THE EFFECTS OF VISUALIZING AND VERBALIZING METHODS IN REMEDIAL SPELLING TRAINING: INDIVIDUAL CHANGES IN DYSLEXIC STUDENTS' SPELLING TEST PERFORMANCE

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A remedial spelling training approach is presented which systematically combines certain visualizing and verbalizing methods to foster dyslexic students' orthographic knowledge and strategy use. It essentially depends upon an integrative application of algorithmic graphs and verbal self-instructions: Visualization and verbalization are intended to focus the students' attention, cognitions, and behaviors on the algorithmic rule components for enhancing their task orientation and self-regulation skills. To that degree, the intervention must provide an intensive and consistent cognitive modeling phase as well as a broad range of special training materials which, in particular, are comprised of various algorithmic and self-instructional task formats. In the present replication study the temporal training effects on the spelling test performance of 9 students with severe spelling difficulties were evaluated. Achievement-related pre-test and follow-up data were analyzed after a treatment time of 40 hours. Empirical results could demonstrate individually and statistically significant gains in students' general and error-specific spelling test performance – in both systematically trained and, to a somewhat lower degree, only incidentally considered spelling skill areas.

Many dyslexic students have no or only scarce knowledge of the important orthographic rules and are not familiar with their implications – and thus they do not follow structurally adequate criteria as much as those seeming subjectively plausible to them. Often they resort to their existing phonological spelling skills, and they try in vain to master the critical word items in terms of phonological correctness (Bailet, 1990; Carlisle, 1987; Darch, Kim, Johnson & James, 2000; Manis & Morrison, 1985; Steffler, 2004). Due to their errors, these students then seem irritated and disappointed over their unsuccessful spelling efforts as they have, from their viewpoint, genuinely pondered over the words and could even come up with an explanation for their decision to choose the spelling they used.

Therefore, the task in remedial spelling training is to enhance, round off, or catch up on the orthographic skills of the students concerned, the acquirement of which had been unsuccessful for them so far – so as to avoid, last but not least, the motivational and socio-emotional long-term effects of failure experiences accumulated in the individual (Faber, 2002a,b; Humphrey, 2002; Licht & Kistner, 1986; Tobias, 1992). The development and persistence of these learning difficulties can be traced back essentially to fundamental knowledge and strategy deficiencies: the students concerned are lacking relevant knowledge with regard to the critical demands; in addition, they do not possess suitable metacognitive planning and control concepts for the acquirement of appropriate learning strategies – or they are unable to adequately apply solution approaches formally known to them (Borkowski, Johnston & Reid, 1987). Therefore, adequate remedial interventions have to teach students the knowledge of relevant rules in an understandable way, and useful behavioral patterns with regard to the in-

struction strategy have to be worked out so as to bring this knowledge to application (Larkin & Ellis, 2004; Mäki, Vauras & Vainio, 2002; Scheerer-Neumann, 1993; Zimmerman, 2000).

In particular, learning theories from the view of action psychology point up the necessity of an instructional approach which enables the students to understand the underlying logic of a certain spelling rule and to form a cognitive concept or tool for further problem solving in that given spelling domain (Arievitch & Haenen, 2005; Gal'perin, 1989). In this sense, the training must include systematic orientation guides for the presentation of the object of learning in a way suitable to the students, as well as effective structuring remedies for a proper acquirement of the skills on the part of the students. Accordingly, the task of gradually developing relevant skills requires, first of all, finding suitable ways of conveying orthographic rules which guarantee that the issues at hand can actually be followed and understood by the students. Most of all, this requires considerations in the direction of resolving the verbal, abstract complexity of orthographic rules by subdividing them into single information chunks of a concrete nature which, when looking at them from the students´ view, seem logically consistent, reliable, and mentally controllable. To that degree, an orientation basis significantly enhancing the learning process can be achieved by implementing visualization and verbalization methods subdividing the orthographic regulations into their characteristic sub-operations, thus presenting them in a methodical sequence of relevant decision criteria – in symbolic-graphic form and as descriptive as possible (Clarke, 1991). In this way, the students receive materialized, quasi prototypic patterns of orthographic problem-solving which are supposed to enable them to acquire knowledge and certainty of the relevant rules in clearly structured steps. If these conditions are fulfilled the next task is to implement adequate strategies making it possible for the students to carry over their acquired knowledge of the orthographic rules to corresponding spelling routines, and to apply it autonomously in order to meet orthographic demands. Therefore, their orthographic knowledge has to be relocated from the physical activity level into their consciousness, habitualizing it there as a behaviorally active pattern of thinking. Thus, the acquirement of skills and strategies is supposed to take place by educationally initiated and monitored internalization processes. In order to achieve this, it is absolutely essential, in the view of action psychology, to carry over the action from the exterior to the interior speech by putting the orthographic rule processing completely into language (Bodrova & Leong, 1998; Galperin, 1989), having the students commenting their rule application aloud – until they master it so well that they gradually need less and less time for the operation and are finally able to do without verbal teacher assistance. Now the students approach the orthographic solution without materialized structuring or overt self-instructions, and they have successfully automatized it as a continuous spelling strategy.

