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**Dr. Christian Marquardt** has been conducting research into the underlying motor skills involved in writing for several years. He received a PhD at the Faculty of Medical Psychology at the Ludwig-Maximilian-University in Munich, Germany, on the subject of kinematic movement analysis. He has been a member of the clinical neuropsychology development team at the Munich-Bogenhausen, Germany, hospital since 1990. Together with his team, he has developed a computer program that analyses the motor skills used when writing.  
**Author, Chapters 1 and 2**



**Dr. Johanna Barbara Sattler**, psychologist and certified psychotherapist, is the head of the First German Advice and Information Centre for Left-handers and Retrained Left-handers in Munich, Germany. She has published numerous specialist publications and holds seminars and presentations for participants working in schools, education and therapy. She is currently researching graphomotor developments in left-handed pre-school and primary schoolchildren, together with Dr. Marquardt.  
**Author Chapter 3**



**Renate Reitmeier** teaches the first two years at the Unterpfaffenhofen primary school in Germering, Germany. As a supervising teacher, she is also responsible for trainee teachers. In addition to this, as a certified left-hand advisor following the methods of Dr. Sattler, Ms Reitmeier has offered writing preparation courses for left-handed children since 2007, in addition to numerous presentations and further training courses for teachers, pre-school teachers and parents.  
**Author, Chapter 4**



**Thomas Baier** is a qualified primary school teacher. He worked for several years as a specialist advisor to renowned publishers of school books. In 1991 he founded CARE-LINE Verlag und Projektagentur GmbH, a publishing and project agency focussing on the cooperation between school and industry, and has been the company's managing director ever since. Thomas Baier has contributed to numerous teaching materials as an educational consultant and editor.  
**Educational Consultant**



# Dear teachers,

Poor posture, cramped pen hold, a high level of writing pressure, writing that is too slow, illegible, scruffy or featuring mistakes – when dealing with writing and learning to write at primary school, the same problems often rear their heads again and again. Teachers, parents and children are often at a loss as to how to solve writing problems.

Writing problems are often considered to result from too little practice or from a lack of fine motor skills. Yet why then does practice alone not automatically lead to improvement? Sometimes, it even leads to a more cramped sitting posture and pen hold, along with pain in the hand. In addition, writing becomes increasingly illegible when making the transition from the shape-dominated initial form of writing to individualised hand writing.

However, these problems can be successfully solved if recent findings of research into motor skills are systematically put into practice. The assumption that an automatic and flowing movement can develop on its own from the precise repetition of a shape has now been refuted. While schools focus in detail on the slow, shape-oriented writing (or drawing) of graphemes, the motor aspects of learning to write are neglected. For the most part, it is left to the children themselves to later attempt to develop automatic writing movements from this precise, slow-motion writing.

The materials presented here provide scientifically-supported assistance for teachers, parents and children with regard to learning to write.

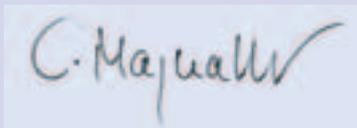
**Chapter 1** examines the current problems in schools and describes the basic elements of learning to write from a scientific perspective.

Leading on from this, **chapter 2** presents a motor skills-oriented approach to learning to write. Simple exercises provide examples and support to encourage the development of key aspects of motor skills for writing.

**Chapter 3** deals with the important subject of handedness and offers particular help for dealing with left-handers.

**Chapter 4** offers concise background information regarding the requirements for learning to write at home, kindergarten and pre-school, which can be used at parents' evenings and information events.

Here's to successful and innovative lessons!



*Dr. Christian Marquardt*

Symbol key:  Useful to know.

 Exercises.

