuracy (2.5 increase on a 20-point scale, $p < 0.05$). This suggests that the specialists were not only superior in combining information from the bimodal presentation of cases, they subsequently also performed better at the diagnostic accuracy test. Our fourth hypothesis suggested an improvement in diagnostic accuracy, and this was supported for the specialists.

Table 3. Main effects found in a full factorial ANOVA on perceived learning, judgment of learning and diagnostic accuracy for residents and specialists concerning bimodal presentation and buzz groups.

		Dependent variable								
		Perceived learning			Prediction of diagnostic accuracy performance			Diagnostic accuracy		
Participants	Factor	M[a]	SD[b]	effect size[c]	M	SD	effect size	M	SD	Effect size
Residents	Bimodal									
	No	7.0	1.1	−1.2	12.5	2.3	−0.2	16.5	2.1	0.1
	Yes	5.7	2.0		12.0	2.4		16.8	1.6	
	Buzz									
	No	6.2	2.1	0.1	10.3	0.8	4.9**	16.7	2.0	0.0
	Yes	6.5	1.2		14.2	1.3		16.7	1.8	
Specialists	Bimodal									
	No	1.0	1.1	2.3*	15.0	1.9	0.4	15.8	1.6	1.4*
	Yes	3.5	1.8		15.8	2.0		18.0	1.3	
	Buzz									
	No	1.8	1.8	0.5	14.8	2.1	0.6	16.7	1.0	0.5
	Yes	2.7	2.1		16.0	1.7		17.2	2.4	

*$p < 0.05$.
**$p < 0.005$; [a]mean; [b]standard deviation; [c]Cohen's *d*: $(M_{yes}-M_{no})/SD_{no}$.

Discussion

With regard to our first research hypothesis, the combined use of bimodal presentation and buzz groups increased the quality of clinical reasoning in the discussion. We have therefore shown that the interaction in the buzz groups is greatly helped by non-transient information available in written form throughout the discussion. The quality of clinical reasoning improved markedly. This process is likely to enhance encapsulation, illness script formation and expertise. It is important to note that the study also showed that the addition of bimodal presentation only or addition of buzz groups only, did not greatly improve clinical reasoning.

The improved quality of clinical reasoning associated with use of a combination of bimodal presentation and buzz group analysis of new, authentic cases may be related to a reduced cognitive load. With bimodal presentation available, the cognitive processes can focus on the building and evaluation of hypotheses. If a written case is not available, many clinical reasoning processes will be spent on data exploration rather than on more desirable building or evaluation of the hypotheses. The resulting diffuse discussion may cause frustration and/or opposition among participants in a busy clinical situation like the morning report. This is an example of the modality effect (van Merriënboer & Sweller 2010). The multimodal presentation reduces extraneous cognitive load by use of both the visual and auditory processor of working memory and then again improve the quality of clinical reasoning.

The results suggest that the deliberate practice in TDC designed to guide participants to use efficient visual problem solving strategies in combination with buzz group interaction prior to making management plans will indeed help learners approach cases with a top-down, forward method.

With regard to the second hypothesis, a positive effect of bimodal presentation on perceived learning was noted among the specialists, but not the residents. This might suggest that the specialists with better prior knowledge were better able to interpret the bimodal information and the following large group discussion and to modulate illness scripts. Interestingly, with regard to the third hypothesis, a strong main effect of buzz groups was found among the residents on judgment of learning. This suggests that residents were strongly influenced by the modelling, coaching and scaffolding offered by the paediatric specialists. No immediate improvement, however, was seen in residents' diagnostic accuracy. This finding confirms that learners can be misled as to whether learning has been achieved, sometimes resulting in overconfidence (Bjork et al. 2013). The subjective judgment of learning can reflect priming instead of immediate acquirement of usable diagnostic skills.