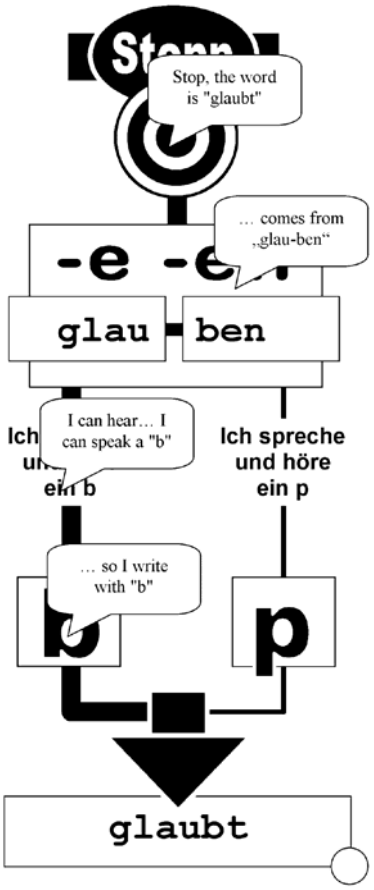


Figure 1. Algorithmic flow chart in the spelling skill area bp (concerning the German spelling of explosive consonant sounds)

In that sense, the successful acquirement and application of orthographic rules may be facilitated significantly if one can successfully manage to subdivide the complex meaning of the rules into clearly structured intermediate algorithmic steps which can easily be visualized – and if one can also successfully manage to support the acquirement of these intermediate algorithmic steps with consistent verbalizing methods. In doing so, the acquirement of orthographic spelling skills may predominantly dependent

upon the implementation of suitable visualizing methods, the development of relevant solution strategies, and most of all, the use of effective verbalizing methods (Thackwray, Meyers, Schleser & Cohen, 1985). For the success of the remedial process it may be crucial to combine both instruction approaches (and thus the implementation of visualizing and verbalizing methods as well) as closely as possible.
For the beginning stages of the translating experience of the intermediate algorithmic steps into language and their subsequent consolidation with regard to the learning strategy, it seems methodically self-evident to utilize and adjust the principles of cognitive modeling and self-instructional learning (Meichenbaum & Asarnow, 1979) – as their efficiency in the development of strategic skills on the part of the students has been proven sufficiently long since, across a wide range of educational problems and school grades (Ellis, Deshler, Lens, Schumaker & Clark, 1991; Harris, 1990; Montague, 1997; Schunk, 1986).

From a methodical viewpoint, the systematic use of visualizing and verbalizing methods in remedial spelling training requires an algorithmic problem-solving plan which is capable of both structuring the acquirement of orthographic knowledge and facilitating the development of orthographic strategies simultaneously – by providing the specific problem-solving steps as well as the self-instruction steps at the same time. In this regard, an algorithmic flow chart (Figure 1 above) has proven to be a suitable method

- that focuses the students' attention on the target word, first of all, introducing a reflexive problem-solving action,
- that determines the relevant orthographic problem as a concrete issue in question,
- that introduces an algorithmically structured problem-solving approach to clear the issue in question with definite decision criteria in clearly structured intermediate steps,
- that presents the algorithmically founded spelling of the target word as a reliable solution,
- and that eventually carries over this solution to an orthographically adequate spelling of the target word.

