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Learning the Pronunciation of Segmental Features of English Phonology at German Primary Schools – The Effects of Explicit Instruction on TRAP and the Dental Fricatives

Dissertation zur Erlangung des akademischen Grades Doktorin der Philosophie (Dr. phil.) im Fach Englische Sprachwissenschaft der Universität Paderborn

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List of Abbreviations

CEFR	Common European Framework of Reference
CLT	Communicative Language Teaching
COE	Council of Europe
ECC	European Cultural Convention
EFL	English as a Foreign Language
ELF	English as a Lingua Franca
GA	General American
GB	General British
KLP	Kernlehrplan
L1	First language
L2	Second language
LFC	Lingua Franca Core
NRW	North Rhine-Westphalia
RP	Received Pronunciation
SLM	Speech Learning Model

1. Introduction

Imagine you wanted to learn how to swim and took swimming lessons. In your first lesson, the instructor says 'Watch me!', jumps into the water and starts swimming up and down the lane. You can see how their head regularly goes underwater and resurfaces, and you can see lots of splashing in the area where the feet must be and around the instructor's head. Maybe you can even make out how the arms are moving underwater. After a while, the instructor stops, looks up to you and says 'Your turn, jump in!'. How would you feel?

Probably quite similar to pupils learning English and being asked to 'Repeat after me'. Unlike other areas of foreign language learning, pronunciation is much less a cognitive feat than a physical one. And, just like any other physical activity, the movements involved must be known and practiced to build muscle memory. In the swimming example, we would probably protest loudly and fear the risk of drowning if we were asked to jump in just after watching someone swim for a short while. Instead, the future swimmers might expect the instructor to describe which movements are involved and give demonstrations on dry land before asking them to practise in the water. With pronunciation exercises, students are often required to repeat sounds or words after the teacher, without receiving any prior explanations as to which movements are required to produce the sounds or words at hand. Although this often leads to decent results in the end (and there is no risk of physically drowning), the pupils might nevertheless be overwhelmed, and target pronunciation may never be achieved. They are being asked to pronounce something they never have pronounced before and have to trust their muscles to know what they are doing, because they might not be able to objectively hear what they are saying themselves. And, in the case of speech, the speaker must trust over 200 muscles to do the right thing (Korte 2010: 159). Moving muscles in a way that is entirely unfamiliar can be quite an intimidating task and needs practice, patience, and a certain amount of courage. Porter and Garvin even go so far as to say: "By requiring someone to utter strange sounds, etc. we are making them

go against deeply rooted conceptions of what is desirable, correct, acceptable, dignified, etc. The teaching of pronunciation will therefore go against the grain, and may even constitute a humiliation." (qtd. In Dalton and Seidlhofer 1994: 7).

Being asked to do this without being adequately prepared can cause the pupils to be afraid of speaking in the foreign language in the first place and result in pronunciation that is far from target-like. Because, once something has been stored in muscle memory, we switch to "pronunciation auto-pilot" to focus our attention on what we are saying rather than how we want to say it (Pennington & Rogerson-Revell 2019: 35). The auto-pilot will draw on anything it is familiar with and, in the case of a language learner, this often means it will draw on the speaker's mother tongue (henceforth L1) if it has nothing from the target language (henceforth L2) to fall back on (Pennington & Rogerson-Revell 2019: 34ff.). If the learner does, however, have a solid L2 base stored in their muscle memory, the auto-pilot will use this, and the learner may include fewer features of their L1 in the pronunciation of L2 words. Whatever pronunciation the auto-pilot draws on, it will eventually become stabilised and even risk becoming fossilized, i.e. a fixed part of the interlanguage (Bach & Timm 2009: 210), rendering any remedial pronunciation instruction useless in terms of cost and effect (Marks 2011: 64). Even if remedial work on pronunciation can still be done, it costs learners and teachers much more effort than introductory work on pronunciation to yield any results at all, and even then, it may not be as fruitful as teachers and learners may have hoped (Ellis & Brewster 2014: 37). For this reason, pronunciation instruction should play a central role in early EFL settings. This is, however, not the case, making remedial work an essential part of more advanced pronunciation instruction (Pennington 2021: 7).

According to Pennington and Rogerson-Revell (2019: 35), learners need to develop a "motor production template" which they can fall back on rather than having to play by ear whenever they learn a new word. Currently, learners in German primary schools are typically not introduced to the English

sound system or individual sounds in isolation, but to new words and their pronunciation as and when they are needed. Transferring such knowledge from one setting to another is, indeed, challenging, especially at that age, but possible and useful on a long-term basis (Mindt & Schlüter 2007: 31). Having built muscle memory for sound production before learning a large amount of new words can help the pronunciation auto-pilot draw on that memory in order to pronounce new words rather than relying on a pronunciation that first runs through an L1 filter. An additional advantage is that connections can be made between different words containing the same phonemes which can help learning and taking control before letting the auto-pilot take over again. Establishing an age-appropriate classroom language that deals with phonemes and their production at the beginning of the learning process can help facilitate vocabulary learning over time, since the learner then has building blocks they can piece together as they need it, rather than trying to transfer pronunciation rules from one word to the next without anyone telling them explicitly that there is a connection. This would also be useful considering the grapheme-phoneme relation of present-day English which makes deriving any kind of phonological rules from one word to the next challenging even for advanced L2 learners, never mind early and especially young ones.

On a segmental level, there are often many overlaps in pronunciation between the L1 and L2, facilitating a rapid sense of success while learning the L2. This is especially important to keep early learners motivated and get them used to speaking in the L2. For those segmental features that are particular to the L2, knowledgeable yet mindful guidance and instruction through the teacher is necessary. That means that the teacher must be aware of which phonological features of the L2 can cause difficulties for their learners. Typically, difficulties occur if the phoneme-grapheme relation differs in the two languages or if the L2 contains phonemes that have no correspondence in the L1 (Pennington & Rogerson-Revell 2019: 71). If the teacher is aware of the difficulties many of their pupils will face, they can incorporate the appropriate guidance and instruction when planning lessons that introduce words with

such challenging phonemes. Because of our muscle memory and the pronunciation auto-pilot, relearning the pronunciation of words is strenuous, so learning a target-like pronunciation when being introduced to the word is most efficient. To be able to teach pronunciation from the beginning, teachers need to put all their linguistic knowledge to use but should also be able to find helpful resources to aid teaching apart from the well-known drilling exercises.

The role of pronunciation in the EFL classroom and in research has changed over the years and its importance varies as different approaches to EFL teaching take centre stage and others move into the shadows. As the teaching approaches changed, so did the perspective on pronunciation teaching, which is partly due to the foci of the teaching methods, but also due to changing cultural viewpoints. For example, when considering the factors that influence pronunciation learning, it is now widely acknowledged that social and psychological factors play an important role which is what sparked an ongoing debate about what the aim of pronunciation teaching should be (Pennington 2019: 3). For a more detailed overview over these factors and the debate about which English to teach, see chapter 3.7.

The current Communicative Language Teaching approach (henceforth CLT) focusses on effectiveness of communication. It puts fluency before accuracy and, in terms of pronunciation, focusses on suprasegmental features. This goes so far that, until recently, pronunciation was considered the "Cinderella of language teaching" (Marks 2011: 65) because of the small amount of attention it received in the EFL classroom. One reason for this might be that EFL teachers do not feel well-equipped to teach pronunciation, believing that their own knowledge and ability in this area is lacking. In a Europe-wide study, Henderson et al. (2015) asked English teachers from seven different European countries about the pronunciation training they received in preparation for becoming English teachers. On a 5-point Likert-scale, with 5 being 'excellent' training and 1 being 'extremely poor' pronunciation training, the highest average score was 3.24 for teachers in Macedonia. Only three nations were given an average rating of less than 3, Germany being one of them with 2.86, the

others being Switzerland (2.81) and France (2.63). The other participating countries Finland, Spain and Poland scored between 3.00 and 3.21. In this study, Germany provided the highest number of participants (n=278), the participant numbers of all other countries were fewer than 100. When being asked about their pronunciation training, most teachers mentioned courses they took on phonetics and phonology which involved theoretical lectures and transcriptions. The authors found that many of the teachers who participated in their survey believed in three "commonly held misconceptions about pronunciation", namely that it suffices to be a native-speaker or to have lived in an English-speaking country, and that having studied phonetics and phonology means being a good pronunciation teacher (Henderson et al. 2015: 268).

The lack of confidence many EFL speakers have in their own pronunciation stands in stark contrast to the fact that, whatever the target pronunciation may be, there seems to be a basic level of target pronunciation that must be achieved in order for the EFL speakers to communicate effectively. This means that, in turn, EFL speakers will always have struggle to communicative effectively if their pronunciation does not meet a certain level, however advanced they may be in other areas of that language, such as lexis or grammar (Celce-Murcia et al. 2010; Derwing & Munro 2015; Levis 2018).

Another aspect that may hinder already slightly insecure teachers is the lack of tried and tested teaching methods specifically for pronunciation. Unlike other areas of language learning, learning the pronunciation of a language is much more a motor skill than a cognitive one. Despite this, the most frequently used method for pronunciation training in the EFL classroom is drilling, not because it is the most efficient way of learning pronunciation, but because of a lack of alternatives (Böttger 2020: 98). And, indeed, very little research has been done in this area. Pronunciation and its teaching have been widely researched throughout the years (see for example Kissling 2013, Waniek-Klimczak & Shockey 2013 or Kautzsch 2014), and the effects of pronunciation training is of growing interest to the research community, but most studies consider more general teaching approaches and their effect on various aspects

of pronunciation and speaking in general. Darcy et al. state that teaching pronunciation is especially challenging for teachers because there is a lack of supporting guidelines: no clearly defined aims in the curriculum, no agreement over whether segmental or suprasegmental features should be focussed on and a "lack of guidance from research in determining level-appropriate pronunciation activity" (2012: 93).

Lee et al. (2020) investigated the effects of perception-based pronunciation instruction compared to production-based instruction, the former being defined as "aimed at increasing the participants' identification or discrimination abilities" and the latter as "eliciting the correct articulation of the target features while making use of corrective feedback" (ibid.). Their own research uses Flege's Speech Learning Model (henceforth SLM) as its theoretical base, assuming that language is learned based on perception (ibid.), and that production can only become more target-like once the phoneme at hand can be audibly perceived (ibid.). The results of this study confirmed this, but all experimental groups, including those who received production-based instructions, showed a significant gain in pronunciation accuracy. Nevertheless, the pronunciation instruction that was given here, whether perception-based or production-based, was given embedded in larger communication-based tasks (ibid.).

