DOCUMENT RESUME

ED 476 470 TM 034 942

AUTHOR	Wimmers, P. F.; Verkoeijen, P. P. J. L.; van de Wiel, M. W. J.; Schmidt, H. G.
TITLE	Inducing Shifts in Clinical Case Processing by Manipulation of Format and Instruction.
PUB DATE	2003-04-00
NOTE	15p.; Paper presented at the Annual Meeting of the American Educational Research Association (Chicago, IL, April 21-25, 2003).
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	EDRS Price MF01/PC01 Plus Postage.
DESCRIPTORS	Biomedicine; Case Method (Teaching Technique); Educational Theories; Foreign Countries; *Graduate Medical Students; *Knowledge Level; *Medical Case Histories; Medical Education; *Physicians; Thinking Skills
IDENTIFIERS	*Expert Novice Problem Solving; Experts; Nephrology; Netherlands

ABSTRACT

The knowledge encapsulation theory (H. Schmidt and H. Boshuizen, 1992) predicts that experts under certain conditions shift from the use of clinical knowledge to elaborated biomedical knowledge. In normal routine cases, experts process cases with their encapsulated clinical knowledge. These differences in processing are reflected in clinical case recall. However, the specific conditions under which this takes place have never been isolated in a controlled setting. The experimental manipulations used in this study were case format and elaborative instruction. Participants were 30 experts (nephrologists in hospitals in the Netherlands), 24 intermediates (students who had completed an internship in internal medicine), and 24 novices (fourth year medical students). Only elaborative instruction in combination with laboratory data cases resulted in a significant increase of recall and a decrease in recall of encapsulated concepts of the experts. These results indicate a processing shift to a lower level biomedical knowledge. (Contains 4 figures and 18 references.) (Author/SLD)

2003 AERA Annual Meeting, April 21 to 25, 2003, Chicago-Illinois

Cognitive Psychology in Professions Education

Division I: Education in the Professions
Location: Sheraton, Columbus A, Level 3
Time and Place:
April 22, Tuesday, 12:25 PM--1:55 PM
Sheraton, Columbus A, Level 3

Inducing Shifts in Clinical Case Processing by Manipulation of Format and Instruction

P. F. Wimmers[1], P. P. J. L. Verkoeijen[1], M. W. J. van de Wiel[2], H. G. Schmidt[1]

Correspondence concerning this paper should be addressed to:

Paul F. Wimmers
Erasmus University Rotterdam
Institute of Psychology
P.O. Box 1738
3000 DR Rotterdam
The Netherlands

Email: p.wimmers@erasmusmc.nl

[1] Institute of Psychology, Erasmus University Rotterdam, the Netherlands.

[2] Faculty of Psychology, Maastricht University, the Netherlands.

Abstract

The knowledge encapsulation theory (Schmidt & Boshuizen, 1992) predicts that experts under certain conditions shift from the use of clinical knowledge to elaborated biomedical knowledge. In normal routine cases, experts process cases with their encapsulated clinical knowledge. These differences in processing are reflected in clinical case recall. However, under what specific conditions this shift takes place have never been isolated in a controlled setting. The experimental manipulations used in this study are case format and elaborative instruction. Only elaborative instruction in combination with laboratory data cases resulted in a significant increase of recall and a decrease in recall of encapsulated concepts of the experts. These results indicate a processing shift to lower level biomedical knowledge.