The application of this problem-solving plan has to be demonstrated by the teacher first by thinking aloud. In the course of this, the teacher also informs the students in detail of the meaning of the problem-solving algorithm and the benefits of the thinking aloud technique for one's own enhancement of orthographic skills (Pressley, 1986; Schunk & Rice, 1987). Under these circumstances, the students can test and practice the problem-solving plan with the teacher's guidance. At first, they apply the plan by thinking aloud, without exception. In doing so, they follow the algorithmic plan determined by them on a respective worksheet step by step with a colored pencil. In the case of errors or uncertainties, the teacher discontinues the ongoing solution attempt and starts to determine the correct solution approach together with the students, repetitively modeling the correct step if needed. In this way, each target word is analyzed by itself before a decision is made. Both the self-instructions and the colored marking of the solution approach should contribute to the students slowing down in their solution behavior, thus replacing impulsive guessing with reflexive action patterns. At the same time, they should be able to perceive their proceeding more consciously and control it more precisely, as the combination of visualized algorithms and verbal self-instruction renders the own success/failure experience more comprehensible. The flow chart helps to precisely locate and promptly eliminate any difficulties in executing a certain problem-solving step.

For the systematic work with algorithmic flow charts of this nature, methodically adequate practice materials in particular play a central role (Faber, 2006). They have to depict the orthographic demands using algorithmically formatted exercise types consistently enabling the students to convert the orthographic skills acquired by them into a strategically adequate behavior (Figure 2).

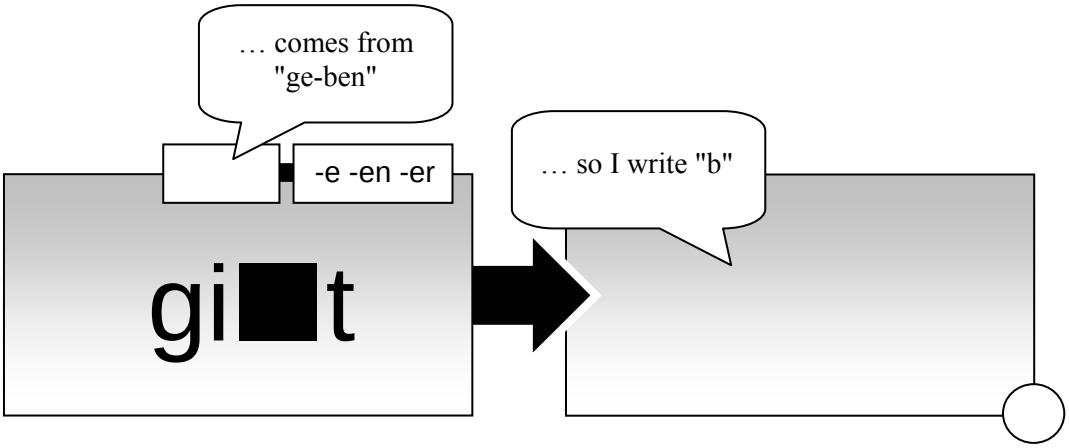


Figure 2. Algorithmic and self-instructional task format: An example

Previous empirical evaluation results

The results of evaluation studies so far conducted in the field of systematic remedial training with graphic problem-solving algorithms and verbal self-instructions could establish and prove significant gains in performance on the part of four training cohorts whose intervention was completed after nearly two years in each case. In the meantime, the relevant analyses encompass an intervention period of about eight years, and they are based on data compiled from overall N = 100 dyslexic children and adolescents – not taking the ongoing study (with the fifth training cohort) into consideration. Overall, it was possible to replicate and to gradually specify the pertinent results and findings (Faber, 2006):