The SLM was revised by Flege and Bohn in 2021, renaming it SLM-r. The overall aim is to understand how phonetic systems reorganise themselves after L2 input throughout a learner's life (23). While it still assumes that perception is the key to effective pronunciation, it works with new assumptions that differ from the original model. For one thing, it claims that "there is no change in how the vowels and consonants found in an L1 and an L2 are learned" (23). In comparison to the original SLM, the SLM-r no longer differentiates between learners of different ages, arguing that the outcome is similar, as is the plasticity of the relevant regions of the brain for L2 speech (24 ff.). The reasons for different speech outcomes in a speaker's L1 and L2 are the L1 filter, which has already been mentioned previously, the L1 phonetic categories, that hinder

L2 categories from being formed, and the fact that the input provided for the L1 is different from that provided by the L2 (23). In fact, it has been shown that, from a neurological point of view, different areas of the brain are active when using an L1 compared to an L2 (Korte 2010: 170). For more details on this, see chapter 3.4.

Atli and Bergil (2012), measured the effectiveness of pronunciation instruction on overall speaking skills of 20 adult Turkish ELT learners after five weeks of instruction. The authors found out that the pronunciation of monosyllabic words proved less difficult for the students, and that their pronunciation of multisyllabic words slightly improved over the five-week period. However, the study does not go into detail on what the pronunciation instruction looked like and how the pronunciation of the phonemes was analysed.

A more recent intervention study focussed on the effect one particular teaching method had. Henderson and Skarnitzl (2022) found that learners can alter their pronunciation by working with a modified recording of their own voice and that these results remain after a three-month period. This study showed promising long-term results regarding intonation patterns in particular. It must be noted, however, that the study was conducted with university lecturers. Apart from being proficient adult L2 speakers, the lecturers were also highly motivated, seeing that they were required to give their lectures in English (Henderson & Skarnitzl 2022: 17).

As can be seen, most studies that focus on pronunciation are conducted with adult learners with various degrees of English proficiency and there is hardly any research at all with young learners (Pennington 2019: 3). This dissertation aims to bridge the age gap in pronunciation research to ask the question “What effect do explicit pronunciation exercises have on the pronunciation of primary school children in Germany?”. It explores the opportunities that explicit pronunciation teaching on a segmental level can offer for young beginner learners. An intervention study with primary school pupils in Germany was conducted to measure the effects specific explicit pronunciation exercises have. The phonemes that are at the heart of this dissertation are the

TRAP vowel /æ/, the voiceless dental fricative, /θ/, and the voiced dental fricative, /ð/. The pronunciation exercises focussed on raising awareness of the perception of the aforementioned phonemes and the movements involved in producing them and finally practising said production. Audio-recordings of all participants before, during and after the intervention were made and analysed and will be presented in this paper.

After providing an insight into the choice of phonemes and target pronunciation, the German educational system will be described with a specific focus on what is expected of primary school pupils in terms of pronunciation. The theoretical background will be concluded with an overview of how pronunciation is dealt with within a CLT setting and which factors influence pronunciation learning. Following this, the methodology behind the study and analysis of the recordings will be explained before reporting the results first of the dental fricatives and then of TRAP. The results will be discussed in terms of how they can be interpreted and what implications can be derived from them for teacher training courses, EFL classrooms and curriculum development. The aim of this dissertation is to find out how effective short, explicit exercises are in order to say whether they or similar exercises can or should be incorporated into primary EFL classrooms.

2. Teaching pronunciation – linguistic considerations

This chapter aims to outline how the phonemes that are at the heart of this study were chosen. In order to do this, the first section will discuss the accent that was used as a target in this study and give reasons for the choice. The sections following 2.1 will describe the phonemes that were used in the study and explain their occurrence in English and the difficulties teachers may expect from German learners of English when dealing with these phonemes.

2.1 The target accent used in the study

The accent used as the basis for the study is Received Pronunciation (henceforth RP). There has been much debate about what RP actually is, since the accent known as RP today is quite different from the one known as RP just 50 years ago. The term RP was introduced around 1870 (Hannisdal 2006: 12) when public schools were established in Great Britain and the majority of the pupils who went to those schools went on to study at the prestigious universities of Oxford and Cambridge. The educators ensured that the prestige associated with these institutions was reflected in the learners' language and, in particular, their accent (Schmitt 2016: 31). But this prestige did not remain exclusive for long since people without public school education soon adapted their accents by borrowing the prestigious RP. The rapid spread of auditory and later audio-visual media also meant a rapid spread of RP across social classes during the first half of the 20th century (Lindsey 2019: 3). In the second half, RP became less important for upward professional and social mobility (Schmitt 2016: 31), however, the prestigious connotations remained in people's minds, and still largely do so today (ComRes 2013).

This whole development inevitably lead to linguistic changes within RP which, in turn, has sparked the discussion whether RP can still be called RP

today. Linguists have advocated for the renaming of the accent (for an overview over this debate see Lindsey 2019: 4). What this new name should be, however, has not yet been ultimately decided and some argue that the term RP should remain in order to be able to understand the development that has taken place and is still underway. Cruttenden, for example, argues for the term 'General British', or GB, to be used since it is often used as a British variety analogous to General American (Cruttenden 2014: 78). Other linguists have suggested calling it Standard Southern English (e.g. König & Gast 2012: 27). In this dissertation, the term RP will be used, as it is the one most commonly associated with the target accent taught in German EFL classrooms (Hutz 2015: 40).

The ever-declining importance of RP begs the question why it is used as the target accent in EFL classrooms and in this study. The latter can easily be answered: on the one hand, RP is the native accent of the author of this dissertation, on the other, RP is still the predominant accent taught in primary schools in Germany. But why? It has been widely argued that a so-called standard variety is expected to be taught, not only by students but also by teachers, parents and those involved in language teaching on various levels (Matsuda & Friedrich 2012: 23, Bayyurt 2018: 413, Matsuda 2013: 1, Matsuda & Matsuda 2018: 66). In addition, RP as an accent and standard British English as a variety are codified to such large extent that any materials imaginable which may be used in the EFL classroom exist for them (Seargeant 2012: 67).

To sum up, there were three main reasons why RP was chosen as the target accent in this study: Firstly, it is the accent spoken by the author of this dissertation, who, more importantly, conducted the study; secondly, RP is still the predominant variety in teaching material for primary schools and considered the target in the curriculum; thirdly, it is one of the most extensively codified English accents.

2.2 Choice of phonemes

Since the scope of this study was limited, a small amount of phonemes had to be chosen before being able to conduct the study. One reason these particular phonemes were chosen was their importance in the English language and especially in comparison to the German phoneme inventory. This section aims to outline how segmental phonological features can be important for communication, and how the importance of specific phonemes can be calculated as well as showing how important the phonemes /ð, θ, æ/ are using these calculations and presenting further reasons for choosing these three phonemes in particular.

Before going into detail about this, a comment must be made on how the vowels will be referred to in this dissertation. Wells' lexical sets will be used throughout, so /æ/ will be referred to as TRAP or the TRAP vowel. The advantage of using lexical sets is that they refer unambiguously to the vowel at hand and the sets of words that include it (Wells 1982: xviii).

One reason these phonemes are so important is because they help to differentiate the meaning of words more than other phonemes do. It has been argued that the responsibility for intelligibility lies with the listener as well as with the speaker (Dalton & Seidlhofer 1994: 10), but, as will be shown in the following, even then target-like pronunciation plays an important role. This is true for English native speakers as well as for learners of English. Language learners must learn to pronounce the 'important' phonemes not only to suit the ears of native speakers, but also to aide fellow learners of the language. When hearing a foreign language, the learner 'filters' what they hear through the sounds of their L1 and must make use of the phonemes specific to the L2 to understand what they are hearing (Schmitt 2016: 52). What causes most difficulties for language learners are in fact not features that strongly differ in the L1 and the L2, but those that are similar, but not the same (Pennington & Rogerson-Revell 2019: 76). This is particularly important for the TRAP vowel, which will be discussed in detail in 2.4.

For speakers whose native language does include the phonemes as well as their typical substitutions, their pronunciation is important because native speakers make use of so-called categorical hearing (Schmitt 2016: 53). Native speakers tend to have an idea of the prototypical pronunciation of each phoneme and anything that sounds vaguely similar to it is recognised as that phoneme by the hearer. This has also been described as a native speaker's 'phoneme magnet': If a speaker's pronunciation is too far away from the prototypical pronunciation of a certain phoneme, the hearer is more likely to assign it to a different phoneme in their L1 inventory than to categorise it as being an entirely unfamiliar sound (Kuhl 1991: 99). Several studies have shown this effect, for example by asking English native speakers to determine what they hear and giving them the minimal pairs bed and bad with various manipulated forms of the vowel. They always found that, in the large majority of cases, the participants choose one of the two minimal pairs and only rarely judge that the word is 'in between' (Schmitt 2016: 53). This means that the closer the speaker's pronunciation is to the actual phoneme prototypes, the more likely the native speaker is to assign it to the intended phoneme upon hearing it.

Assigning what the hearer perceives to the phoneme the speaker intended is not always of equal importance, but depends on the phoneme at hand. One way of measuring the importance of a phoneme is by determining its functional load. On a more general linguistic level, functional load is 'used to assess the relative amount of work carried out by each element of a linguistic class' (Gilner 2020). In terms of pronunciation, functional load can be defined as 'the number of pairs of words in the lexicon that [a phoneme] serves to keep distinct' (Catford 1987: 88). Brown (1988) first connected determining a phoneme's functional load to foreign language teaching and said it helped teachers determine which phonemes they should spend time on in class (593). It must be added here that Brown's definition of functional load was more detailed than Catford's, including not only minimal pairs, but also the frequency and distribution of the phoneme, how likely it is to occur, how many of the minimal pairs also belong to the same part of speech, how similar they are phonetically,

and how many minimal pairs can occur in the same context (593). Brown ranked RP phoneme pairs that are commonly merged by learners between 1 (= minimal importance) and 10 (= maximal importance) and ranked /θ, s/ at 5, /ð, z/ at 7 and /æ, e/ at 10 (Brown 1988: 604). The full list can be seen in Figure 1. TRAP is also fairly stable across native accents (Trudgill & Hannah 2008: 117), with some intra-lingual variation due to coarticulation (see chapter 2.5). Since none of the three phonemes studied exist in the German phoneme inventory and their functional load is considered particularly high, they are well suited for this study.