With regard to the fourth hypothesis, a positive effect of bimodal presentation on diagnostic accuracy was noted among the specialists. This suggests that the specialists not only perceive relatively more learning with bimodal presentation of cases: they are better able to combine the written and the oral information resulting ultimately in higher diagnostic accuracy. They are able to develop their expertise by integrating new knowledge into their illness scripts and to actually apply those (Schmidt & Rikers 2007). On the other hand, the residents possess less knowledge encapsulated as illness scripts, and additional time and effort is required for encapsulation to occur (Schmidt & Rikers 2007). Thus, the results suggest that extra efforts are necessary to improve learning outcomes for the residents. One such effort could be a specialist thinking aloud and relating what steps he or she would take to make a diagnosis after the analyses in the group (Balslev et al. 2010). This might deepen the residents' understanding and enhance the diagnostic accuracy. Feedback about the clinical course, work-up and treatment of TDC on subsequent morning reports along with self-directed learning efforts is extremely relevant and may aid clinicians to develop new illness scripts on a long-term basis.

Judgment of learning, i.e. prediction of how well residents would perform on the diagnostic accuracy test, was significantly increased by buzz groups. This is a remarkable effect and may illustrate how self-assessment abilities are very often uncorrelated with actual performance measures (Bjork et al. 2013). The increased judgment of learning may reflect beliefs or even overconfidence in one's diagnostic abilities that can occur after discussing a case with a senior colleague (Bjork et al. 2013). This represents an important result for clinical learners and teachers, because it shows that instruction has effects on how students perceive and regulate their learning. As alluded to above, the subjective judgment of learning can reflect priming, which can be followed by later learning of usable diagnostic skills.

As there is little or no evidence for the utility in education of perceived learning styles (Pashler et al. 2008), we do not believe that differences in learning styles might affect the results of this randomized controlled study.

The main strength of this study is the controlled, randomised design, with interaction among specialists and residents directly involved in clinical paediatrics on a daily basis. It is important to note that this study simulates working conditions in paediatric departments as none of the participants knew the diagnoses of the cases beforehand. The specialists had to diagnose cases concurrently with modelling, coaching and scaffolding the unfolding diagnostic process. Thus, the residents were able to participate in ongoing, diagnostic processes. It is also a strong point that all of the groups in the study used stepwise approaches to presentation and analysis of cases, because stepwise approaches will help participants apply a top-down and forward approach focusing on the important symptoms first. As this randomised study was designed to compare the four groups, the differences in the dependent variables must be caused by the treatments given in buzz, bimodal or buzz-bimodal groups. We believe that our approach to measurement of clinical reasoning is valid, as it includes evaluation of correct as well as faulty theories (de Grave et al. 1996). The discussion of contrasting theories might indeed stimulate learning (Ark et al. 2007).

Some shortcomings of the present study must be kept in mind. Firstly, this study focuses on immediate learning effects, and we therefore lack information on learning effects that may appear over the long term. The number of participants was small, i.e. 24 clinicians, and half of these were trainees. However, because the size of some of the resulting effects was quite large (effect size 1.4 to 4.9) it was still possible to achieve statistical significance for a number of major effects, despite the relatively low numbers of subjects in the study. Still, these numbers were not sufficient to allow the detection of effects of moderate size (effect size 0.4 to 0.6) or lower in the current study. Therefore we believe that the major effects that are found significant in this study can be generalized to other medical training programs, but then again we may have missed some of the smaller effects.

Medical students regularly participate in morning report. Unfortunately, due to restrictions in simultaneous audio recording of multiple buzz-groups with more than two participants, we were unable to include medical students along with the residents and specialists in the buzz groups. It is however most likely that positive effects on clinical reasoning might also be seen with medical students.

We and colleagues at a number of paediatric departments in Denmark restructured and modified morning report by daily, (A) bimodal presentation, and (B) buzz group discussion of a single selected case. Importantly, we added (C) a final wrap-up clinical reasoning remark by one of the specialists to help the trainees direct their learning further (Kassirer 2010). This three-step procedure is readily implemented, it is extremely sought after, and an upper time limit at 10 min is applied. We recommend this procedure as a regular agenda item at morning report to improve clinical reasoning and learning.

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