On the basis of relevant norm test scores, the students trained over a longer period of time were able, interindividually as well as intraindividually, to achieve highly significant gains in spelling performance. This result is maintained even when empirically taking into consideration regression-related gains in performance prior to the treatment. At the same time, the students trained over a longer period of time were able to achieve, particularly in statistical and practical terms, significant gains in the systematically trained spelling skill areas. To a slightly lesser but still significant extent, this also holds good for the spelling skill areas only incidentally considered. In this respect, strategic transfer effects must have taken place in the course of the intervention. The analyses could establish significant improvements in the untrained spelling skill areas as well, which also indicates the possibility of strategic transfer effects. The gains in performance achieved in each case and cohort were not significantly correlated to gender, age, or regular school training conditions. Finally, some first empirical evidences suggest that advances in the students' performance – with the proviso of conceptually adequate approaches, procedures, and training conditions – can be achieved largely independent of any teacher effects. These preliminary findings, however, have to be replicated again, by all means, with additional evaluation studies – and they have to be specified further with regard to a comprehensive series of conceptual and/or methodical questions of detail.

Evaluation study

Evaluation goals. With another evaluation setting, the objective of the study was to replicate and to differentiate the results of previous evaluation findings. In this sense, the performance data of the present training cohort were supposed to be analyzed in detail, considering the following questions: (1) Does the students' general spelling test performance significantly increase? (2) Do their individual error-rates in three systematically trained spelling skill areas significantly decrease, and, to a somewhat lower extent, (3) do their individual error-rates in two incidentally considered spelling skill areas significantly decrease as well?

*Subjects***.** The training cohort was comprised of 9 (4 female and 5 male) students from different grade levels (Figure 3) who displayed normal cognitive abilities but had extensive

orthographic difficulties which, in most cases, had already been accumulated over a longer period of time. Descriptive spelling error analyses revealed clear evidence, that the students' orthographic difficulties could be traced back to a lack of rule-dependent competencies and strategies in most cases – violations of the phonologically based spelling of words were relatively rare overall (Figure 3). In the majority of cases, the performance problems were associated with inadequate (mostly impulsive, inactive and unfocused) learning styles, motivational orientations mainly characterized by test anxiety and avoidant behaviors, as well as socio-emotional conspicuities in a large number of cases.

*Basic training conditions***.** In all cases studied, the spelling training consisted of an individually compiled sequence of area-specific training steps addressing different orthographic problems with extensive use of visualized problem-solving algorithms and verbal self-instructions. This concerned the spelling skill areas explosive consonant graphemes (gk/dt/bp), i-graphemes (i/ie/ih), as well as doubling of consonants (II+). In contrast, the incidentally considered spelling skill area capitalization was only picked out as a central theme in cases of individual uncertainties or errors; the students were then supposed to show the critical front part of the word with the aid of a corresponding signal card and by thinking aloud (Faber, 2006). Similarly, the incidentally considered skill area of phonologically based spelling was picked out as a central theme as required, by also focusing the students' attention on the critical work part with signal cards (Blackwell & McLaughlin, 2005), and getting them to think aloud about their spelling activities. Often this concerned problems around the subjects of differentiating phoneme sounds and, in particular, structuring or segmenting words – the mastery of which is, with elaborate syllablization exercises, already a central component part of the spelling strategies imparted in the training units dealing with explosive sounds and doubling of consonants. The intervention took place once a week for 60 minutes each with single individuals or groups of two. It was carried out by the author and another teacher who received regular consultation with regard to questions as to the diagnostic and methodical implementation of the approach.