Rank Ordering of RP Phoneme Pairs Commonly Conflated by Learners

Vowels		Consonants	
10	/e, æ/ /æ, ʌ/ /æ, ɒ/ /ʌ, ɒ/ /ɔː, əʊ/	10	/p, b/ /p, f/ /m, n/ /n, l/ /l, r/
9	/e, ɪ/ /e, eɪ/ /ɑː, aɪ/ /ɜː, əʊ/	9	/f, h/ /t, d/ /k, g/
8	/iː, ɪ/	8	/w, v/ /s, z/
7	—	7	/b, v/ /f, v/ /ð, z/ /s, ʃ/
6	/ɔː, ɜː/ /ɒ, əʊ/	6	/v, ð/ /s, ʒ/
5	/ɑː, ʌ/ /ɔː, ɒ/ /ɜː, ʌ/	5	/θ, ð/ /θ, s/ /ð, d/ /z, dʒ/ /n, ŋ/
4	/e, eə/ /æ, ɑː/ /ɑː, ɒ/ /ɔː, ʊ/ /ɜː, e/	4	/θ, t/
3	/iː, ɪə/ /ɑː, aʊ/ /uː, ʊ/	3	/tʃ, dʒ/
2	/ɪə, eə/	2	/tʃ, ʃ/ /ʃ, ʒ/ /j, ʒ/
1	/ɔː, ɔɪ/ /uː, ʊə/	1	/f, θ/ /dʒ, j/

Figure 1. Functional load of phoneme pairs ranked by Brown (1988: 604).

2.3 The voiced and voiceless dental fricatives

As the name suggests, dental fricatives are produced by placing the tip of the tongue at the back of the upper central incisors. The alternative term 'inter-dental fricatives' comes from the fact that some native speakers of English pronounce the phoneme by putting the tongue between the upper and lower central incisors (Schmitt 2016: 97). Central incisors typically emerge at the age of around six or seven, so children at the age of nine or ten are unlikely to have difficulty pronouncing these phonemes due to dentition (Lam & Koudela 2010: 169).

The dental fricative can be voiced or voiceless. Within a word, there are several rules that apply which determine the voicing of the dental fricative. A word-initial <th> is pronounced voiceless in content words and voiced in function words (Schmitt 2016: 98). In medial position, the voicing depends on the word's etymology, Anglo-Saxon words being voiced and classical ones voiceless (ibid.). In word-final position, <th> tends to be voiceless, but if the word-final graphemes are <-the>, the dental fricative tends to be voiced. This can change if this word ending is subject to suffixation, in which case there would be free variation (ibid.).

There is little variation in the English consonant system across many native accents (Brown 1988: 596). Brown argues that the dental fricatives are more likely to be substituted with /f/ or /v/ than with /s/ or /z/ because the latter are less similar (599). German native speakers, however, do tend to substitute /θ/ with /s/ and /ð/ with /z/ (Swan & Smith 2001: 38), as do Russian native speakers (ibid. 147). This, and the fact that Brown rates the minimal pairs of the dental fricatives and alveolar fricatives at 5 and 7 (in comparison to minimal pairs of the voiced dental and labio-dental fricative at 6 and the voiceless ones at 1) shows how worthy these phonemes are of teacher's time in the German EFL classroom.

2.4 TRAP

According to Schmitt (2013: 117), „Teaching the TRAP vowel is of the highest importance". As with the dental fricatives, the TRAP vowel proves to be challenging for many German learners of English. The perception of foreign language pronunciation is filtered through the L1 perception. We complete the acquisition of this skill at the age of approximately ten months (cf. Eimas et al. 1971; Ohala 2008; Gut 2009). Because TRAP does not exist in German, German learners of English tend not to perceive it as a distinct phoneme at all but merge the perception and production of TRAP with that of DRESS, even at high overall English proficiency levels (Kautzsch 2014: 215). So much so, that the learners do not even consider the possibility that they may be different from one another (Schmitt 2013: 122). In contrast to the dental fricatives, TRAP is not recognised as a challenging phoneme or conveyed as such to the learners (ibid. 126). This remains challenging for the learners, even after being confronted with the fact that they are two distinct phonemes (ibid. 121). The reason for the tendency to merge TRAP with DRESS is the previously mentioned categorical hearing (see chapter 2.2).

The closest phoneme to TRAP in the German phoneme inventory is /ɛ/, so upon hearing the TRAP vowel, the learner is inclined to categorize the perceived sound not as the unfamiliar TRAP but as the well-known /ɛ/, which is very similar to the English DRESS vowel. To help learners distinguish words pronounced with DRESS and words pronounced with TRAP, Schmitt (2013: 118) suggests pointing out that, typically, TRAP is spelt with <a> and DRESS is spelt with <e>. However, although this suggestion might help some learners, it is not an entirely failsafe approach. On the one hand, the present-day English phoneme-grapheme relation is notoriously unreliable. Just a look at words like <any> and <Thames> or <be> and <read> shows that this rule-of-thumb can only be applied to a limited set of words and requires more background knowledge on

English orthography and phoneme-grapheme relations[1]. On the other hand, the previously discussed dental fricatives are spelt with <th> and, despite a relatively clear phoneme-grapheme relation, their pronunciation still proves challenging for German learners of English. As will be seen in the results in chapter 5, voicing, the only distinctive feature of the dental fricatives that cannot be derived from the spelling, does not cause learners any difficulties at all.

2.5 Occurrence and coarticulation

Segmental features, as they are taught, are only models of the phones they represent. This means that in naturally occurring connected speech, they will not necessarily sound exactly like the phoneme they are represented by (Dalton & Seidlhofer 1994: 125). In conversations and other settings in which we are required to process spoken language, other factors such as the lexical and phonological context are also taken into account, rendering a precise articulation of each segmental feature unnecessary (Cruttenden 2014: 5). Nevertheless, knowing the features of the phonemes at hand is important when teaching them, or words containing them. In the following, the features of the phonemes relevant to this study as well as their allophonic variations will be presented.

The dental fricatives can appear in any position. The only change they may be subjected to are due to progressive assimilation of the manner of articulation (Roach 2009: 112). Here, the word-initial voiced dental fricative, if preceded by a nasal or plosive at the end of the previous word, adapts its manner to that consonant (ibid.). This feature is not particularly relevant to this study since the focus lay solely on segmental features within words, not crossing word boundaries. Whenever German learners of English encounter dental

[1] In the UK and some other English-speaking countries, reading is often taught by introducing phonics, which connect phonemes to graphemes and grapheme-combinations in order to provide support when trying to initially grasp the various rules that need to be applied when initially trying to understand phoneme-grapheme correspondences in English (Read with Phonics 2023).

fricatives in close proximity to alveolar fricatives, they may confuse the pronunciation of the two and pronounce one as the other (Schmitt 2016: 100). This can happen within a word (e.g. *Thursday*), or across word boundaries (e.g. *the house*).

The TRAP vowel is an unrounded, tense open front vowel. Especially in northern British accents, and not at all in RP, it is undergoing a change in that it is lowered and more closely resembles cardinal vowel [a] (Cruttenden 2014: 84). This development, while prominent in many present-day British accents, is not reflected accurately in textbooks, since they tend to use more conservative versions of the accent (Seargeant 2012: 67). Since it is a short vowel, TRAP does not occur in word-final position, but all other positions within a word are possible (Schmitt 2013: pp. 119). It does not exist in the German phoneme inventory and even in English, it is unique in that it does not, unlike all other vowels, have a 'rounded counterpart and there is no parallel vowel in the back region of the vowel quadrilateral' (ibid). Schmitt also lists the allophonic variations to TRAP that should be mentioned here (2013: 120). TRAP is subject to pre-fortis clipping if followed by a voiced consonant and, if preceded or followed by a nasal one, TRAP, too, is nasalised (ibid.). In most British English accents, TRAP is raised before [ɬ] and before velars. In unstressed syllables and function words, TRAP is weakened. Many American accents tend to merge DRESS and TRAP if TRAP occurs before /r/, because TRAP is raised (ibid.).

3. Teaching pronunciation – considerations for the classroom

'What are the three most important subjects at school?' Ask anyone who grew up in Germany this, and their answer will probably be 'German, Maths, and English'. Since the early 1960s, learning a foreign language has been part and parcel of education at secondary schools in Germany (BIG-Kreis 2015: 6). The role of the foreign language – in most cases English – was consolidated in the late 20th century, when it was introduced as a subject in primary school in some federal states and fully established as a nationwide primary school subject in 2005 (ibid.). The popularity of immersion programmes at school and even at pre-school level is ever-increasing and currently there are nearly 1300 bilingual daycare centres for children in Germany (Verein für frühe Mehrsprachigkeit an Kitas und Schulen fmks e.V. 2022).

In North Rhine-Westphalia (henceforth NRW), the most densely populated German federal state and the one in which the data for this study was collected, English has been part of the primary school curriculum since 2003 (QUA-LiS NRW 2022a). Pupils were introduced to English as a foreign language (henceforth EFL) in their third year at primary school, giving them two years of EFL classes before moving to secondary school. This decision was based on the recommendation of the Commission of the European Communities to promote the acquisition of other, in particular European, foreign languages. According to their Action Plan 2004-2006, "the ability to understand and communicate in other languages is a basic skill for all European citizens" (Commission of the European Communities 2003: 3). Five years after EFL was introduced to primary schools in NRW, the curriculum was changed to accommodate teaching English from year one onwards. This dramatic change of the curriculum was the result of the so-called EVENING study, which evaluated the success of teaching EFL at primary schools in NRW. The North Rhine-Westphalian ministry of education had commissioned the study to assess English at primary school. The study was divided into four parts, namely a survey of

headmasters, teachers, class observations and testing learning outcomes (QUA-LiS NRW 2022b). One of the biggest findings of this study was the remarkable development of the pupils' language proficiency, especially with regard to oral skills (Börner et al. 2013: 9).

Despite the success of introducing English to the curriculum from year one, some federal states, including NRW, have gone back to teaching English from year three. One reason is a study from Jäkel et al. (2017) which investigated the difference in English receptive skills between learners starting aged 6-7 and learners starting aged 8-9 and came to the conclusion that, although early starters outperform late starters in their first year of secondary school, they are overtaken by their late-starting fellows two years later (Jäkel et al. 2017: 646).

