



Research Article

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In this section I am pleased to include a research report from one of our students on the advanced diploma course *'The Teaching and Learning of Handwriting from Nursery through Secondary School'* run by the NHA and the Institute of Education University of London. This report is a revised version of coursework submitted for the diploma.

An Audit of Typical Pencil Grasp in a Nursery/Reception Class

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Introduction

Guidance from The National Literacy Strategy (2001, p.161) on developing handwriting advises teachers that "...If children are to develop a fluent and fast handwriting style, they must learn to hold a pencil with a grip that is relaxed but allows for efficient control of the pencil". It goes on to state that "...experts agree that children should be encouraged to hold the pencil between the thumb and forefinger with the pencil resting on the third finger" - a rudimentary description of the dynamic tripod grip. However, little guidance is given regarding what constitutes a normal developmental progression of pencil grip and when, if at all, teachers or Occupational Therapists should intervene.

"The development of pencil grasp in young children follows a fairly predictable course in children who are typically developing" (Amundson and Weil, 1996). "Knowledge of age differences in pencil grip can prevent premature attempts to elicit complex prehensile movements and therefore forestall the resulting maladaptive grip patterns" (Ziviani, 1995).

The maturation of grip postures has been addressed in only a few studies (Goodgold, 1983; Hwang, 1991; Rosenbloom and Horton, 1971; Saida and Miyashita, 1979, Schneck and Henderson, 1990 - cited in Tseng, 1998). However, use of different

classification criteria in describing similar or identical pencil grips, cultural differences and differences in the age ranges studied makes it difficult to draw comparisons from the results.

Rosenbloom and Horton (1971) - cited in Schneck and Henderson (1990), studied the development of pencil grip, including development of the tripod grasp, in 128 British children between the ages of 1.6 and 7 years. Pencil grip was seen to develop in 3 stages: a) a palmar grasp with the index finger extended along the shaft, b) a static tripod grasp i.e. the tripod posture of the fingers without the intrinsic components of movement and c) a dynamic tripod grasp i.e. the three fingers functioning together to make small highly co-ordinated movements.

Saida and Miyashita (1979) - cited in Schneck and Henderson (1990), replicated the British study on a Japanese population of 154 children between the ages of 2.3 - 6.5 years. They identified 4 developmental stages in pencil grip: palmar grasp, incomplete tripod posture, static tripod grasp and dynamic tripod grasp.

Goodgold (1983) - cited in Tseng (1998), studied handwriting movement in 20 American pre-kindergarten and 57 kindergarten children. Four stages of pencil grip development were identified: a fist grip, a palmar grasp, a grip with various oppositions of thumb and fingers and the dynamic tripod grasp. They also observed a developmental trend in pre-school children's acquisition of handwriting movement skills. In all three studies, the grips that developed prior to the dynamic tripod grip and the variations of mature grips other than the dynamic tripod grip were not fully described.

Schneck and Henderson's (1990) study expanded the sample size to 320 children aged 3 - 6.9 years, with 20 boys and 20 girls at each 6 month interval. They produced a developmental scale of pencil and crayon grips that assessed the components of grip and arm posture. Initially, eleven grips described in the literature were included in the scale. However, the interdigital grip was not observed in any of the children in the preliminary investigations and was subsequently excluded. The 10 point grip scale developed takes the form of a whole configuration system, where the identified grips represent the most



common component combinations and account for most grip possibilities.

Schneck and Henderson (1990) recorded the grip type used by each child to perform a drawing and colouring task. Hand preference was also noted. The study confirmed Goodgold's (1983) findings of a developmental progression of pencil grips and went on to classify the recorded grips into 3 stages:

- Primitive - grips seen infrequently after 4 years of age.
- Transitional - grips that decreased with age but continued into the sixth year.
- Mature - grips observed to increase with age.

The data showed that large percentages of children at all of the age levels studied used mature pencil grips. Mature grips included the lateral tripod and dynamic tripod. The dynamic tripod grip was found to be the most common mature grip demonstrated in all but the youngest group of children. However, 25% of children in each of the four highest age levels used the lateral tripod grasp. Although the general developmental trends were similar, Schneck and Henderson (1990) demonstrated that before the age of 4.6 years, more girls showed mature grips than boys. This gender difference was not demonstrated in the older age groups.