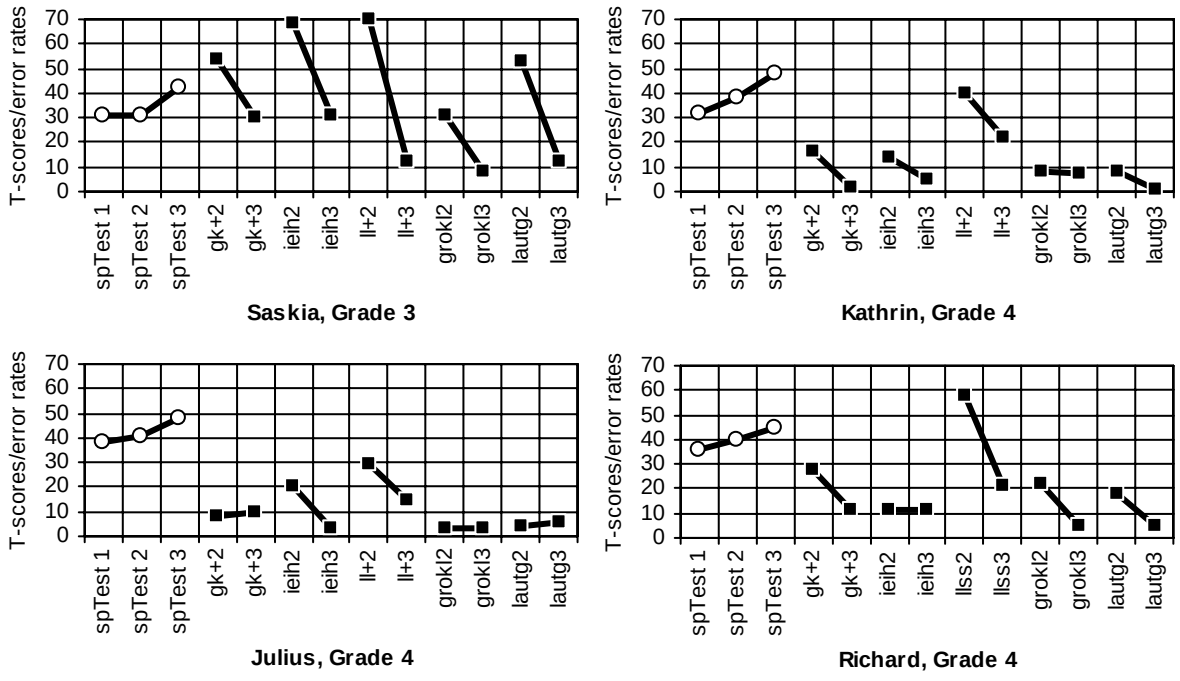
*Measurements and statistical analyses***.** The students' spelling achievement were first assessed in pre-test 1 six months prior, on an average, to the beginning of the training, again in pre-test 2 directly at the beginning of the training, and in subsequent follow-up tests after 40 hours into the training. According to grade level, this took place with standardized, norm-referenced spelling tests (Faber, 2006). In pre-test 2, it was possible to use parallel forms of the instruments employed in pre-test 1. As follow-up measures instruments with norms for the next higher grade level were administered in each case. Evaluation of test results was carried out quantitatively on the basis of grade-related T score norms, as well as qualitatively with the proviso of descriptive error categories. For this purpose, individual error rates were generated from an especially developed word list (Faber, 2004). It promises, as to content and psychometry, more adequate results with regard to the students' individual error ratio, as these are not any longer directly depending upon the item pool of a certain spelling test. The internal consistency of the word list amounted to $\alpha = .93$ (Cronbach's Alpha). The sum total of list words correctly written correlated with the T score norms of the spelling test procedures by $r = .56$ ($p = .005$) and turned out to be significantly influenced by the grade level ($r = .55$, $p = .007$) but not by gender ($r = .01$, $p > .05$). Due to the previous course of the training, the corresponding error percentage scores in the learning skill areas explosive consonant graphemes, i-graphemes and doubling of consonants were used, for the study at hand, as error-specific performance criteria for the systematically trained spelling competences – and the error percentage scores in capitalization and phonologically based spelling were used as error-specific performance criteria in the incidentally considered skill areas. As children and adolescents with severe spelling difficulties in particular tend to several misspellings in one single word often, the ordinary test sum scores can, foreseeably, only roughly reflect the extent of their individual problems. Therefore, their individual error frequency was recorded as an additional performance criterion, relativizing the sum total of individual errors in the spelling test with the total item sum of the corresponding procedure. With the test norm

scores, the error frequency of all students at measurement time 2 correlated to r = -.73 (p = .000).