## Chapter 1

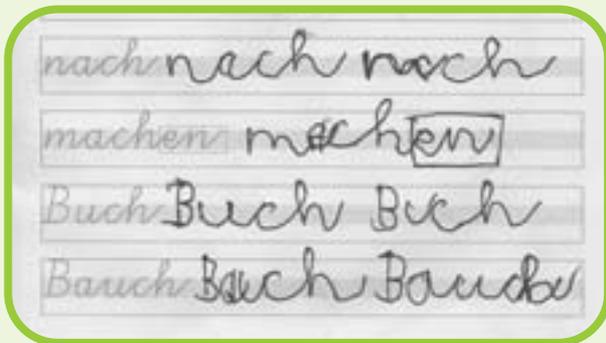
*Writing problems  
from the current  
scientific perspective*

# Problems when learning to write at school

Handwriting requires the ability to exercise precise motor control, intact coordination skills and visual-motor control of the fingers and hand. Writing is linked with development of these motor skills in accordance with the writer's age.

## Common individual writing difficulties which emerge when starting to learn to write include:

1. specific wrongly-shaped capital and small letters,
2. changing letter shapes,
3. lots of curves and bent figures in the basic shapes of letters (ovals, garlands, loops at top/bottom), so that the writing can be called meandering,
4. changing writing directions, noticeable leftwards slant,
5. connections between letters made too close together, too far apart or incorrectly,
6. irregular orientation on the paper,
7. frequent breaks and displacement within the letters and at different points.



Writing difficulties shown by a year 1 pupil



## Finger and hand motor skills

Harmonious coordination between finger and hand movements is of special significance. Motor skills are always learned initially by the larger joints, with the smaller ones following. In particular, coordination of finger movements is still limited in children. Children who have problems with writing skills often find it difficult to bring together the tips of each of their fingers, from little finger to index finger, with the tip of their thumb in such a way that the thumb curves in a rhythmic gripping movement towards the finger tips. Often, the thumb remains extended and the fingers in turn stretch to reach it. Good flexibility and coordination of the thumb and index finger, however, supports flowing and rhythmical writing.



*Problematic pen hold. Freedom of movement in the joint is restricted and the grip pressure is too high*

## Correct sitting posture

Posture anomalies and a poor seating posture resulting from these can also affect writing. The more the arms and hands have to support the upper body when writing, the more pressure is exerted by the hand on the writing surface, restricting movement of fingers and hands. The children write increasingly from the wrist, and the cramped strokes alter the basic shape of the writing. As a result, writing is slower, the hand is more difficult to move and the children tire more quickly.

Many of these writing difficulties can be directly linked to the task itself, namely copying letters precisely in a small space. If children are allowed to write with large movements, to create only shapes that resemble letters or perhaps even to write on the desk without a pen and instead using their finger, the movements then become considerably more flowing and the amount of energy required decreases dramatically. Prescribing a normative initial form of writing before children actually start to learn to write – in other words, writing that pays considerably more attention to shapes, even more so than adult handwriting – is, from a child's motor development perspective, highly problematic and excessively demanding.

## Initial form of writing at school

Development of flowing, legible and efficient handwriting is undoubtedly one of the long-term aims of teaching writing. However, the way in which these aims are accomplished is a matter of some controversy. There is agreement, however, that some initial form of writing should be taught as a basic starting point, which can be used for the subsequent development of an individual form of handwriting.

All common methods of teaching writing put the learning focus on a target alphabet. The teaching model behind this assumes that repeating letter shapes often and precisely leads to the movement patterns being developed, fine-tuned and ultimately saved in the brain as an automatic movement programme. **However, this model overlooks the fact that completely different motor control processes are required for copying shapes and for fast writing.**

# Differences between initial writing forms to well-practised writing

If you compare the initial form of writing with the handwriting of well-practised writers, what is immediately noticeable is the striking difference in the formal aspects in particular.



Initial form of writing at school



Handwriting of well-practised writers

## The differences can be seen in

- the degree of precision in shaping the letters (capital letters are written as "block letters"),
- the uniformity of rotational direction when writing ("n" is written as "u"),
- the simplification of certain letters, insofar as these remain legible ("h" becomes "l"),
- the omission of entire letters at the end of words,
- the fact that the pen is lifted every 2–3 letters,
- the systematic connection of groups of letters where the movement required is straightforward ("el", "ch") and the systematic separation of groups of letters where it is not ("nd", "ig"),
- various size ratios and pen angles.