Tseng (1998) replicated Schneck and Henderson's (1990) study on a sample of 326 Taiwanese children. The results demonstrated a similar developmental progression but identified a further four grip patterns - three variations of the interdigital grasp, which were classified as primitive grasps, and the quadrupod grasp, classified as a mature grasp. In Tseng's (1998) study, the dynamic tripod grasp was not the most common mature grip used by all the age groups. In the older age groups, 40% of children used the lateral tripod grip, which equalled the numbers using the dynamic tripod grip. These findings demonstrate cultural differences in the frequency of grip types and the ages at which different pencil grips are observed.

In working with young children in the classroom it is not only important to have knowledge of the typical development of pencil grip, but also to under-

stand the variables that may affect this. Schneck and Henderson (1990) demonstrated that the use of pencil grip is influenced by the nature of the task for which the writing implement is used. Many children used less mature grips when colouring spaces than when drawing. The impact of the diameter and shape of the writing implement on pencil grip is less clear. Previous studies by Wiles (1942-1943), Lamme and Ayris (1983) and Carlson and Cunningham (1990) - cited in Burton and Dancisak (2000), found no differences in performance or grip related to diameter of the writing implement. Henderson et al (1995) also concluded that a change of pencil did not affect grip, following a trial of the use of triangular pencils. However, Burton and Dancisak (2000) found that grip level decreased with increasing pencil diameter.

In the present investigation, two studies were conducted. The aim of study one was to establish the pencil grips used by typically developing Nursery and Reception Class children in a British sample. The aim of study two was to investigate whether the pencil grips used are consistent across different writing tools available within the classroom.

Study One

Method

Participants. The participants of this study were 50 children attending the Nursery and Reception classes of a mainstream Primary School in Blaenau Gwent, Wales. The age range was 3.8 - 5.10 years. Due to relatively small numbers of children, it was not possible to group them into 6-month age bands, as in other studies. Children were therefore divided into broad age bands: 3 years, 4 years and 5 years. There were 9 three year olds, 12 four year olds and 29 five year olds. Equal numbers of boys and girls were included in the study but this was not represented in each of the age bands.

Measurement. Pencil grip was assessed using Tseng's (1998) 14 grip pattern rating scale, which combined the Schneck and Henderson (1990) 10 grip scale with the four additional grips observed in Tseng's study, placed in developmental order:



Primitive Grips

1. Radial cross palmar grasp - pencil positioned across palm projecting radially, held with fist hand, forearm fully pronated, full arm movement. (Morrison, 1978, cited in Schneck and Henderson, 1990)
2. Palmar supinate grasp - pencil positioned across palm projecting ulnarly, held with fist hand, wrist slightly flexed and supinated away from mid-position, full arm movement (Erhardt, 1984, cited in Schneck and Henderson, 1990).
3. *Interdigital grasp (variation 1) - Fingers are fist into the palm and the pencil is positioned across the palm and projects ulnarly from the interdigital space of the index and middle fingers. Movement mainly occurs in the metacarpophalangeal joints of the fingers and at the wrist. The forearm may be positioned on the table (Tseng, 1998).
4. *Interdigital grasp (variation 2) - Fingers are fist into the palm and the pencil is positioned across the palm and projects ulnarly from the interdigital space of the middle and ring fingers (Tseng, 1998).
5. *Interdigital grasp (variation 3) - Fingers are fist into the palm and the pencil is positioned across the palm and projects ulnarly from the interdigital space of the ring and little fingers (Tseng, 1998).
6. Digital pronate grasp (only one finger extended) pencil held in palmar grasp with index finger extended along pencil toward tip, arm not supported on table, full arm movement (Morrison, 1978, cited in Schneck and Henderson, 1990).
7. Brush grasp - pencil held with fingers, eraser end of pencil positioned against palm, hand pronated with wrist movement present, whole arm movement, forearm positioned in air (Schneck and Henderson, 1990).
8. Grasp with extended fingers - pencil held with fingers, wrist straight and pronated with slight ulnar deviation, forearm moves as a unit (Schneck and Henderson, 1990).

Transitional Grips

9. Cross thumb grasp - fingers fist loosely into palm, pencil held against index finger with thumb crossed over pencil towards index fingers, finger and wrist movement, forearm positioned on table (Gesell, 1940, cited in Schneck and Henderson, 1990).

10. Static tripod grasp - pencil stabilised against radial side of third digit by thumb pulp with index pulp on top of shaft, thumb stabilised in full opposition, wrist slightly extended and hand moving as a unit, pencil resting in open web-space, forearm resting on table (Rosenbloom and Horton, 1971, cited in Schneck and Henderson, 1990).
11. Four finger grasp - pencil held with four fingers in opposition, wrist and finger movement, forearm positioned on table (Schneck and Henderson, 1990).