3.1 The Common European Framework of Reference

At the basis of any teaching syllabus in Germany is 'The Common European Framework of Reference for Languages: Learning, Teaching, Assessment', or CEFR for short. Although it does not prescribe how languages should be taught, its Common Reference Levels are used to measure the learners' proficiency. To provide a better understanding of the CEFR, it is necessary to take a look at its history, main aims and the linguistic aspects relevant to this study.

By signing the European Cultural Convention (henceforth ECC) of 1954, the member states of the Council of Europe (henceforth COE) pledged to support efforts to ease the communication between all citizens of Europe. As a result, any language teaching promoted since then focusses on the communicative needs European citizens might have when learning another European language. Because signing the ECC meant promoting European languages, learning one ought to be a positive experience. The descriptors used in the CEFR focus on what the learners can already do, rather than on what they have

yet to learn. This empowering approach enables learners to successfully use their language skills at every level of learning (COE 2020: 28). The language learning experience is much more positive if the education received is of a high standard and the teachers are well trained. Enabling this is another of the CEFR's aims, as well as providing language that educators can use to discuss the teaching process and curriculum development with a wider and international circle of educators (COE 2020: 11). To unite these aims, teaching European languages within Europe meant using communicative tasks. The language that is to be learned is no longer only the subject of the lessons, but also its medium. The CEFR 2001 includes a chapter on such tasks and their implementations, but leaves it up to the educator as to how exactly and to what extent they are included in the language teaching (COE 2020: 32).

The development of the CEFR began in 1991, at the symposium 'Transparency and coherence in language learning in Europe. Objectives, evaluation, certification' in Switzerland, but it was not until ten years later that the CEFR was actually launched. It is used not only in European countries, but also in other continents and is the Council of Europe's second most translated document, trumped only by the Convention of Human Rights (COE 2022).

The CEFR published in 2001 is accompanied by a companion volume of which the most recent update was published in 2020 after a large-scale project was launched in 2013 (COE 2022). Although the conceptual framework of 2001 is still valid, the companion volume alters and adds to the original version. The data used in this paper was collected before this latest version was published. Nevertheless, it is this latest companion volume that will be described here. The results of this study, despite being based on data collected before 2020, should be relevant to teaching today, which orients itself around the new CEFR descriptors. Some alterations are even of particular interest for this dissertation as they deal with phonology and with young learners (COE 2020: 23f). One important addition is that the focus of phonology now lies on "Sound articulation" and "Prosodic features" (COE 2020: 24). The overall aim for phonology at A1 level, the level at which pupils at the end of their time at primary

school should be, is that a limited number of words can be "understood with some effort by interlocutors used to dealing with speakers of the language group" (COE 2020: 135). Sounds are expected to be reproduced correctly (ibid.). The subcategory "Sound articulation" determines that A1 speakers can be expected to "reproduce sounds in the target language if carefully guided" (ibid.) and to "articulate a limited number of sounds, so that speech is only intelligible if the interlocutor provides support (e.g. by repeating correctly and by eliciting repetition of new sounds)" (ibid.). This means that it is acceptable if pronunciation of individual sounds is not target-like at this level. It also means that later remedial pronunciation work is taken for granted on higher levels, because, by the time learners reach the level C1, they should be able to produce target-like pronunciation for most phonemes of the target language and self-correct those they do not pronounce target-like (COE 2020: 134).

To provide a comparison, the previous version of the CEFR did not subcategorise 'phonological control'. Learners at A1 level should be able to pronounce "a very limited repertoire of learnt words and phrases can be understood with some effort by native speakers used to dealing with speakers of his/her language group" (COE 2001: 117). In comparison to the newer version, this one does not provide any suggestions for teachers within the descriptors (or outside of them) and goes into less detail on whether segmental or suprasegmental features are meant. Additionally, the interlocutor is more specific, namely a native speaker. However, it is not specified whether they be a native speaker of the target language or the native language of the learner, this is up for interpretation. The other substantial difference is that target-like pronunciation should be achieved once the learner has reached level B2. This means that the new CEFR provides more detail on which phonological goals should be achieved and, in the long term, allows more time for achieving them.

3.2 The curriculum for English in primary schools in NRW

In Germany, each federal state has its own school curriculum. It is on the basis of this curriculum that each school formulates its own, school-internal one. Since the data collected for the study presented in this paper was provided by primary school pupils from NRW, the curriculum of this federal state serves as the basis upon which the study was built. The curriculum was published in German, so the direct quotes in the text are translations by this author; the original quote is provided in square brackets afterwards. The previously mentioned change in the curriculum was implemented in 2021. That requires a look at both the curriculum that is currently in use as well as the one it replaced, since the latter was valid at the time of data collection. In order to do this, the relevant parts of the curriculum that is currently valid in NRW will be described first, followed by the description of differences relevant to this paper that can be found in the previously valid curriculum. First, the general aims of EFL at primary school will be presented, followed by learning techniques that pupils are expected to pick up along the way. Finally, I will take a closer look at the role pronunciation plays in the curriculum and how it is supposed to be taught.

The curriculum orients itself around the CEFR, and when the pupils leave primary school, they are expected to have achieved the proficiency level of A1 - basic users (KLP 2021: 36). There are several overarching aims of EFL in German primary schools. First and foremost, primary school pupils are expected to learn 'fundamental communicative and intercultural competencies' [grundlegende kommunikative und interkulturelle Kompetenzen] to use English as a means of communication not only in Europe, but all over the world (ibid). The Council of Europe claims that motivation is key to successful language learning and this stance is also reflected in the curriculum. On the one hand, fluency is put before accuracy, and on the other hand, teachers are advised to see errors as a necessary part of the language learning process. They

should be dealt with mindfully, either by giving corrective feedback and discussing them as they happen (should this be appropriate in the respective situation) or in one-on-one talks to reflect on the errors made (ibid.).

Corrective feedback can be given by teachers or peers in written or oral form. Since this study focusses on pronunciation, written corrective feedback will not be commented on here. Oral corrective feedback is defined as "oral comments that a teacher or an interlocutor makes on errors that occur in second language learners" output (Wang & Li 2022: 2). The comments allow the learner to hear the target-like version of what they said without losing motivation by being told they were wrong. Corrective feedback through the teacher can allow the pupil to realise that, although there might be room for improvement, their current language skills are already sufficient to achieve communicative goals. Additionally, the teacher can use corrective feedback to give the pupils more language input, as can be seen in the example below. (Elsner 2020: 28).

E.g. P: '*I go shopping yesterday*.'
T: '*You went shopping yesterday? Did you buy anything nice?*'
P: '*I bought a pullover*.'

While learning the basics of the English language, EFL lessons also serve as guinea pigs for language learning, since English lessons are the first structured encounter with learning a foreign language (KLP 2021: 48). Pupils should be confronted with and try out a wide range of language learning strategies and reflect upon which ones work best for them. By doing so, they are prepared for learning English after transitioning to secondary school as well as any other foreign language they may aspire to learn (KLP 2021: 36). Examples for such learning strategies are understanding the meaning of words or phrases through other, non-verbal cues such as the situation or gestures, being able to describe their learning process as well as any difficulties they encounter, and learning to use printed and digital resources such as dictionaries (KLP 2021: 48). Again, motivation plays an important role and pupils should not approach

learning English as having to start entirely from scratch but should instead make use of their already existing learning strategies. Learning English through the help of their existing skill sets should encourage pupils to continue along this path.

Another way of learning the new language is through rituals. They play an important role in any primary school lesson, but are all the more important in the EFL classroom where they additionally serve as opportunities to learn English in chunks and repeat these regularly and over a longer period of time, e.g. by using a ritual that includes fixed expressions or singing a song to welcome everyone at the beginning of each lesson. Once the pupils become more confident users of English, they should be encouraged to deviate from the fixed chunks they have learned, connect various pieces of linguistic knowledge, and create their own, freely spoken English (KLP 2021: 37). Another important aid, according to the curriculum, is writing, which should be used to learn and remember new vocabulary from the start (KLP 2021: 37). Finally, pupils should be encouraged to actively compare English to their native language(s) to find out similarities and, more importantly, differences (ibid.).

Despite the ongoing debate about ELF and the target variety of English that should be taught, the curriculum makes it quite clear that the aim of English lessons at primary school should be a native English variety (ibid.). Teachers should use audio, and audio-visual material that features native speakers of English and, judging by the audio material included in official and state-sanctioned textbooks, the target variety at primary school level is Standard British English (see for example the textbooks 'Bumblebee', 'Playway' and 'Sally'). In addition to including native English, the tasks and materials should be authentic (KLP 2021: 37). The concept of authenticity is not explained in any detail in the new curriculum. In the one that it replaces, however, authentic situations are defined as ones that can or do happen in real life, and authentic materials are defined as originally being designed for native speakers and not abridged to suit any learner level. Examples might be postcards, soft-

ware, money etc., but also anything that is typical from the country or countries that speak the language, e.g. certain foodstuffs or toys (QUA-LiS NRW 2022c). This paints a clear picture of what is expected of primary school pupils' pronunciation targets. At the end of year four, the aims, in terms of pronunciation, are to have mastered 'fundamental phonetic and intonation patterns' [wesentliche Laut- und Intonationsmuster], and to develop an 'increasingly correct pronunciation and intonation' [zunehmend korrekte Aussprache und Intonation] (KLP 2021: 41). Pupils should be able to reproduce these phonetic and intonation patterns and apply them in familiar communicative settings [Die Schülerinnen und Schüler wenden bekannte Aussprache- und Intonationsmuster in vertrauten Kommunikations-situationen verständlich an. Die Schülerinnen und Schüler reproduzieren die Aussprache- und Intonationsmuster bekannter Wörter und Redemittel (u. a. Sprachrhythmus, Sprachmelodie).] (KLP 2021: 46). To help them do this, the above-mentioned strategy of reflecting upon similarities and differences between the pupils' native languages and the target language should be employed. They should be able to describe these similarities and differences on a meta-level and be able to develop their own theories on linguistic regularities in English (KLP 2021: 48). Additionally, the curriculum is of the opinion that 'imitation is the foundation of any first or second language acquisition and idiomatic communication is not imaginable without imitatively or reproductively used words and structures (chunks)' [Imitation ist die Grundlage eines jeden erfolgreichen (Erst- wie Zweit-) Spracherwerbs und idiomatische Kommunikation ist ohne imitativ und reproduktiv genutzte Wörter und Strukturen (chunks) nicht denkbar.] (KLP 2021: 36). Apart from the common 'repeat after me' exercises, reproductive speech in form of (nursery) rhymes or songs are recommended imitative exercises to practice pronunciation and intonation patterns (QUA-LiS NRW 2021).