Introduction

The classic studies conducted by de Groot (1965), about expertise and recall of chess positions showed all an monotonically increasing relation between expertise and the amount of recall. This increasing amount of recall with level of expertise is also found in many other domains, for example in bridge (Charness, 1979), baseball (Spillich, Vesonder, Chiesi & Voss, 1979) or computer programming (McKeithen, Reitman, Rueter & Hirtle, 1981). The nature and the amount of recall are dependent on the activated knowledge structures (Patel & Groen, 1986). Therefore, it could be expected that experts recall more information from a case than novices, because they have richer and better organized knowledge structures to facilitate memory. However, if a medical expert diagnoses a case and is asked to write down the details of this case, it is often the intermediate level participant who produces more elaborated recall than novices or experts. This effect, known as "intermediate effect," is most frequently seen in the medical domain and is a robust phenomenon (e.g., Boshuizen, 1989; Boshuizen & Schmidt, 1992; Cleassen & Boshuizen, 1985; Patel & Groen, 1991; Schmidt & Boshuizen, 1993a, 1993b; Van de Wiel, Boshuizen & Schmidt, 1994a, 1994b).

The knowledge encapsulation theory (Schmidt & Boshuizen, 1992) was introduced to explain this intermediate effect; experts use their encapsulated knowledge and students, on the other hand, make use of their more detailed biomedical knowledge and this depicts the elaborated recall of the intermediate level expert. This encapsulation process—clustering of lower-level biomedical concepts into higher-level clinical concepts—begins during the internships of the medical students when they encounter real patients and their diseases.

Despite the fact that this intermediate effect is so robust, some studies have shown the opposite—an increasing case recall with increasing levels of expertise (e.g., Norman, Brooks & Allen, 1989). The effortful analysis of the cases consisting of only laboratory data resulted in a more elaborated recall in the incidental recall condition, according Norman et al. (1989). Another remarkable aspect of this study was the instruction given. In Norman's procedure, the participants had to give a problem formulation and had to explain how the individual values are related to this formulation. This was done to establish an expectation that the investigators were primary interested in the manner of problem formulation instead of recall. The knowledge encapsulation theory predicts that experts are still capable of using their biomedical knowledge structures, as shown in the elaborative recall of the above mentioned study. Nevertheless, under what specific conditions this shift from clinical knowledge to biomedical knowledge takes place, have never been isolated in an experimental setting.

An attempt of Verkoeijen, Van de Wiel, Kooman, and Schmidt (2001) to replicate the findings of the study of Norman et al. (1989) and to induce a non-automatic mode in case processing of experts, showed differences in case recall and processing time between the expert groups of the routine cases (laboratory data and clinical context) and the laboratory data only cases. Processing of the lab only cases was more effortful and the representations of the case recall were more elaborated. Nevertheless, there was no significant difference in recall between the expert groups of the unusual lab only case condition; the monotonically increasing effect found in the study of Norman et al. (1989) was not replicated. A possible explanation given for these findings is the discrepancy in expert groups between both studies. The experts in the study of Norman et al. (1989)

were al nephrologists, whereas the expert groups of the study of Verkoeijen et al. (2001) consisted of mostly internists. The laboratory data cases were mainly designed for nephrologists.

The present study is conducted to isolate what aspects of experimental manipulation accounts for the processing shift of the experts from clinical knowledge to biomedical knowledge. That is, the cases of an unusual format (laboratory data only) or the problem formulation instructions. It was predicted that experts in the control condition would solve the cases (context and laboratory data) in a fast automatic fashion with use of clinical knowledge. Experts who were confronted with cases of the unusual format would process the cases in a more elaborated fashion. The experts who participated in the elaborative condition (laboratory data cases with elaborative instruction) would shift from automatic processing towards a non-automatic elaborative processing with use of biomedical knowledge. The processing shift of the experts would result in an enhanced recall of the cases and less use of encapsulated concepts in their recall. A processing shift would also have a reflection on case processing time. As mentioned before, biomedical case processing is more demanding and therefore more time consuming. Inducing a processing shift in solving clinical cases would provide support for the knowledge encapsulation theory what postulates that under certain conditions, experts could return to their lower level biomedical knowledge structures.

Method

Participants

The 30 experts in this study were all nephrologists from different hospitals in the Netherlands. The 24 intermediates were students who had completed their internships in internal medicine. The 24 novices were all fourth-year medical students. The participants were divided over the different conditions and received a small compensation for their participation.