Mature Grips

12. Lateral tripod grasp - pencil stabilised against radial side of third digit with index pulp on top of shaft of pencil, thumb adducted and braced over or under anywhere along lateral border of index finger, wrist slightly extended, fourth and fifth digits of tripod and wrist movements on tall and horizontal strokes, forearm resting on table (Schneck, 1987, cited in Schneck and Henderson, 1990).
13. Dynamic tripod grasp - pencil stabilised against radial side of third digit by thumb pulp with index pulp on top of shaft of pencil, thumb stabilised in full opposition, wrist slightly extended, fourth and fifth digits flexed to stabilise metacarpophalangeal arch and third digit, localised movement of digits of tripod and wrist movements on tall and horizontal strokes, forearm resting on table (Rosenbloom and Horton, 1971, cited in Schneck and Henderson, 1990).
14. *Quadrupod grasp - the way children held the pencil was identical to the dynamic tripod except that the pencil was stabilised against the radial side of the fourth digit by the thumb pulp with the index and middle finger pulps on the shaft of the pencil and the thumb stabilised in full opposition. Children demonstrated intrinsic hand muscle movements in a co-ordinated manner and with their forearms resting on the table (Tseng, 1998).

(* denotes grips identified by Tseng, 1998).

The illustrated form of Schneck and Henderson's (1990) 10 grip patterns was utilised for ease of scoring, with descriptors added for the four additional grip patterns identified by Tseng (1998). Given the age range of the children in this study, it was not, however, anticipated that the interdigital grasps

would be observed, as Tseng noted these only in children under the age of 3 years.

Procedure

The children were tested in small groups, the size of which depended on their age. The three and four year olds were tested in pairs, as they frequently needed higher levels of instruction and support. The five year olds were tested in groups of four, as they were used to working in this small group format and required less support. All children were tested in a quiet room, seated at standard height, Nursery/Reception sized classroom furniture.

Each child was presented with an A4 sized sheet of plain paper (in portrait position) and a sharpened HB pencil (7mm Diameter). They were asked to make a drawing of a person - a familiar activity which was considered to be appropriate across the three age bands. Where younger children required assistance with the task, a circle was drawn by the assessor and the child was encouraged to add facial features. The drawing products were not scored.

Each child's pencil grip was observed during the drawing task and assigned a rating from the 14 grip rating scale. It was noted that younger children tended to change hands and/or grips whilst drawing. Where this occurred, the most advanced grip observed was rated. Each grip was then classified as Primitive, Transitional or Mature, according to Tseng's (1998) Classification System.

Results

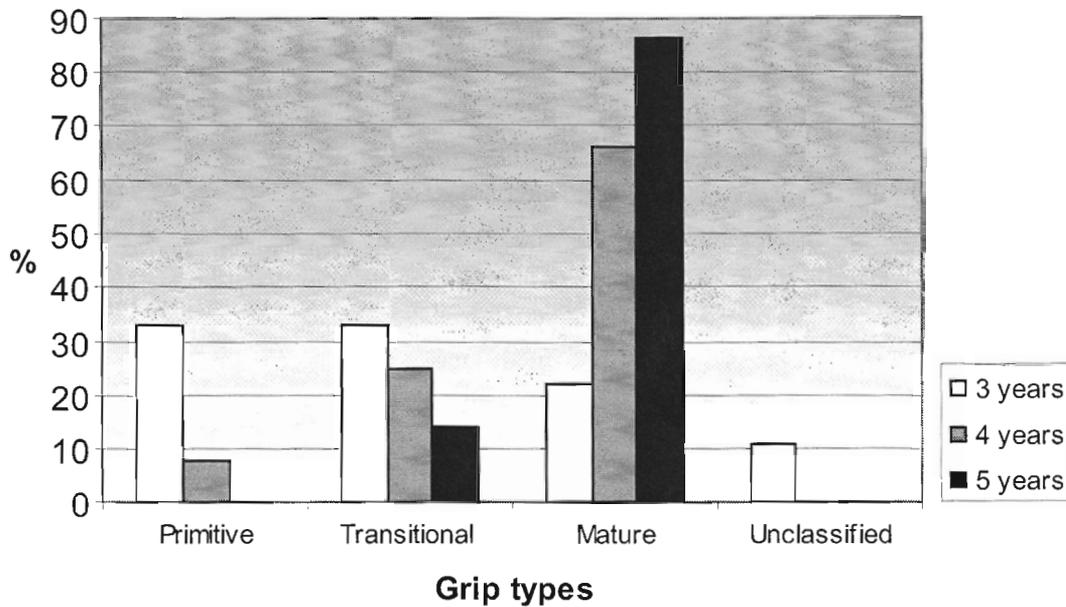
49 out of the 50 grips observed could be classified according to Tseng's (1998) 14 item grip scale (Table 1). Only one grip, exhibited by a 3 year old, could not be precisely classified; the pencil was held with the thumb and three fingers in extension, spread along the entire length of the pencil shaft.