While the initial form of writing is entirely dominated by precise letter shapes, the well-practised handwriting seems to have been influenced almost completely by efficiency. Almost anything goes to make the writing more efficient, as long as it remains legible. **However, it is the very aspect which is emphasised most strongly at school which we can surprisingly scarcely find in the well-practised adult handwriting.**

How does this serious difference between the prescribed writing form and the writing ultimately learned come about? Of course, the initial form of writing only presents an exact and form-oriented model to be followed. However, the question of how to take this copying and develop it into free-flowing handwriting is not answered by current standard methods of teaching writing, nor is the issue of whether this transfer is possible without encountering problems. In practice these issues are left for the most part up to the schoolchildren themselves. The only aspect of the subsequent individual handwriting which has educational consequences is a lack of legibility. However, the problems which occur when making the transition from an initial writing form, with a strong emphasis on shape, to actual handwriting, have not yet been systematically investigated.

# Making the transition to well-practised handwriting

Following the transition to an individual and more quickly written form of writing, some handwriting is scarcely legible and increasingly deteriorates. It is exactly this gap between precise “copying” of the initial writing form (neat writing) and then the faster and movement-oriented writing encouraged later that causes many schoolchildren to experience serious problems. When copying, the shape of the letters is visually checked and corrected while writing. As the writing speeds up, however, the letter shapes can no longer be checked as precisely while writing.



*Fast writing of the word “Rocket” by a year 4 pupil*

Fast writing is controlled by automatic motor programmes. The key element is that in automated writing, the letters created are the result of the movement made and can no longer be directly checked. If, by this stage, the child has not developed any appropriate and coherent (to them) concept for faster writing, problems are inevitable. However, the development of appropriate motor skills is neither encouraged nor checked in standard methods of teaching writing.

Expert studies show that when children are forced to write faster with insufficiently developed writing movements, they are unable to control the shapes, the writing becomes illegible and the spelling mistakes increase. Repeated practice only bears success here, if movement-specific aspects of writing are practised and the child is instructed in how to adapt their writing to make it more movement-friendly. If the focus continues to be on the precision of the written letters, this may lead to increased cramping and then to even greater problems.

In addition to writing problems, children may display other symptoms such as an increased inability to concentrate, hyperactive behaviour, difficulty reading and spelling. They may also need support in terms of physical and motor development and behaviour. Yet even when the developmental requirements for learning to write are in place, children clearly do not always possess sufficient concepts in order to deal with the complex challenges posed by writing. In order to solve these writing movement problems, the principles behind the actual movements used in the process of writing have to be investigated. As early as 1970, H. Grünwald, founder of simplified cursive, called in the introduction to the book “Schrift als Bewegung” (“Writing as movement”) for “writing to be viewed less in terms of form and far more in terms of movement aspects”. This approach to writing movements has only been followed sporadically in the almost 40 years since.

# Kinematic writing analysis

It is quite difficult for an outside observer to understand why analysis of writing movements and extensive research into motor learning have scarcely been taken into account so far in discussions on teaching writing. Since the introduction of graphic writing tablets, recording writing movements no longer poses a great challenge from a technical point of view. Writing on a graphic tablet does not differ greatly at all from normal writing conditions. A special wireless stylus, similar to a rollerball pen, is used to write on a sheet of paper on the tablet. The position of the writing tip on and across the writing surface is registered with a precision of 0.2 mm and 200 data points per second, and then transmitted to a PC where this information is recorded. In addition, writing pressure is measured using a pressure gauge in the stylus. This recorded positional data is then used at a later stage to calculate exact movement aspects such as speed and acceleration.