Material

The cases were designed using two different formats and the participants were divided according to three conditions. In the CL-condition (context and laboratory data), the cases comprised of two sheets. The first sheet provided a clinical context, i.e. the medical history of the patient, the results of the physical examination and some additional findings. The second sheet contained 19 pieces of laboratory data presented in a standard medical format. The two following sheets were blank response sheets for respectively; diagnoses and recall. The order of the cases was counterbalanced to correct for order effects. Assignment to one of the three conditions was made random for all participants.

The cases of the L-condition (laboratory data only) and E-condition (laboratory data only with elaborative instructions) were essentially the same as in the CL-condition, but without the clinical context. The material of these two conditions was an exact replication of the cases from the study conducted by Norman et al. (1989) and the study of Verkoeijen et al. (2001).

Procedure

All participants were informed that six cases would successively be presented and that they have to read through each case in order to provide a diagnosis. Subsequently, they were told to write down all the information they remembered for each case. In the CL-condition, participants were informed that they were allowed to turn pages back and forth between the clinical context and the laboratory data. There were no time constrains for the procedure. Although, reading and processing times were recorded. To let the participants get used to the procedure, a sample case was given in advance. All the participants were tested separately.

Analysis

Diagnoses made by the participants were recorded with points awarded for correct ones. The resulting diagnostic accuracy score ranged form 0 (completely inaccurate) to 10 (completely accurate). The free recall protocols were scored by means of a proposition analysis method introduced by Patel and Groen (1986). Two independent raters scored the diagnostic accuracy and free recall of the cases. A Pearson correlation of .857 [p = .000] and .977 [p = .000], respectively, were found between the raters in a subset of twelve cases. Data were analysed by using repeated measures (ANOVA). An alpha level of .05 was used for all statistical analysis.

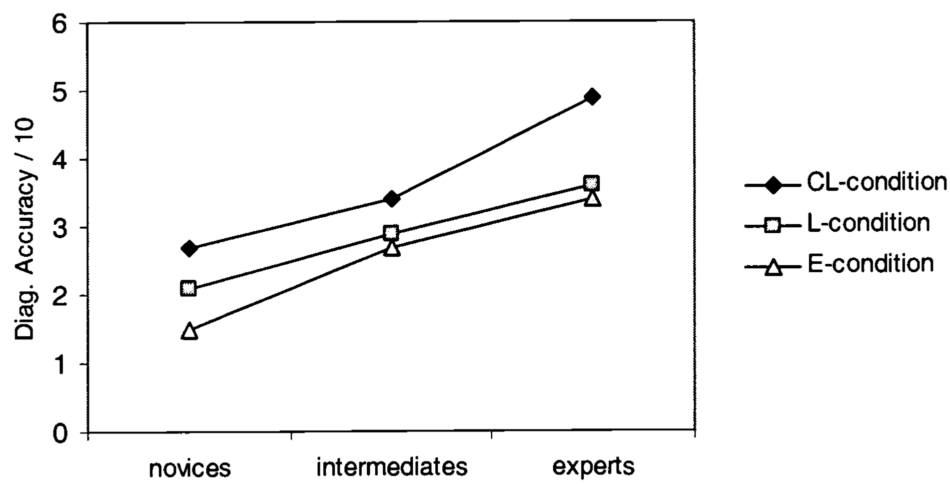
Results and Discussion

Using the knowledge encapsulation theory as a theoretical framework, it was predicted that novices and intermediates would process the cases in all three conditions in the same elaborative way by using their biomedical knowledge structures. The experts, on the other hand, would only process the routine cases of the CL-condition on an automatic processing mode, resulting in an intermediate effect between levels of expertise. The lab data only condition (L-condition) would be more effortful to solve. Furthermore, it was predicted that experts of the elaborative condition would shift from an automatic processing towards a non-automatic elaborative processing mode with use of biomedical knowledge.

The results show no significant effects of condition between the student groups [F (2, 21) = 4.402, MSE = 43.458, p = .025] or intermediate groups [F (2, 21) = 53.083, MSE = 34.291, p = .236].