As anticipated, the interdigital grasps described by Tseng were not observed, as the age range in this study did not go below the age of 3 years. The quadrupod grip, described by Tseng was, however, noted on 5 occasions.

Table 1
Study 1: Number of children in each age group using each type of pencil grip

Pencil grip	Age (years)		
	3	4	5
Primitive			
Radial cross palmar grasp	0	0	0
Palmar supinate grasp	2	0	0
Interdigital grasp	0	0	0
Digital pronate grasp	1	1	0
Brush grasp	0	0	0
Grasp with extended fingers	0	0	0
Transitional			
Cross thumb grasp	0	0	0
Static tripod grasp	3	3	4
Four finger grasp	0	0	1
Mature			
Lateral tripod grasp	0	2	14
Dynamic tripod grasp	1	5	7
Quadrupod grasp	1	1	3
Unclassified	1	0	0
TOTAL	9	12	29

Figure 1. Percentage of children using Primitive, Transitional and Mature pencil grips



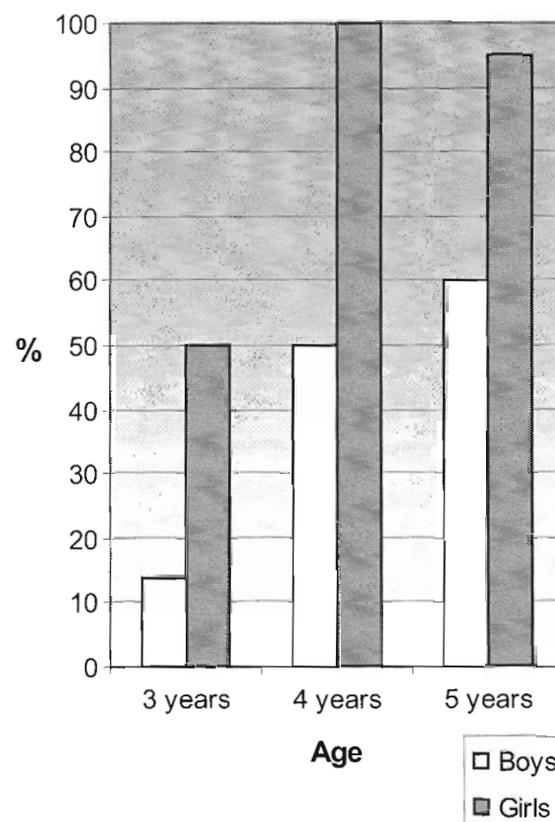
This study replicated the developmental progression found by both the American and Taiwanese studies, with the frequency of the primitive and transitional grips decreasing with age (see Figure 1). 22% of the 3-year olds were able to use a mature grip, compared to 66% of 4-year olds and 86% of 5-year olds.

Of the 5 year olds using mature pencil grips, 58% used the lateral tripod grip compared to 29% using the dynamic tripod grip. The dynamic quadrupod grip, described by Tseng (1998) was used by 12.5% of children. Although not directly comparable with the American and Taiwanese data it would appear that a significantly higher percentage of the older children in this study used a lateral tripod grip.

Tseng's (1998) study did not look at the differences between boys and girls. However, in this study (Figure 2), the gender differences were largely comparable with Schneck and Henderson's (1990) findings in relation to the younger group. 50% of the 3 year old girls in this study demonstrated a mature pencil grip as compared to 14% of 3 year old boys. At age 4 years, 50% of boys were demonstrating a mature pencil grip compared to 100% of girls. In Schneck and Henderson's (1990) study gender differences in the number of children using a mature grip were not demonstrated beyond 4.6 years. At age 5, 95% of girls in the present study demonstrated a mature pencil grip compared to 60% of boys.

More boys (30%) using a mature grip demonstrated a dynamic tripod grasp than girls (21%) in the older age group; this also follows the findings of Schneck and Henderson (1990).