In comparison to the previously valid curriculum, not much has changed in the current version, especially with regard to the overall aims and pronunciation in particular, despite two years of English lessons having been cut. One important change, however, is the role of the English teacher. While the now

outdated curriculum means for teachers to serve as language models, and specifically mentions the teachers as role models regarding pronunciation (QUA-LiS 2022c), the new one envisions an EFL approach that is independent from the teacher (KLP 2021: 37). This new approach hopes to allow pupils to study more independently and according to their individual needs and progress. Audio and audiovisual teaching materials are recommended as alternatives (ibid.). The other important change, which may have an influence on how pronunciation is taught and learned, is that writing takes a more prominent role. The old curriculum proposed that listening and speaking should be taught first, and only later should reading and writing slowly be introduced (QUA-LiS 2022c). Now, writing is seen as an important tool to aid teaching and learning (KLP 2021: 35).

3.3 How pronunciation is taught and learned

Learning a foreign language is not, as was assumed in the past, fundamentally different from learning a native language as babies do. This assumption by early linguists and psychologists, called 'fundamental difference hypothesis', was made since the learning outcome between L1 and L2 is often different (Pennington & Rogerson-Revell 2019: 58ff.). L1 learners become fully proficient in that language in most cases, while L2 learners rarely do. Today, however, it is assumed that language learning is achieved by processing input on a cognitive level, regardless of that language being the first, second or third (Pennington & Rogerson-Revell 2019: 59).

In addition to the fundamental difference hypothesis, the critical period, first introduced by Lenneberg postulated that the optimal age for learning a language lies between two years of age and the beginning of puberty (Elsner 2010: 22). However, Flege and Bohn argue that brain plasticity does not de-

crease with age for those areas relevant to L2 speech production and perception (2021: 24). Additionally, despite older learners rarely achieving the same proficiency in a foreign language as in their first, many still achieve a high level of proficiency, and there seems to be no clear cut-off point for being able to do so (Schlak 2003: 22). Currently, several biologically determined sensitive periods are assumed to take place between the ages six and ten (Bleyhl 2005: 7, Korte 2010), rather than one critical period. These are also seen as a "window of opportunity" in which foreign language learning is easiest and most motivating for the learners and yields the best results (Zydatiß 1999: 198). These are especially interesting for pronunciation teaching, since, up to the age of about nine, learners seem to be able to integrate new sounds into their existing phoneme inventory fairly easily (Elsner 2010: 23). After this sensitive period, that ability rapidly decreases.

The main difference between learning a native language and a foreign one is that the first language is implicitly acquired, whereas foreign languages are explicitly learned, often in a classroom setting. However, as the age of the learners increases, their ability to implicitly draw new knowledge from one instance of input decreases (Long, 2015: 4). Despite this, Böttger suggests that pronunciation should at first be taught through imitation (2020: 99), which is strongly supported by the curriculum (KLP 2021: 36).

3.4 Learning (pronunciation) and the brain

In order to best support language learning, a basic understanding of learning from a neurological point of view is necessary, and there are some differences between learning and L1 and an L2 worth mentioning. The parts of the brain that are active when learning an L1 compared to an L2 seem to be entirely different (Korte 2010: 159). While a 13-month old child uses both sides of their brain upon hearing a spoken word, and have a considerably higher amount of

synapses, a child that is only one year older already starts using only the left side of the brain to process language (ibid.). Additionally, we can auditively distinguish our L1(s) from other languages as soon as we are born (160). Broca's area, the part of the brain that is responsible for learning grammar of the L1 and organising the motor skills required for speaking, develops between the age of 15 and 24 months. A strong neuronal connection between Broca's area and Wernicke's area, where we process and store the meaning of words, is formed at this early age. If a language is learned after the age of ten years, this is no longer done on the left side of the brain in Broca's area, but on the right (170). This explains why it is so hard for older L2 learners to achieve nativelike pronunciation. SLM-r and Lee et al.'s study both advocate perception-based pronunciation training (Flege-Bohn & Ocke-Schwen 2021; Lee et al. 2020). One reason why this is so important is that our ability to perceive different phonemes decreases from the age of six months and specializes on the phonemes of our L1 (Korte 2010: 165). Korte goes as far as to say that it is impossible to practise the perception of non-L1 phonemes from early childhood onwards (171).

Cognitive tasks such as learning seem to be easier if movement is involved, and we often move, even if only minimally, whenever we are dealing with a cognitive task (Hannaford 2013: 130). Some people may go on a walk or for a run to help them think, students may doodle or chew chewing gum while attending a lecture and you may be playing with a pen or tapping your finger while you are reading this. Because of the speed with which the cerebellum, which seems to coordinate sensory information, transmits information to the neocortex, which controls motor functions, learning is actually more effective if movement is involved (Hannaford 2013: 131). Studies have shown that this effect is enhanced if the movement is in some way connected to what has to be learned. A study by Soden-Fraunhofer et al. showed that adult participants who combined learning fictitious names for made-up, non-existing objects (devised that way to imitate foreign language learning) with a movement that helped describe the object, were able to remember more words than those who only

pointed at the cards depicting the objects (2007). Additionally, Toumpaniari et al. showed that, while any kind of movement related to the object yields better results than no movement at all, the more movement involved the better (2015). They taught Greek pre-schoolers English animal names and let one experimental group gesture while saying the name and the second move around while saying the name (e.g. hop around the room to learn the word rabbit). Both experimental groups performed better than the control group who learned the animal names without moving, but the group which moved around the room showed the best results of the three groups.

3.5 Pronunciation in CLT settings

The importance of grammar or vocabulary in EFL is indisputable. This is not the case for pronunciation and its importance in language teaching changes with each teaching method that is used. Currently, modern foreign languages are typically taught through CLT. This approach developed in the 1970s, when Henry Widdowson criticised that learners knew a lot about the language on a meta-level, but were not able to apply this knowledge in order to communicate effectively (Larsen-Freeman 2000: 121). During this time, Hymes developed the concept of communicative competence and from that, CLT was born (ibid.). This method encompasses several approaches to teaching foreign languages, such as immersion or Task-Based Language Teaching (TBLT). Especially in the early stages of CLT in the 1970s and 1980s, the sole purpose of the foreign language classroom was to bring meaning across, clearly putting fluency before accuracy which lead to pronunciation falling by the wayside (Levis & Sonsaat 2018: 265). This is true for many contemporary ELT settings, too, but does not apply to early learners for a number of reasons (Böttger 2020: 98). Most importantly, the aim of teaching pronunciation to beginner learners should be for these new speakers of English to establish “automated, imitative

articulatory processes" ["automatisierte, imitative Artikulationsprozesse"] (Bausch 1995: 227). If the focus of pronunciation teaching does not lie on accuracy in the early learning stages, the risk of fossilization is high (Böttger 2020: 98). Once the pronunciation has been learned, it would require some remedial work to relearn, if, indeed, it can be changed at all (Ellis & Brewster 2014: 37; Böttger 2020: 98). This means that, while not overly important in CLT in general, pronunciation should play a big part in primary school English and there is reason to argue that it should be allotted plenty of lesson time.

> "Pronunciation, more than any other aspect of a foreign language, will always be influenced by very personal factors such as the learner's attitude to the target language and to the speakers of that language, by individual differences in ability and motivation to learn, etc. This may be the most important reason why, especially in pronunciation, there can never be a one-to-one relationship between what is taught and what is learnt. It would be self-defeating for the teacher to think or hope that there ever could be." (Dalton & Seidlhofer 1994: 72).

This quote shows that instead of treating pronunciation as the "Cinderella of language learning" (Marks 2011: 65), so named because pronunciation tends to be neglected by teachers as Cinderella is by her stepsisters, it should rather be considered as being just as important as the other areas of language learning and that special attention should be paid to how it is taught. Dalton & Seidlhofer state that there are two ways of teaching pronunciation: Either bottom-up, where segmental features are taught first, and it is assumed that the suprasegmental ones are acquired implicitly, or top-down, where the suprasegmental features are taught, and the segmental ones will follow automatically without explicit attention (69).

There is a typical structure consisting of six stages that is used in CLT settings, especially for the introduction of new grammatical structures. The six stages are noticing, comprehending, structuring, contrasting, monitoring, and mastering (Haß 2017: 111-112). In the first step, the pupils notice that a up until

that point unfamiliar grammatical structure is used. Then, the pupils try to understand the form and function of the grammatical structure (= comprehending) and may have to rely on the teacher's help (= structuring). Once this has been accomplished, the structure is compared to the L1, in this case German, equivalent and later to other grammatical structures that may be similar in form and/or function (= contrasting). In the fifth stage, monitoring, pupils learn a rule of thumb that they can use in order to check their language use themselves. The final stage, mastering, focusses on practising the structure in various exercises and tasks. This teaching method can also be applied to pronunciation. Instead of focussing on a grammatical structure they would instead focus on a segmental or suprasegmental feature and use audio language material (Dalton & Seidlhofer 1994: 71).

In contrast Ellis & Brewster (2014) suggest that the mechanics of pronunciation should be taught when introducing new words and sentence patterns (37). This is especially important for vowels. They claim that consonants are rarely difficult to learn, even when they are not part of the learners' L1 inventory. Once the pupils have learned how to produce the phoneme at hand, said phoneme should be put into context and repeated extensively. Rather than following the exposure-exercise-explanation pattern, they advocate the application of an exposure-explanation-exercise pattern.

Whichever pattern is applied, even in meaning centred CLT settings, it is recommended that time should be spent on explicit pronunciation practice. Böttger argues that the priority of fluency over accuracy should not be valid for early pronunciation instruction, because a lack of accuracy in pronunciation can result in communication difficulties or even a breakdown in communication whenever the language is used, even after several years of learning (2020: 98).