Diagnostic accuracy was highest in the CL-condition [F (2, 69) = 9.575, MSE = 5.696, p = .000], and total case recall showed an intermediate effect [F (2, 23) = 5.284, MSE = 271.873, p = .013]. Figure 1 showed diagnostic accuracy as a function of level of expertise.

Figure 1. Diagnostic accuracy as a function of level of expertise (CL/L/E-condition).

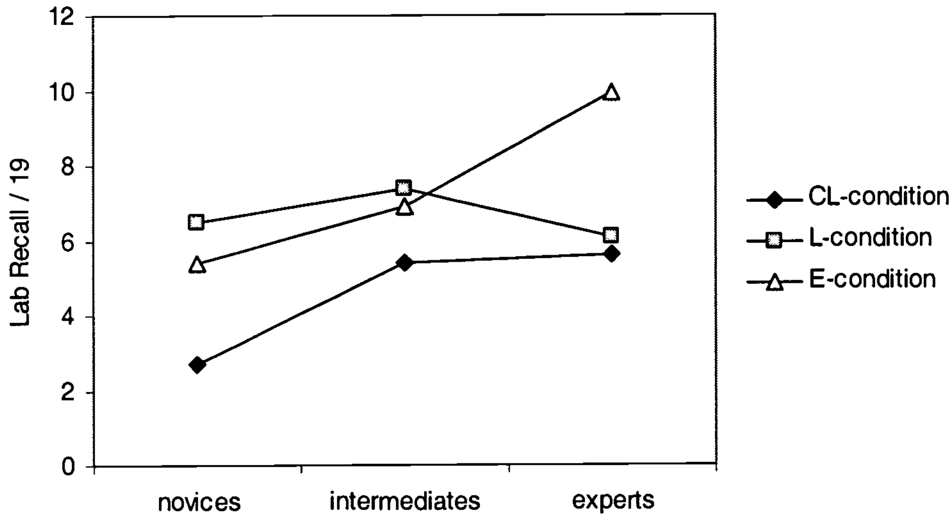


A separate analysis of laboratory recall in the L-condition showed no significant effect of level of expertise just as the study of Verkoeijen et al. (2001) revealed [F (2, 24) = .635, MSE = 40.177, p = .539]. These results do also not confirm the monotonically increasing effect found in the study of Norman et al. (1989). The laboratory data processing time of the experts in the L-condition showed a significant condition effect [F (1, 19) = 10.778, MSE = 8514.655, p = .004]. The results showed absolutely no laboratory recall differences of the experts between the CL and L-condition. However, the recalled summaries of the experts decreased with 57% in the L-condition. Experts of the L-condition needed more time to process the cases and recalled fewer summaries in comparison with the experts of the CL-condition. Laboratory data recall as a function of level of expertise is showed in figure 2.

The processing shift what resulted in an elaborated case representation in the Norman at al. (1989) study was not caused by the case format. Therefore, the experts' processing could not be manipulated by the unusual case format. The robustness of the way experts process cases is worthy of special notice. It was already been shown in other studies, with different experimental manipulations. For example; motivation (De Bruin, Van de Wiel, Rikers & Schmidt, 2001), cases from a different medical discipline (Rikers, Schmidt & Boshuizen, 2000) or intentional versus incidental instructions (Van de Wiel et al., 1994b).