Figure 2. Percentage of boys and girls using mature pencil grips at each age



Study Two

Method

Participants. The participants of this study were 10 children - 5 attending the Nursery Class and 5 attending the Reception Class. Children defined by the class teacher as being of average general ability were selected randomly. Although not specifically requested, each class teacher selected two boys and three girls. The Nursery Class sample comprised one 3 year old and four 4 year olds. The Reception Class sample comprised five 5 year olds.

Measurement. Tseng's (1998) 14 grip pattern rating system (see Study 1) was used to categorise each child's pencil grip.

Procedure. The children were tested individually in a quiet room, seated at standard height, Nursery/Reception sized classroom furniture.

Each child was presented with a sheet of A4 sized paper, pre-printed with three boxes at the top of the page, each containing a shape - a vertical line, a horizontal line and a circle. These were selected from the Beery-Buktenica Developmental Test of Visual Motor Integration (Beery and Beery, 2004) as shapes achievable in copied form by the age of 3 years in typically developing children.

The child was asked to copy the three shapes using a sharpened H.B pencil (7mm Diameter). The child's pencil grip was observed and rated. The child was then asked to repeat the exercise using a large barrelled 'Staedtler Maxi' pencil (8mm Diameter, hexagonal) and again using a triangular barrelled, 'Handhugger' pencil (9mm Diameter). The writing tools were selected as those most commonly used in the Nursery/Reception classroom, in the researcher's experience. The drawing products were not scored.

Results

All children in the younger age group had an already established mature pencil grip. In this group, four out of five children demonstrated consistency of grip across the 3 tools. One child demonstrated consistency of grip across the H.B and 'Maxi' pencils but changed grip for the 'Handhugger' pencil, bracing his thumb across the shaft; this was still

a mature grip but appeared to reflect the need for greater stability in controlling the writing tool.

In the older age group, two of the children used transitional grips and three used already established mature grips. Four of the five children demonstrated consistency of grip across the 3 tools. One child demonstrated consistency of grip across the 'Maxi' and 'Handhugger' pencils but changed grip for the H.B pencil with the narrower shaft diameter; again, this was still a mature grip but appeared to reflect the need for greater stability in controlling the writing tool. Overall, pencil size/shape did not appear to significantly impact on grip form once a mature grip had been established. Although not a formal part of this study, preliminary findings would appear to suggest that grip was influenced by task more than writing tool, with changes of grip observed between writing and drawing tasks.

Discussion

The findings of Study 1 suggest there is a developmental progression of pencil grip, with maturity of grip being reached by a large percentage of children by the age of 5 years. The findings of Study 2 were inconclusive in relation to the impact of size/shape of the writing tool on grip form.

Schneck and Henderson's (1990) illustrations enabled a direct visual comparison of grip, which aided ease of rating when working with groups of children. It was anticipated that the addition of descriptors for the 4 grips described by Tseng (1998) would give a more comprehensive rating scale, enabling classification of all observed grips. However, in this study, it was still not possible to rate one child's grip precisely, according to the 14 point scale. Burton and Dancisak (2000) highlighted the fact that "individual participants often showed idiosyncratic finger positions that did not match any of the grips described by Schneck and Henderson", but went on to use the general characteristics of the grips in order to classify them. Classification according to the general characteristics was not considered in this current study as it was felt that degree of variability in rating would negatively influence any comparisons with previous studies. However, without a degree of generalisation it is extremely difficult to account for all idiosyncrasies of grip within a rating scale whilst retaining ease of use. Clarification on use of the rat-

ing scale would assist with comparisons between studies.

Although sample sizes were smaller and less representative than the American and Taiwanese studies, similar trends were documented in relation to the developmental progression of pencil grip. Age differences in pencil grip development were demonstrated by the increasing percentage of children in each age group who used mature grips. Tseng (1998) concluded that Taiwanese children tended to achieve a mature grip at an earlier age than American children. By the age of 5 - 5.4 years, 94.8% of Taiwanese children had developed mature grips. Only 77.5% of American children had developed mature grips at this age. At 5 years of age 86% of children in this study had developed a mature grip, placing their pencil grip development between the Taiwanese and American children.

Tseng (1998) attributed the original differences in mature grip development to cultural factors, specifically the fact that Asian children usually use chopsticks, which requires dextrous manipulation similar to the dynamic tripod grip. There would appear to be fewer cultural differences between the development of the American children and the population in this study.