Students' individual changes in spelling performance were, at first, documented for each single case and subjected to a conventional visual data inspection. Data from pre-test 1 and 2 respectively were the base rate to control for positive changes in unaddressed problems. Follow-up data (from measurement time 3) served as indicator for intervention-related improvements. This was done to explore particular intra-individually marked student development, also with regard to subject-specific effects of the intervention. Furthermore, summarizing statistical examination of total performance effects in the entire cohort was carried out using nonparametric Wilcoxon tests with an (one-tailed) alpha error probability of $p < .05$ (Siegel & Castellan, 1988). This procedure should clarify to what extent individual improvements are so similar that interindividually reliable replication of certain intervention effects for all students can be assumed.

Results.

The visual inspection of single-case data shows that most students have clearly improved standardized test results (Figure 3). The extent of the improvements, however, varies significantly. While some test results are remarkable, and almost instantaneous, other cases developed in a much slower manner. In addition, the comparisons between pre-test and follow-up data concerning the error-specific results show that all students have reduced their initial error ratio in the systematically trained areas to a greater or lesser extent: All students have decreased their individual error rates, which was, in some cases, extremely high before the training – and some have made remarkable progress.



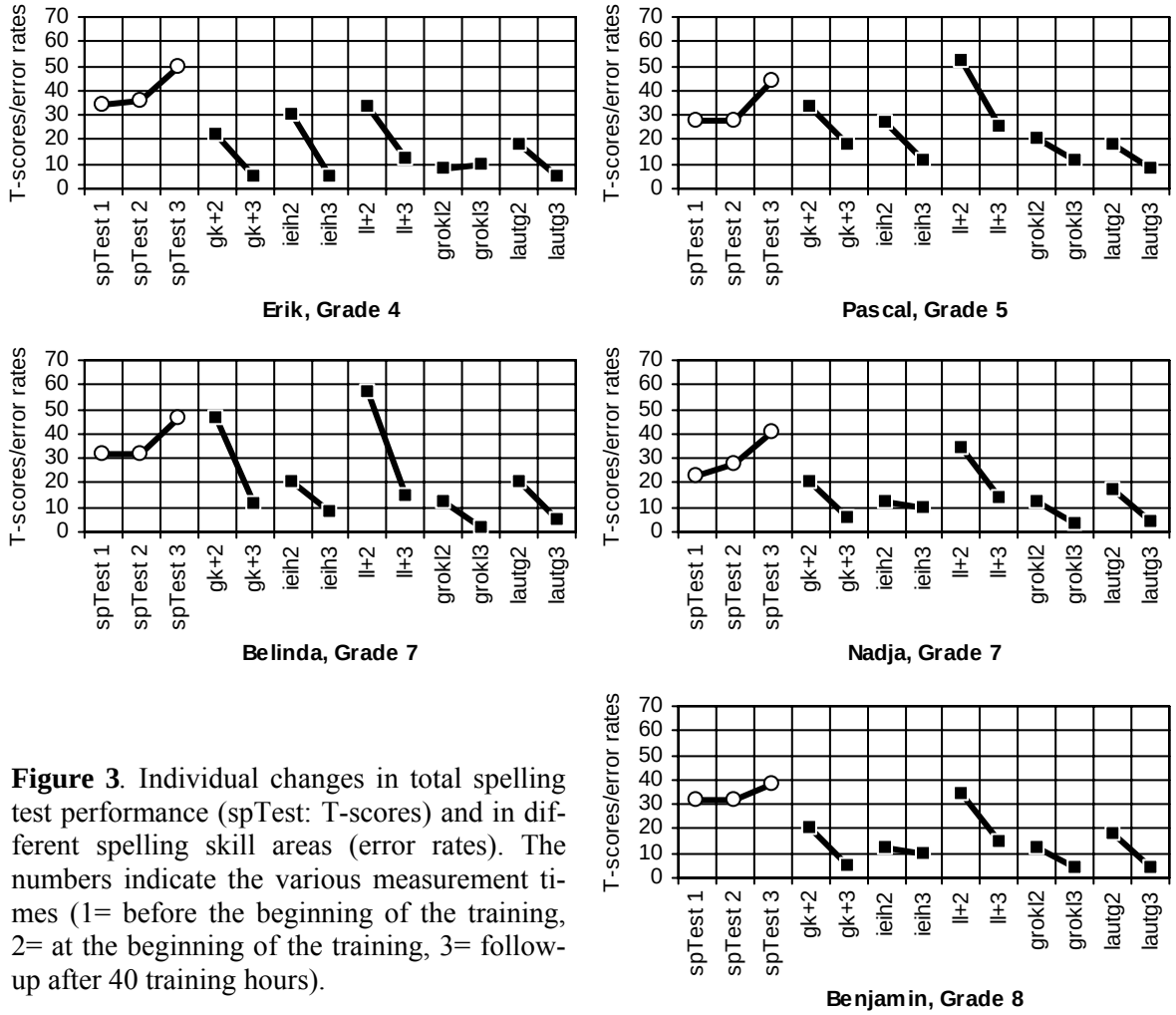


Figure 3. Individual changes in total spelling test performance (spTest: T-scores) and in different spelling skill areas (error rates). The numbers indicate the various measurement times (1= before the beginning of the training, 2= at the beginning of the training, 3= follow-up after 40 training hours).

After 40 hours of remedial training, at measurement time 3, all students make significantly less multiple spelling errors per word than at the beginning of the training at measurement time 2 (Table 1).