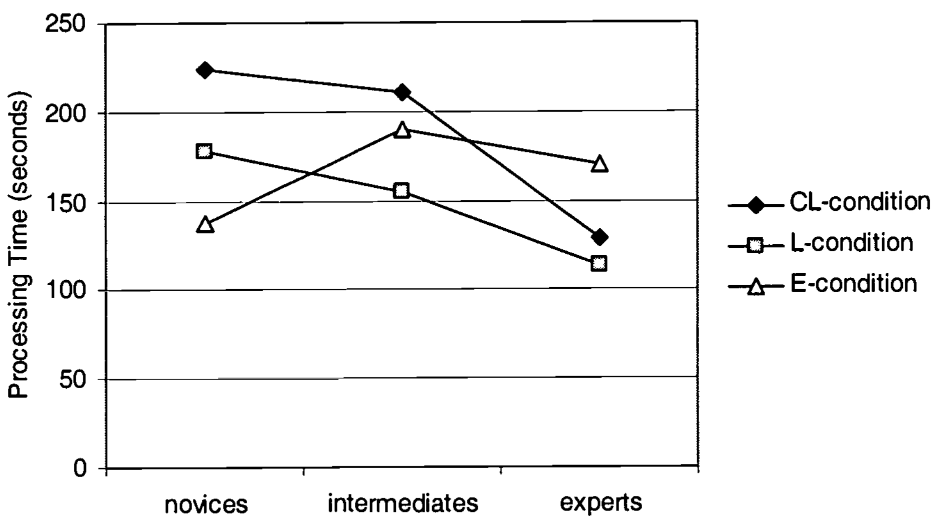
On the other hand, the experimental manipulation of the elaborative condition (E-condition) was highly successful. As predicted, the amount of laboratory data recall of the experts increased from 6 to almost 10 propositions (62%) in comparison with the L-condition—a significant condition effect [F (1, 18) = 10.052, MSE = 42.206, p = .005], (see figure 2). The monotonically increasing effect as found in the study of Norman et al. (1989) is replicated.

Figure 2. Lab data recall as a function of level of expertise (CL/L/E-condition).



Experts laboratory data processing time increased with 51% [F (1, 18) = 6.089, MSE = 16456.072, p = .024] in comparison with the L-condition and 189% [F (1, 17) = 32.030, MSE = 11154.530, p = .000] in comparison with the CL-condition. Figure 3 showed the processing time as a function of level of expertise in all conditions.

Figure 3. Processing time as a function of level of expertise (CL/L/E-condition).

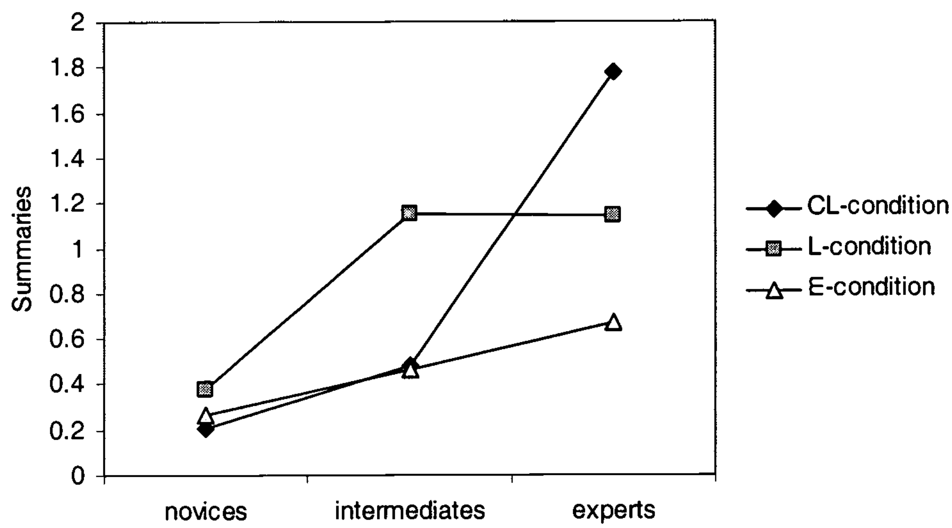


Furthermore, recalled summaries showed an increase of 70% in comparison with the experts of the L-condition (see figure 4).

On the basis of the above mentioned results of the E-condition can been concluded that the experts have processed these cases with use of lower level biomedical knowledge.