In this study, 58.3% of five year olds using a mature grip, demonstrated a lateral tripod grip, compared to 40% in the two oldest age groups of Tseng's (1998) study and 25 - 27.5% in Schneck and Henderson's (1990) study. The quadrupod grasp accounted for 12.5% of mature grips in this study. Therefore, over 70% of mature grips observed in 5 year olds in this study are accounted for by grips other than the dynamic tripod grip. A further study of 6 year olds would be informative in establishing whether use of the lateral tripod is in fact a transitory stage in developing a dynamic tripod grip or whether it can be considered an established grip pattern. "Any grip, efficient or inefficient that has been used over time becomes kinaesthetically locked in. An immature tool grip that is kinaesthetically locked in inhibits a student's ability to advance to a higher level, even after hand development has progressed" (Benbow, 1987 - cited in Henderson and Pehoski, 1995, p.267). If this trend towards more common use of the lateral tripod grasp is further evidenced, should we be concerned?

"Handwriting speed and legibility have not been found to be adversely affected by pencil hold alone" (Sassoon et al, 1986; Ziviani and Elkins, 1986 - cited in Ziviani, 1995, p.186). The studies of Bergmann (1990), cited in Schneck and Henderson (1990) and Schneck and Henderson (1990) indicate that "until further studies are conducted, the lateral tripod grasp should be considered an acceptable alternative to the dynamic tripod grasp". However, the need for stability in the hand is given as a reason for why children deviate from the dynamic pencil grasp (Summers, 2000). Children have a greater flexibility in their joints than adults. "When joint stability is insufficient for controlled mobility, then pencil grasps, such as the lateral tripod and quadrupod grasp are seen as effective adaptations that provide stability" (Benbow, 1995; Ziviani, 1982 - cited in Summers, 2000). Tseng (1998) hypothesises of younger children that "...it is possible that because their intrinsic hand muscles are not yet ready for such delicate manipulations of a pencil, they adopt the lateral tripod grip to obtain better stability through extrinsic hand muscles". It may, therefore, be that as a society we are inadvertently pre-disposing children to develop lateral tripod and quadrupod grips by introducing writing tools before the child is developmentally ready.

The disadvantages of less dynamic grasps, which often create tension in the hand, are often apparent only after writing for extended periods of time. Therefore, they do not emerge until much later in a child's education when greater volume of work is an expectation. A study of 15 year old children classified as 'good' or 'poor' writers, carried out by Sovik, Amtzen and Karlsdottir (1993) - cited in Henderson et al (1995), found that quality of writing did correlate with grip and that most teenagers with 'poor' grips complained that they found writing painful. A less dynamic pencil grasp might therefore be storing up difficulties for children later in their educational careers. Longer term studies are required to investigate the links further.

Differences in the developmental progression of pencil grips between boys and girls were noted in this study. The results suggest that the progression rate of boys is slower than that of girls in developing a mature pencil grasp. Gender differences should therefore be kept in mind by teachers and

occupational therapists when evaluating children's performance in relation to handwriting skills and intervention.

The second study looked at the impact of the size / shape of the writing tool on grip form. However, it should be noted that the children in the sample for this study were inadvertently biased towards those with established maturity of grip. Due to the nature of selection, this was not determined until after the trial had begun. Equally, and for the same reasons, in addition to small sample size, the sample group was found not to be representative for age or sex. The results should therefore be interpreted cautiously.

Consistency of grip across the three tools trialed was evidenced in 80% of the children in this study. This suggests that once a mature grip has been established, the writing tool does not significantly influence grip form. However, it is unclear whether tool size / shape might impact on primitive and transitional grips. Further studies looking at younger children are required. Of the two children in the study that demonstrated inconsistency of grip, one demonstrated decreasing grip form with decreasing diameter of the writing tool and the other decreasing grip form with increasing diameter, but only on the largest tool. Results were therefore somewhat inconclusive and did not replicate the findings of Burton and Dancisak (2000) who suggested that grip level decreases with increasing implement diameter. At this stage, there would appear to be little evidence to support the provision of larger writing tools for the very youngest children, common in many Schools and Nurseries. Greater evidence is required to direct classroom practice.

Conclusion

This study demonstrated a developmental progression of pencil grip comparable with the studies of Schneck and Henderson (1990) and Tseng (1998). Mature pencil grips were demonstrated in 22% of 3 year olds, 67% of 4 year olds and 86% of 5 year olds. Girls appeared to reach a stage of mature pencil grasp before boys. Of the mature pencil grips used, the lateral tripod grip was used with almost twice the frequency of the dynamic tripod grip. The impact of size / shape of writing tool on pencil grip was inconclusive. Further study with a more representative sample is required.

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