While summarizing this individual case data into group-statistically analyzable achievement parameter, the average test scores of all tested students, which differed significantly before the intervention, had increased during the follow-up test by an average of 10 T-score-points (Figure 4). The extent of the intraindividually achieved changes can be verified from an inference-statistical perspective for the entire group (Wilcoxon test: $Z = -2.68$, $p = .007$). There is no noteworthy correlation between the extent of the achievements so far, e.g. the difference between the second and third measurement time, and the grade the student is in ($r = .-16$, $p = .712$). The students' age do not influence the improved test results. This is also true for the gender variable, which does not correlate with the improvement in spelling test

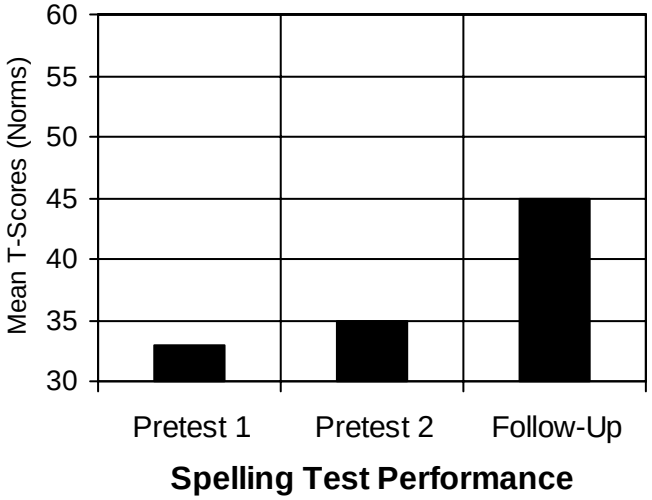


Figure 4. Changes of spelling test performance in the training cohort: Norm-referenced spelling test scores 6 months prior to the training (pre-test 1), at the beginning of the training (pre-test 2), and after 40 hours of training time (follow-up)

performance (r = -04, p = .910).

The group-statistical analyses regarding error-specific student improvements in the systematically trained spelling skill areas have similar results (Table 1). The errors regarding the skill area of explosive consonant graphemes (gk+) as well as the skill area of i-graphemes (ieih) and doubling of consonants (II+) decreased after 40 hours of training to an extent that cannot be attributed to chance, as evidenced by inference-statistical analysis. But there are also substantial changes with regard to the incidentally considered spelling skill areas. As could be expected, changes in this area are less significant, but are also statistically more significant than could be explained by chance. The average error ratio for capitalization (grokl) and phonologically based spelling (lautg) has notably decreased. Altogether, for the entire training cohort spelling performance has improved in a statistically significant manner.