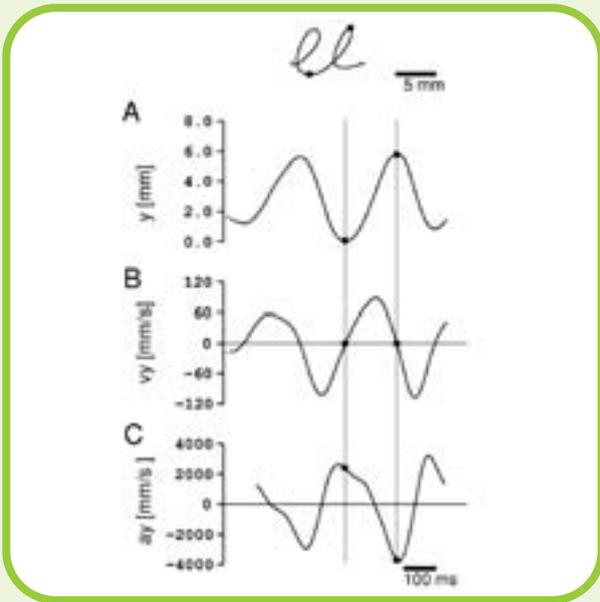


Graphics tablet for recording writing

## Characteristics of well-practised hand writing

All the details of the movement performed when writing can be examined with the help of the recorded data from the computer analysis. Despite the considerable variety of individual handwriting styles, there is a surprising degree of uniformity in the way movements are made by well-practised writers. The writing movements are always fast, flowing and seemingly effortless. Flowing writing can be characterised in a simplified form by a quick series of up and down strokes (using the wrist) at the same time as the pen is moved back and forth (by the fingers). This is accompanied by picking up and putting down the writing instrument, and the necessary hand movement for writing longer sentences.

If we view the smallest unit analysed in writing movements, i.e. an individual up or down stroke, the accompanying speed curve always shares one specific characteristic for well-practised writers. With its regular and rhythmical movement, the writing is similar to the even swing of a pendulum. In the image overleaf, the writing movement of a well-practised writer is shown using the example of the letters "ll". A stroke in the y-direction (upwards) is indicated by two marks (A). The speed profile (B) for this stroke indicates a regular and symmetrical movement. The speed is at its peak exactly in the middle of the movement. A similarly even acceleration and deceleration phase (C) can be recognised in the acceleration profile. This means that the muscles are accelerated and then decelerated just once per individual movement. Just 200 ms are required for an "l" here, in other words five "l"s would be written per second.



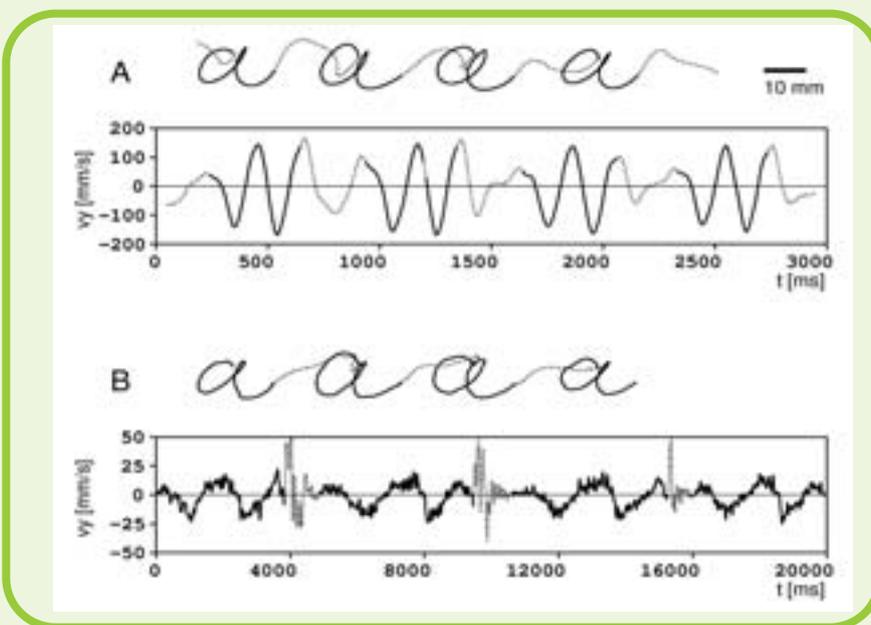
When the same letter is automatically written several times, a surprisingly high level of repeated precision in all details of the movement is evident. This uniformity of speed and acceleration curves shows that the same sequence of movements is always performed here.