Many teachers and textbooks use the popular 'repeat-after-me' method, frequently realised as drilling exercises, for teaching the pronunciation of new words or phonemes. However, as was mentioned in 3.4, Learning (Pronunciation) and the brain, this ignores the fact that many pupils fail to perceive the

distinctive features of some phonemes, if they are not part of their L1 inventory. Therefore, explicit pronunciation instruction is vital to successful pronunciation learning. Some pupils may have an inherent talent for imitation, but this method cannot be relied on for the whole class, since only very few people have this inherent talent. That is why, in addition to the linguistic background knowledge required for explicit pronunciation instruction, the teacher must also be aware of the learner internal and external factors that influence pronunciation learning.

3.6 Factors that influence pronunciation

In light of the debate around which 'type' of English should serve as the target in EFL classrooms, pronunciation has moved into the spotlight. It is the first thing you notice about the language of a speaker and it can encompass not only linguistic, but also social information about them. It has also been argued that some accent features result in stereotyping (see for example Böttger 2020: 99). One reason why pronunciation has become such a crucial aspect in this discussion is the fact that there are many external, non-linguistic factors that influence how we pronounce words. It is especially important for teachers to know about these factors, since they influence pronunciation, but cannot themselves be influenced by the teacher or the learner.

Because these factors cannot be influenced, because fluency is still more important than accuracy in most real-life communicative settings, and because most speakers of English nowadays are not actually English native speakers, many linguists argue that the focus should be on English as a lingua franca (henceforth ELF) and that non-native speakers should retain their L1 accent when speaking English without suffering negative consequences such as bad marks when learning the language (Widdowson 1994, Jenkins 1998). A figurehead of this approach is Jennifer Jenkins, whose research focusses on the in-

terplay between pronunciation and intelligibility (Jenkins 2000). She developed the Lingua Franca Core (henceforth LFC), concrete pronunciation targets that must be achieved by EFL learners in order to maintain intelligibility by other ELF speakers (Jenkins 1998) and found out which phonological features are not necessary for pronunciation teaching (Jenkins 2002). The LFC uses RP and GA (General American) as underlying target accents, but the aim is not to master all details of these accents to sound like an English native speaker, but to master those phonological features she found out to be crucial for intelligibility (Jenkins 2000: 131). According to the LFC, neither of the dental fricatives must be pronounced as such for intelligibility (Jenkins 2000: 138). For vowels, the most important thing to ensure intelligibility is that the speakers pronounce their vowels consistently in terms of their quality and quantity (Jenkins 2000: 145). If they can do this, speakers tend to be understood despite a non-native pronunciation of vowels. Intelligibility can be heavily compromised if speakers vary in their pronunciation of the same vowel, e.g. by changing its length (ibid.). While arguing that a mastery of the LFC will be more achievable for most learners of English, and sufficient for the overwhelming majority of situations in which learners might find themselves needing to speak English, she also acknowledges that the LFC is not sufficient if a native English accent is aimed for (Jenkins 2000: 136). She has previously stated that the EU, while using ELF, still promotes native English varieties as standard varieties that should be used as norms to be achieved in the EFL classroom (Cogo & Jenkins 2010). As was seen in chapter 3.2, the curriculum for primary schools in NRW demands a native English accent as the target accent, as does the CEFR (see chapter 3.1), making the LFC an insufficient target for pronunciation teaching.

Regardless of which target pronunciation the teacher is aiming for, the factors that influence pronunciation teaching remain the same. Many of these factors are of a nature that cannot be influenced by the teacher at all. These include attitude and identity, anxiety, gender, and musicality. For a full description of these factors see Richter (2019). Factors that the teacher can par-

tially influence or accommodate for are motivation, formal pronunciation instruction, exposure to the target language, and learning styles. The factors that will be considered in the analysis are age, dentition, native language background and L2 input.

3.6.1 Age

Age is a factor much debated among applied linguists, because, if age indeed influences how we learn pronunciation, there must be a cut-off point after which it is more difficult than before. A description of neurological factors can be found in chapter 3.4. Most relevant for this study, however, is the development of the vocal tract during childhood. Typically, children can pronounce the vowels of their L1 by the time they are three years old (Flipsen & Lee 2012: 927). Because their vocal tract continues to grow, they must constantly adjust their vowel production until the vocal tract has reached its full length during the late teens or early adulthood (ibid.). However, the vocal tract does not grow so fast that a substantial change must be reckoned with within the 12-week period in which the study took place.

3.6.2 Dentition

Starting at an age of approximately six years, children start losing their primary teeth and the permanent dentition erupts (Lam & Koudela 2010: 169). This can affect pronunciation of phonemes involving the teeth, in particular the incisors, as dental fricatives do. Typically, the mandibular central incisors (the bottom two front teeth) erupt at six years of age, followed by the maxillary central incisors (top two front teeth) one year later. The mandibular lateral incisors erupt roughly at the same time as the maxillary central ones. The last incisors to erupt are the maxillary lateral ones at approximately eight years of

age. Their growth, however, does not interfere with the pronunciation of the dental fricatives. Pronunciation training should not be put on hold during this time, but teachers should be aware of how phonemes are produced in order to give support to children struggling with pronunciation due to missing or erupting teeth.

3.6.3 L1 background

The contrastive analysis hypothesis, originally set up by Robert Lado, states that all learner errors can be predicted by contrasting L1 and L2 (Celce-Murcia et al. 2010: 22). This stance is no longer taken, but it is universally acknowledged that the L1 influences how an L2 is learned to some extent. In addition to the L1, there seem to be other, universal factors that prevent errorless L2 acquisition (Brown & Larson-Hall 2012: 84). However, for pronunciation, the L1 does seem to play an important role, since most L2 pronunciation that is not target-like seems to be due to negative transfer (Celce-Murcia et al. 2010: 23). In this context, the term transfer refers to the way in which the L1 influences the L2. This can have an enhanced language-learning effect, referred to as positive transfer, or present a hinderance to language learning, referred to as negative transfer (Brown & Larson-Hall 2012: 84). In the case of segmental phonological features, one can assume that L2 phonemes that do not exist in the L1 will prove difficult for learners.

3.6.4 L2 input

L2 input combines the factors ‘exposure to the target language’ and ‘amount and type of prior pronunciation instruction’ (Celce-Murcia et al. 2010: 18). Although the input learners receive does not equal the output they produce, an immersive EFL approach seems to yield the best results, implying that the

more L2 input the learners are subjected to, the more they learn (Celce-Murcia et al. 2010: 19). Immersion programs even seem to yield better long-term results, as Harada (2007) showed in a study with Japanese EFL learners who had participated in immersion programs as children. In Germany, immersion programs are rare, and instead, primary school pupils attend two to three English lessons a week, amounting to 90-135 minutes. These are not filled entirely with L2 input, so it must be assumed that the participants of this study received only a fraction of the L2 input required for optimal learning conditions. It can also be assumed that most participants had not received any prior pronunciation training. Bilingual or immersive pre-school institutions such as kindergartens are spread across Germany, but the majority of kindergartens is still monolingual. Celce-Murcia et al. assume that most prior pronunciation training will have been in form of drills by teachers who are also not native speakers (2010: 19). It is useful for later teachers to know about this training in order to understand their pupils' pronunciation. Prior pronunciation training can provide a solid basis for a target-like pronunciation auto-pilot, but it can also be the cause for remedial pronunciation work. Although the participants of this study will, in most cases, not have received any type of prior pronunciation training, the pronunciation training described by Celce-Murcia can be taken as prior pronunciation training through the primary school teachers for this study.

4. Participants and Study Design

The study was designed as an intervention study involving three primary school classes from two different primary schools. The heavy workload of teachers, the schools' responsibility to supervise minors and the fact that many studies are conducted at schools for research projects ranging from Bachelor theses to nationally funded large-scale research made finding schools willing to cooperate difficult and limited the number of participants to these three classes.

Before the beginning of the study, the first class was observed during English lessons for several weeks in order to get a better understanding of how vocabulary was introduced and which material was used. The picture cards used for the elicitation of the words were then taken from the additional material for the textbook Playway (Gerngroß 2009), since this was used by the class. The process of the word elicitation will be explained in chapter 4.3. Additionally, each class was observed for at least two English lessons before the first recordings for two reasons: The first and main reason was that the pupils had the chance to get to know the researcher and familiarise themselves with her. That way they would feel more comfortable in the one-on-one sessions that were recorded. The second reason was to allow the researcher an insight into the pupils' typical English lessons and get to know the materials they used for learning. These preparations helped conduct the study as efficiently as possible. Conducting the study at the schools during the lessons rather than in lab conditions had the advantage of making the participants of the study, namely the pupils, feel as comfortable as possible and, should the study have any effect, allow them to connect the effect to the physical space that is their everyday learning environment.[2] The disadvantage of this were the many unforeseeable changes and deviations from the original plan that had to be accepted

[2] A frequently used mnemonic is the connection of contents to be learned with physical spaces (e.g McCabe 2015: 169).

and adapted to during the course of the study. Although these conditions were not ideal, they are quite realistic since teachers encounter the same conditions during their day-to-day lessons. Transferring the effectiveness of exercises done in laboratory conditions to day-to-day English lessons may not be as easy as if the exercises were tested in fairly comparable teaching conditions.

This chapter will describe the setting, design and procedure of the study at the heart of this dissertation and of the analysis of the collected data. Firstly, the cohort of participants and their division into the groups needed for the study will be described as well as the considerations necessary when planning to analyse children's speech.

4.1 Participants

For this study, 72 participants took part in an intervention study. The participants were all primary school pupils from three different classes and two different schools and teachers. Two classes were in year 4, the last year of primary school, one was in year 3, meaning that the age span of the pupils involved in the study was eight to ten years. The teachers will be referred to as Teacher A and Teacher B to differentiate them while maintaining anonymity. The classes will be called Class 4A, Class 3B and Class 4B to codify the important information of school, year, and teacher. Class 4A was taught by Teacher A in one primary school and classes 3B and 4B were taught by Teacher B in a different primary school. For an overview of the information on the classes, see Table 1. The pupils all spoke German, 40 said that they spoke no other languages and three reported having distant relatives who spoke another language (two English, one Dutch). Four said they could understand a second language (three Russian and one Polish) and eleven said they could speak a few words in another language (five Russian, two Spanish, one each French, Chi-

nese, Polish, Italian). 14 called themselves bilingual (seven Russian, two Albanian, one each Hindi, Polish, Kurdish, Ghanaian English, and Persian). In sum, 40 pupils had no language contact except German outside of school and 32 had varying degrees of contact with another language, ranging from knowing somebody who speaks that language to being raised using that language. Since there is no other way of obtaining information on the pupils' language backgrounds, their self-reports must be relied on for this study. However, keeping in mind the young age of the participants, it is hard to tell exactly how much language contact they had with languages other than German outside of school. Some, who report being raised bilingually, may very well be fluent in two or more languages. Others however, who for example report knowing 'some' of another language, may range from knowing single words in isolation to understanding and being exposed to vast amounts of another language, but not being able to produce said language to a similar extent as German.