Table 1. Error rates in various spelling skill areas: Pre-test and follow-up data (gk+ = explosive consonant graphemes, ieih = i-graphemes, ll+ = doubling of consonants, grokl = capitalization, lautg = phonologically based spelling)

Spelling skill area gk+ (systematically trained)			
Pre-test 2	Follow-up	Wilcoxon	p
Median = 27	Median = 10	Z = -2.55	.011
Spelling skill area ieih (systematically trained)			
Pre-test 2	Follow-up	Wilcoxon	p
Median = 20	Median = 8	Z = -2.49	.013
Spelling skill area II+ (systematically trained)			
Pre-test 2	Follow-up	Wilcoxon	p
Median = 50	Median = 16	Z = -2.67	.008
Spelling skill area grokl (incidentally considered)			
Pre-test 2	Follow-up	Wicoxon	p
Median = 12	Median = 5	Z = -2.10	.036
Spelling skill area lautg (incidentally considered)			
Pre-test 2	Follow-up	Wilcoxon	p
Median = 16	Median = 5	Z = -2.43	.015
Total error rate			
Pre-test 2	Follow-up	Wilcoxon	p
Median = 102	Median = 42	Z = -2.67	.008

Discussion.

The results of the present evaluation study show noted performance gains in the students' spelling after 40 hours of remedial training – both for individual cases, which show intra-subjectively noteworthy student changes, and for the entire group, whose competence increase is more significant than can be attributed to chance and thus prove inter-subjective replicability of the case-related achieved results. As expected, the students improved most in the systematically trained spelling skill areas and less in the only incidentally considered spelling skill areas. Students' performance gains in the incidentally considered area of phonologically based spelling, unless they arrived at syllabizing solution strategies by transfer, which had been systematically studied in connection with the explosive consonant and double consonant skill area. If the improvements in the capitalization skill area, which was also trained implicitly, are the result of the respective signal card and/or strategic transfer effects, remains to be seen. Possibly, the algorithmic and self-instructive process has lead to a more conscious awareness of language-structural word markers.

Considering the small size of the sample, these interim results should only be seen as a first impression and thus only allow for preliminary conclusions about the possible effects of the intervention. We are waiting for finalizing analyses, since the results for each individual case need to be stabilized and improved upon with further training. With this caveat, these results confirm the findings from previous research on the group level and point to the positive effects of systematic work with algorithmic and self-instructive learning in remedial spelling training: The students' improvements are much more significant between test points 2 and 3 than between 1 to 2, which is proof for the effects of the intervention. The heterogenous composition of the training cohort has not influenced these results – on the contrary, changes

can be noted across gender and grade levels. This may also be an indication for appropriate individual adaptation of the training.

Concerning the individual data, these results also provide important information about a educationally helpful assessment of the training to date: The progress, evaluated by spelling tests, seems quite marginal, even though the respective students have significantly improved in various areas. The results of the norm-referenced spelling tests can (so far) only somewhat reflect this progress – e.g. the intra-subjectively achieved competency increase is not sufficient in a social comparison. Due to the often massive amount of errors in several areas at the beginning, these relative discrepancies between intra- and inter-individual evaluations of training effects are to be expected. For an evaluation of the students' improvement, the case-specific before and after differences in the systematically trained areas should be used, and looked at within the context of all case-specific problem aspects – particularly the extent to which certain critical characteristics concerning cognitive-motivational, behavioral, and knowledge-based learning conditions of the respective students make learning more difficult or could even block learning.

Independent from practical and conceptual perspectives of this nature, it might be interesting as well, eventually, to examine whether the visualizing and verbalizing methods developed can be systematically transferred to rule-specific spelling trainings in the orthographies of other languages, and whether they can be integrated into other training approaches phonologically oriented (Faber, 2006; Lovett, Lacerenza, Borden, Frijters, Steinbach & De Palma, 2000; Mäki, Vauras & Vainio, 2002).

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