In contrary with the explanation given by Norman et al. (1989), is the increased recall of the experts not a consequence of the effortful analysis of the laboratory data, but a consequence of a combination of lab only cases with elaborative instructions.

Figure 4. Recalled summaries as a function of level of expertise (CL/L/E-condition)



In conclusion, experts of the CL-condition processed the cases in an automatic mode, experts of the L-condition, on the other hand, needed more time to solve the cases and recalled less summaries what indicated an increase of effort. However, a real processing shift took place in the E-condition as shown in the case recall representation, processing time and recalled summaries. Experts can, like the knowledge encapsulation theory suggests, under certain conditions, shift from an automatic mode of processing with use of clinical knowledge to an elaborative mode of processing with use of biomedical knowledge.

References

Boshuizen, H. P. A. (1989). De ontwikkeling van medische expertise. Een cognitief-psychologische benadering. Dissertation [Proefschrift], University of Maastricht, The Netherlands.

Boshuizen, H. P. A., & Schmidt, H. G. (1992). On the role of biomedical knowledge in clinical reasoning by experts, intermediates and novices. Cognitive Science, 16, 153-184.

Charness, N. (1979). Components of skill in bridge. Canadian Journal of Psychology,33,1-16.

Claessen, H. F. A., & Boshuizen, H. P. A. (1985). Recall of medical information by students and doctors. Medical Education, 19, 61-67.

De Bruin, A. B. H., Van de Wiel, M. W. J., Rikers, M. J. P., & Schmidt, H. G. (2001). Explaining the intermediate effect in clinical case recall: An attempt at experimental manipulation. Paper presented at the Annual Meeting of the American Educational Research Association, Seatlle, WA, April 10-14, 2001.

De Groot, A. D. (1965). Thought and choice in chess. (2nd ed, 1978), 's-Gravenhage, Holland: Mouton.

Norman, G. R., Brooks, L. R., & Allen, S. W. (1989). Recall by experts medical practitioners and novices as a record of processing attention. Journal of Experimental Psychology; Learning, Memory and Cognition, 15, 1166-1174.

Patel, V. L., & Groen, G. J. (1986). Knowledge based solution strategies and the use of biomedical knowledge by medical students. Medical Education, 24, 129-136.

Patel, V. L., & Groen, G. J. (1991). The general and specific nature of medical expertise: A critical look (pp. 93-125). In: K. A. Ericsson, & J. Smith (Eds.). Toward a general theory of expertise, prospects and limits. Cambridge: Cambridge University Press.

McKeithern, K. B., Reitman, J. S., Rueter, H. H., & Hirtle, S. C. (1981). Knowledge organization and skills in computer programmers. Cognitive Psychology, 13, 307-325.

Rikers, M. J. P., Schmidt, H. G., & Boshuizen, H. P. A. (2000). Knowledge encapsulation and the intermediate effect. Contemporary Educational Psychology, 25, 150-166.

Schmidt, H. G., & Boshuizen, H. P. A. (1992). Encapsulation of Biomedical Knowledge. In A. E. Evans & V. L. Patel (Eds.), Advanced models of cognition for medical training and practice, (pp. 265-282). New York, NY: Springer Verlag.

Schmidt, H. G., & Boshuizen, H. P. A. (1993a). On Acquiring Expertise in Medicine. Educational Psychological Review, 5 (3), 205-221.

Schmidt, H. G., & Boshuizen, H. P. A. (1993b). On the origin of intermediate effects in clinical case recall. Memory & Cognition, 21(3), 338-351.

Spilich, G. J., Vesonder, G. T., Chiesi, H. L., Voss, J. F. (1979). Text processing of domain-related information for individuals with high and low domain knowledge. Journal of Verbal Learning and Verbal Behavior, 18(3), 275-290.

Van de Wiel, M. W. J., Boshuizen, H. P. A., & Schmidt, H. G. (1994a). Differences in knowledge application by students and medical experts in clinical reasoning. Paper presented at the Annual Meeting of the American Educational Research Association in New Orleans, Louisiana, April 4-8, 1994.