	School	**Teacher**	**School year**	**n analysed participants**	**n total participants**
Class 4A	A	A	4	17	24
Class 4B	B	B	4	15	27
Class 3B	B	B	3	17	21

Table 1. Overview of the participants analysed and their distribution across the three school classes.

At this age, the children are not expected to have fully replaced their primary teeth yet (Lynch 2013: 3). However, none of the upper or lower lateral or central incisors were missing in any of the children at any point in time during the study, meaning speech, and particularly the production of the dental fricatives, was not impeded due to the children's dentition.

Although children's vocal tracts and oral cavities are still growing, they were not expected to grow at such a rate that it influences their speech during

the course of the study. Vorperian & Kent (2007) compiled acoustic data from studies on the vowel spaces of children to create average vowel spaces of children aged four to 18. There is only little difference between eight, nine and ten year-olds, so it can be assumed that the vowel-tract growth was not so extensive that it affected the acoustic analysis. They also looked at the difference between sexes and notes that there was a difference that started around the age of four, however they did not calculate an age at which the difference becomes significant. In a more recent article, Barbier et al. state that the growth of the vocal tract is not subject to sexual dimorphism before puberty at all, rendering a division between boys and girls unnecessary (2015).

At the time, reading and writing were not major parts of the curriculum in primary schools in NRW, with both skills only being tentatively introduced and the main focus lying on speaking and listening (KLP 2008: 73). For this reason, it could not be assumed that the participants of the study were able to read or write in English. How this affected the data elicitation process will be described in more detail in section 4.3.

4.2 Data Collection

Intervention studies are commonly used to measure the effects of a teaching method or approach for learners of all ages and levels of language proficiency (e.g. Banales Faz 2015; Restrepo, Morgan & Thompson 2019; Rodge, Hagen, Melby-Lervåg, Lervåg 2019; Santos, Olivieira, Cunha, & Osés 2017). They are especially well suited to try out any new ideas in the language classroom because learners can easily be split into groups to compare teaching methods and it is possible to measure performances before and after the intervention. Since time is a valuable resource in any curriculum-based classroom setting, the timing of such a study must be well thought out. In this case, participants were taken out of class for a maximum of five minutes per session. That way, the

lessons could take place as planned by the teacher and no pupil missed out on too much content but instead could catch up easily. The recordings took place during English lessons, so the pupils were already in the right frame of mind for learning English, rather than being taken out of other lessons and having to switch e.g. from Maths to English.

The aim of the intervention study was to find out whether explicit pronunciation exercises affected the pronunciation of the phonemes under scrutiny. For this intervention study, each class was randomly split into three groups. During the intervention, group 1 of each class worked on the pronunciation of the TRAP vowel whereas group 2 worked on the pronunciation of the voiced and voiceless dental fricative. Group 3 served as the control group and did not receive any intervention. All three groups were recorded in a pre-test one week before, in a post-test one week after the intervention, as well as seven to nine weeks after the intervention, as a delayed post-test, meaning that, in total, the recordings spanned a time of ten to twelve weeks. The intervention itself was split into two sessions, one week apart, to allow for repetition of central parts of the exercise and for slightly more time for the exercises. This resulted in a total of five recordings for each participant of the intervention groups 1 and 2 and three recordings for the participants of control group 3. For an overview of the recordings and the groups involved, see Table 2. If a pupil was ill during both intervention sessions and missed those recordings, but was present for the pre-test, post-test, and delayed post-test, it was put into group 3 post-recording so as not to waste resources. The teachers and the researcher were also recorded saying the words from the picture cards to see which pronunciation the participants were used to from their English lessons and which pronunciation they were subjected to during the intervention.

Week	Stage	Groups involved
1	Pre-test	1, 2, 3
2	Intervention I	1, 2
3	Intervention II	1, 2
4	Post-test	1, 2, 3
10-12	Delayed post-test	1, 2, 3

Table 2. Overview over the stages of the study and the time in between recordings.

4.3 Words elicited

The words that were elicited from the participants had to fulfil certain criteria, the obvious one being that they should contain at least one phoneme relevant to the study. Additionally, the target group, namely primary school pupils, had to be kept in mind when compiling the word list. All pupils were beginner learners of English, constraining the data elicitation process in several ways. Firstly, typical texts used for the elicitation of certain lexical sets, such as 'Comma Gets a Cure' (Honorof et al. 2000) or 'The Rainbow Passage' (IDEA, n.a.), could not be used, since participants at this level of English could not be expected to read (or write) in English, even less so if the words were entirely unfamiliar to them. Secondly, it was not possible to elicit words through conversation, because the learners at German primary schools are used to scaffolding and practising certain phrases or sentences copiously before producing sentences themselves. It was not possible to practise anything prior to the study's recordings due to the limited classroom time available for the study. Additionally, any English language contact between the participants of the study and me as the researcher were avoided before the intervention recording so as not to influence their pronunciation in any way.

Finally, the curriculum at the time discouraged reading or writing English at primary school, which meant that the words that were intended to be elicited had to be easily recognisable on pictures. Wherever possible, the picture cards

used by the teacher to introduce new vocabulary during their usual English lessons were used during the word elicitation process. All three classes used the textbook Playway (Gerngroß 2009), so the picture cards from the Playway material were used. Some examples can be seen at the beginning of the appendix ('Examples of picture cards'). Due to the small number of available words and a limited availability of picture cards, some exceptions were made. If a picture card was not available from the textbook, but the word could be displayed as a picture, a different picture was chosen (as for example the picture of the apple in the appendix). Another exception had to be made for words that could not easily be depicted graphically. These were the days of the week and the months. Here, the written words with an illustrated background were used. The background helped understand the writing, but if the pupils signalled that they did not know what was being asked of them, the researcher said in German what it said without actually saying the English words that were supposed to be elicited (e.g. 'Wochentage'). Again, the picture used to elicit the days of the week can be seen in the appendix.

The words were chosen according to how familiar they were to the participants and whether they contained one of the relevant phonemes or a phoneme that may typically be used as a substitute (e.g. /s/ for /θ/) and to check for speech impediments. The familiarity of the words was determined by looking at the school curriculum, talking to the participants' English teachers and surveying the units from the textbooks the participants used. The words are listed in Table 3 below according to the respective phoneme that was analysed. They were not, however, presented to the participants of the study in this order, but rather in a random order unrelated to the phonemes to avoid priming.

Some of these words, such as the days of the week, are learnt in a fixed succession when learnt as new vocabulary by the participants. This may result in the participants rushing the individual words and blending the pronunciation of segmental features differently to when they pronounce each word in

isolation. In order to counteract this phenomenon, the words were either elicited in a different order or some words in such an order were skipped, forcing the participants to pause and think before saying the next word.

TRAP	DRESS, BATH, PALM, START	**Dental fricatives**	**/s, z, t, d, f, v/**	**Other words**
Apple	Arms	Bathroom	*coins*	blue
Attic	Bathroom	Brother	dress	boy
Black	Bedroom	*Father*	elephant	Monday
Cap	Dress	Mother	February	green
Carrots	Elephant	Mouth	Friday	knee
Cat	February	Thirteen	hazelnut	
Dad	Legs	Three	nose	
Family	Lemon	Thursday	*pence*	
Hands	March		*pounds*	
Hat	Red		Saturday	
Jacket	Wednesday		sister	
January	Yellow		Sunday	
Saturday			trousers	
			Tuesday	
			vanilla	

Table 3[3]*. Words that were intended to be elicited, categorised by the relevant phonemes they contain.*

[3] It was anticipated that the participants would say either *dad* or *father* and *coins* or *pence and pounds*. In both cases, either choice was useful for the study, which is why all words are listed here, but it was assumed that only one of the two options would be elicited per participant. Those words are in italics in Table 3.

4.4 Recording Apparatus

The microphones used for the recordings were 'Easy-Speak' microphones by Westermann. The microphones are designed in a child-friendly way, yet the quality of the recording is sufficient for acoustic analysis. They are used in schools for language learning purposes, so the participants of the study were familiar with the microphones before participating in the study. This familiarity with the recording equipment helped the participants act as they would do under normal circumstances and lowers the risk of pronunciation being influenced by external factors of the setup. After each recording, the sound file was saved to the laptop and cleared from the microphone to make space for the next participant's recording.

To minimise background noise, the recordings took place in a separate room with only the participant and the researcher present. Additionally, the microphones had to be held close to the mouth, so the participants were occasionally reminded to do so. To make the participants feel as comfortable as possible in this rather unnatural learning environment, references to the position of the microphone or to other aspects of the setting were kept to a minimum.

4.5 The Intervention

Two things set the pronunciation exercises apart from the traditional drilling exercises: Firstly, the fact that perception and production were explicitly discussed, and secondly, the movements used to physically follow and understand the positions involved in the production of the phonemes.

To measure and optimise the effect of the pronunciation exercises for each participant, they received one-on-one training during all sessions of the

recording. For this reason, the instructions given in the two intervention sessions were scripted so as to achieve as much comparability between the participants as possible. This being said, the exercises studied are ultimately intended for use in a classroom setting. For that reason, the instructions were not read out, but presented freely, so that the setting remained as natural as possible. The process of the intervention as well as the exercises used will be described in the following.

Before starting the pre-test, the pupils were asked about their language background and notes were made during the recording on their dentition and whether there were any audible speech impediments such as a lisp. The instructions before the intervention and for the two post-tests were identical and the same for all groups. The participants were informed that they would be shown picture cards and were asked to say the English word or expression for what they saw on each card. If they did not know the word, they could say 'weiter' ('next'), and the next card would be shown. It was explicitly stated that the recordings were not vocabulary tests that would be marked and that the teacher would not learn about their performance during the recordings.

The two interventions differed in their focus. While the first intervention focussed on bringing together the perception of the phoneme in the example word and producing the phoneme in isolation, the second intervention focussed on pronouncing the target phoneme within the different words.