Characteristic of automatic writing movements

## Non-automatic movements when copying

Slow drawing movements which focus on accuracy are the opposite of fast writing movements which cannot be controlled in detail. Copying movements such as these are characterised by a constant visual comparison of target and performance. In the following example, a writer was asked to initially write the letter "a" in normal handwriting

and then to copy it precisely. The writing is very similar in both cases. Automated writing results in the usual smooth and regular speed curves (A). However, in the speed profile which accompanies the copied letter we can see the numerous irregular acceleration and deceleration patterns (B). The copying took almost seven times as long.



Different movements when writing and copying the same letters

Irregularities and frequent deceleration and acceleration phases are typical for all non-automatic movements. For such movements, the muscles are activated several times for an individual movement. Much more time is required for copying in comparison with normal writing. Non-automatic movements are typical for unlearned movements or movements which require an extremely high level of precision. Non-automatic movements are therefore subject to completely different control mechanism from automatic movements. **That is why children do not necessarily learn the dynamics of fast writing from practising slow drawing movements.**

## Motor Learning as a solution

Which mechanism is actually involved in learning writing motor skills, if writing cannot be learned through repeated practice alone? Motor learning always develops from initial, slower, large-scale movements down to ever more precise, faster and thus less controllable movements. Experiencing the dynamics of the movements is of particular importance here. Motor learning always involves the individual adapting and trying our various solutions. For example, walking is often learned as a result of falling over often and thus getting to know factors which are important for balance. Just a walking is the result of movement, so is writing on a page. Studies from the UK show that children actually develop problems walking later if they learned to walk using a babywalker.

Unlike the model of learning through frequent practice, the **"pattern" learning model** views a movement as a pattern and focuses on the experience of movement under variable conditions. In this model learning is defined as the **"repeated search for a solution to specific task"**, and not at all as "repeating the solution to a specific task". Using this model as their starting point, teachers do not have to confront children so often with a model solution for writing, but rather assist children in the search for their own individual solution. Of course, these individual solutions should not additionally confuse or cause incorrect and obstructive movements. It can be concluded that children may get to know the letter shapes from an initial writing model, yet they do not get to know the way these letters can be written dynamically. Excessive emphasis on precise forms of writing makes the search for this all the more difficult. **That is why when writing is taught, the focus should not be only on the form of the writing itself, but also on encouraging the development of writing movements and experiencing movement.**



# Closing remarks

More recent methods of analysing writing represent an attractively simple way to analyse the system behind well-practised handwriting and establish principles for the construction of joined-up writing. Such an approach, however, shifts the focus of teaching to write – it is no longer on a precise standard form of writing, but instead on the individual path to acquiring efficient writing motor skills. Children should learn suitable writing motor skills right from the start, which are increasingly channelled into the intended form of writing in the course of the learning process. Furthermore, the critical influences on the writing process can also be systematically identified and linked to each other.

It has therefore been shown that the joining-up process required in writing at school and the complex letter shapes are not suitable for flowing writing in terms of motor skills. Other investigations have shown that automatic writing is considerably hampered by conscious visual checks of writing form. This also applies to the border lines used in the initial stages of teaching children to write. A more recent study suggests that the motor skills possessed by children when they start school should be used directly for teaching writing. Other concepts such as creative teaching of writing call for writing to be learned at the very dividing line between forced movements and the breakdown of the letter shapes. Here, instead of being encouraged to write extremely slowly and neatly, the child is guided to write with the greatest possible speed of movement whilst still paying attention to form in principle.

The exercises presented in chapter 2 attempt to take these aspects for promoting writing motor skills into consideration. They therefore deliberately focus on promoting the kinetic aspects of writing.