Van de Wiel, M. W. J., Boshuizen, H. P. A., & Schmidt, H. G. (1994b). The influence of task instruction and lab data format on clinical case recall. Paper presented at the Annual Meeting of the American Educational Research Association in New Orleans, Louisiana, April 4-8, 1994.

Verkoeijen, P. P. J. L., Van de Wiel, M. W. J., Kooman, J. P., & Schmidt, H. G. (2001). Case representation by medical experts, intermediates and novices for laboratory data presented with or without a clinical context. Paper presented at the Annual Meeting of the American Educational Research Association in Seattle, Washington, 2001.

Reproduction Release

(Specific Document)

TM034942

I. DOCUMENT IDENTIFICATION:

Title: *Inducing shifts in clinical case processing by manipulation of format and instruction*	
Author(s): *P. F. Wimmers, P. P. J. L. Verkoeijen, M. W. J. van de Wiel, H. G. Schmidt*	
Corporate Source: *Erasmus University Rotterdam, Institute of Psychology*	Publication Date: July 2002

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, Resources in Education (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic media, and sold through the ERIC Document Reproduction Service (EDRS). Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce and disseminate the identified document, please CHECK ONE of the following three options and sign in the indicated space following.

The sample sticker shown below will be affixed to all Level 1 documents	The sample sticker shown below will be affixed to all Level 2A documents	The sample sticker shown below will be affixed to all Level 2B documents
PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY SAMPLE TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)	PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE, AND IN ELECTRONIC MEDIA FOR ERIC COLLECTION SUBSCRIBERS ONLY, HAS BEEN GRANTED BY SAMPLE TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)	PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY SAMPLE TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
Level 1	Level 2A	Level 2B
↑ [X]	↑ [ ]	↑ [ ]
Check here for Level 1 release, permitting reproduction and dissemination in microfiche or other ERIC archival media (e.g. electronic) *and* paper copy.	Check here for Level 2A release, permitting reproduction and dissemination in microfiche and in electronic media for ERIC archival collection subscribers only	Check here for Level 2B release, permitting reproduction and dissemination in microfiche only

Documents will be processed as indicated provided reproduction quality permits.
If permission to reproduce is granted, but no box is checked, documents will be processed at Level 1.

I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce and disseminate this document as indicated above. Reproduction from the ERIC microfiche, or electronic media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries.

Signature:	Printed Name/Position/Title: WIMMERS, RESEARCHER, M.S.	
Organization/Address: Paul F. Wimmers Erasmus University Rotterdam Institute of Psychology P.O. Box 1738 3000 DR Rotterdam The Netherlands	Telephone: +31 10 408 7411	Fax: +31 10 408 9477
	E-mail Address: p.wimmers@erasmusmc.nl	Date: 8 April, 2003

III. DOCUMENT AVAILABILITY INFORMATION (FROM NON-ERIC SOURCE):

If permission to reproduce is not granted to ERIC, or, if you wish ERIC to cite the availability of the document from another source, please provide the following information regarding the availability of the document. (ERIC will not announce a document unless it is publicly available, and a dependable source can be specified. Contributors should also be aware that ERIC selection criteria are significantly more stringent for documents that cannot be made available through EDRS.)

Publisher/Distributor:
Address:
Price:

IV. REFERRAL OF ERIC TO COPYRIGHT/REPRODUCTION RIGHTS HOLDER:

If the right to grant this reproduction release is held by someone other than the addressee, please provide the appropriate name and address:

Name:
Address:

V. WHERE TO SEND THIS FORM:

Send this form to the following ERIC Clearinghouse:	
ERIC Clearinghouse on Assessment and Evaluation **1129 Shriver Laboratory (Bldg 075)** **College Park, Maryland 20742**	**Telephone: 301-405-7449** **Toll Free: 800-464-3742** **Fax: 301-405-8134** **ericae @ericae.net** **http://ericae.net**