At the beginning of the first intervention, the participants were asked to recall anything they remembered from the last time. After that, they were shown the picture card(s) that would be focussed on. For group 1 in the year 4 classes this was a house, and the rooms *bedroom, bathroom* and *attic* were pointed out. For group 1 in year 3, this was an overview of the months, where *January*, *February* and *March* were pointed out. The vocabulary for rooms in a house had not yet been introduced in year 3, which is why different words were chosen. The other alternative of using the months for all classes was dismissed because it is not possible to elicit the months using pictures. Written

words were used only as exceptions during the elicitation to avoid the participants' pronunciation being influenced by their seeing the graphemes. Using written words was not entirely unavoidable because of the limited amount of vocabulary the pupils could be expected to know, as described in 4.3. For group 2 in all classes, the number *three* was chosen as well as a picture of a family of four, including *mother*, *father*, *brother* and *sister*.

In the first intervention recording, group 1 was asked whether they heard a difference in the first vowel of each practice word. Since some participants did not know the word 'vowel', this sometimes required some negotiation of meaning before the question was clear[4]. After the description of their perception, the participants received a brief explanation that the vowels in question are three distinct vowels in English and that the vowel in *attic / January* is difficult to hear for German native speakers. To understand and feel how TRAP is produced they were to pronounce the nonsense word [e:ja] and stop just after finishing the pronunciation of /j/. This part of the exercise is based on Kelly's halfway-house technique in which learners 'travel' from one known phoneme to another, and are asked to stop halfway (2010: 40). The participants were also asked to place the tip of their index finger onto the tip of their nose and to simultaneously place their thumb under their chin while saying [e:ja]. Afterwards, they were asked to describe how their finger and thumb moved. The participants were asked to repeat the pronunciation of [e:ja], so they could be stopped at the right time. They were then asked to describe the position of their thumb as well as that of their mouth and tongue. To stop the position of the tongue from being too high (as would be the case with DRESS), the participants were asked to pay attention to their tongue, too. An additional tip to find the tongue position was to smile while pronouncing TRAP. Once they had mastered the pronunciation of TRAP by first saying [e:ja], they were asked to pronounce TRAP in isolation.

[4] In German primary schools, vowels are often introduced as 'Königsbuchtaben' ['regal letters'], 'Silbenkönige ['syllable kings'], or 'Selbstlaute' ['self-sounds'] to help the pupils learn syllable structures while learning to read and write (Grundschulschnüffler 2020).

Group 2 was asked whether they had heard of the <th> before. Since it is common knowledge in Germany that German native speakers tend to have difficulties pronouncing dental fricatives, it could be assumed that many participants had already heard of the concept of 'the <th>' before, despite not being able to read English yet. If they had heard of it, they were asked to describe how they pronounce the sound. If they had not heard of it, the participants were shown the number *three* and asked how they produced the first sound in the word *three*. If they did not know how to describe their articulation, they were asked to watch the researcher pronounce *three* and describe what they had observed. Following this check of the participants' existing knowledge, the participants were asked to place a finger on their central incisors. They were asked to open their mouths just wide enough to allow the tongue to fit in between the top and bottom incisors. All three things, top and bottom teeth as well as tongue, should touch the finger, thus aligning them and aiming to pronounce an interdental fricative. Once teeth, tongue, and finger were in place, the participants were asked to push air through the mouth to pronounce /θ/. Once the pronunciation of the voiceless dental fricative had been achieved, the participants of group 2 were asked to describe the difference between /s/ and /z/ and to place their fingers on their throat as an aid. The alveolar fricatives were used to discuss the idea of voicing instead of the dental fricatives, because alveolar fricatives are part of the German phoneme inventory and would themselves not cause the participants difficulty. Instead, they were able to focus on feeling and describing the voicing. No participant had difficulty understanding this part of the task, otherwise the buzzing of bees and hissing of snakes would have been introduced to help with the pronunciation of the voiced and voiceless alveolar fricatives. After describing what they feel (vibration of the throat in the voiced alveolar fricative compared to no vibration in the voiceless one), the participants were asked to transfer this to the pronunciation of the voiced and voiceless dental fricative. The participants were encouraged to place their finger on their teeth in addition to the fingers of the other hand on the throat. That way they could simultaneously check the

place of articulation and the voicing. Once both voiced and voiceless dental fricative could be pronounced, the participants were asked to pronounce the word *three* with no vibration and then the word *brother* with vibration.

At the beginning of the second intervention, the participants of group 1 were asked to recall everything they remembered from the previous session. After a brief repetition of the exercise with the index finger on the nose and the thumb under the chin and pronouncing /æ/ in isolation, the participants were asked to pronounce *attic* while focussing especially on the word-initial vowel. Once this had been done, the participants were told that they would be shown some of the picture cards they had already seen during the first recording, and that these ones all included TRAP. They were asked to say the English words for the objects they saw on the card and pay special attention to the vowel. They were reminded that it was not a vocabulary test and that the participants should focus primarily on their pronunciation. In order to do this, they were encouraged to keep their fingers in place on nose and chin. If, during this word elicitation, TRAP was pronounced more like DRESS, the participants were encouraged to repeat the word.

As soon as these two words had been mastered, the participants were shown the other picture cards and told beforehand that they all included one of the <th> forms that had just been practiced. Just as group 1, they were asked to say these words and pay special attention to the pronunciation of the <th>. Also in line with group 1, they were asked to repeat the word if the pronunciation of the dental fricative could be improved.

4.6 Analysis of recordings

Because of the different articulatory features of vowels and consonants, the analysis of the dental fricatives differed from that of TRAP. In addition to the

participants' recordings, the teachers' and researcher's recordings were also analysed using the following methods.

For the dental fricatives, the pronunciation of /f, v, s, z, t, d/ was also checked to see if there were speech impediments that might affect the pronunciation of the dental fricatives, such as a lisp, and to aid the auditive analysis of the dental fricatives.

The pronunciation of group 1, the intervention group for TRAP, was analysed acoustically using praat (Boersma & Weenink 2021). Additionally, the German vowels /e:, E, E:, a:, a/ were analysed to compare TRAP to as well as DRESS, because that is what German learners of English typically substitute TRAP with. Because it facilitated swift annotations in praat and in the scatter plots excel, the German phoneme symbols were replaced by *beten, betten, bäten, Rat, Ratte* as a counterpart to the standard lexical sets in English. To maintain a unified description, these words will also be used in the remainder of this dissertation to refer to the respective German vowels. By having English as well as German phonemes as points of comparison, it was possible to describe the articulatory features of TRAP more precisely. This was especially important because the formant values measured in this study were not normalised, making comparisons of said values between speakers rather difficult.

The process of analysis of the three phonemes will be described in detail in the following.

4.6.1 The dental fricatives

The dental fricatives were analysed auditively. The acoustic analysis of consonants is generally less straightforward than that of vowels, with different settings and foci being necessary depending on the different manners of articulation (Ladefoged 2007: 138). Thus, analysing fricatives acoustically would not bring any advantage compared to an auditive analysis for the purpose of this study.

All recordings were analysed by the researcher. Two more people with a background in linguistics, but different first language backgrounds (Brazilian Portuguese and Singapore English**)** also analysed the fricatives so that all fricatives were evaluated twice: once by the researcher herself and once by one of the two other judges. The results were compared to establish inter-judge reliability. A third analysis took place for all cases in which the previous two analyses did not match. If, after three analyses, there was still no match, but one of the three judges determined that the sound was a plosive, this was checked in the spectrogram. However, if the stop could not be unambiguously determined, the phone was marked as 'unclear'. An excerpt from the analysis spreadsheet can be seen in the appendix ('Excerpt auditive analysis dental fricative 1st and 2nd judge') as well as the analysis of the 3rd judge (Auditive analysis of dental fricatives 3rd judge).

All recordings and words including dental fricatives were mapped out in a spreadsheet, and a notation system was created to enable quick but standardised notation of the judges' perceptions. The spreadsheet and the notation system can be found in the appendix ('Excerpt spreadsheet dental fricatives annotations' and 'Tagging and abbreviations in auditive analysis of dental fricatives'). In addition to noting the consonant they heard where a dental fricative is pronounced in RP, the judges also made some additional notes. It was noted whether dental fricatives were pronounced as such from the beginning. They also noted whether the participants were aware of and able to describe voicing. If so, the judges also noted whether the participants' description of voicing matched the actual difference in voicing as perceived by the judges. Thirdly, the judges noted whether they could perceive a lisp and whether /f, v, t, d/ were pronounced target-like. Some additional information was always annotated, regardless of which phoneme was analysed. This additional information included any occasions in which the participant corrected themselves in their pronunciation (e.g. 'faz- father'). If this was the case, the first token was disregarded in the analysis, because it could be assumed that the participant themselves thought the pronunciation was not target-like, hence feeling the

need to change it. If the researcher was unsure if the word written in the annotation was actually the one the participant said or intended to say (e.g. 'cloud' was used by one participant while looking at a picture of a dress, presumably in an attempt to pronounce *Kleid* in an English fashion). If an English word was said within rapid German speech, this was also noted (e.g. '*Also bei* bathroom *hört es sich an wie ein [a], aber bei* bedroom *eher wie ein [e].'*). Within the intervention recording it was noted whether the word was said before or after the intervention. When measuring the effect of the intervention, any tokens produced before the actual intervention may lead to different results. Unlike the acoustic analysis (see 4.6.2), the results of the dental fricatives could be compared across speakers.

4.6.2 TRAP

Analysing the vowels for this study required three major steps:

1. Annotation of the soundfiles
2. Acoustic analysis of the soundfiles via praat
3. Merging the results from praat into excel files and visualising the speakers' pronunciations.

To prepare the soundfiles for the acoustic analysis, each recording was manually annotated in praat in order for a script to run through the recording and measure the vowels. The annotation was done in three tiers, as can be seen in Figure 2. The script can be found in the appendix ('praat script').

In the first tier, a boundary was set roughly around each word that included a vowel relevant to this study. An exact boundary was not necessary, since the word boundaries merely facilitated browsing through the recording in praat and were irrelevant for the acoustic analysis. The annotation in tier one included the elicited words and, if applicable, any additional information that may be important for the analysis (mentioned in the last paragraph of 4.6.1).

The second tier showed the lexical sets that were analysed. The boundaries were set around the vowel. The boundaries were not set at the very beginning and end of the vowels, but only around the part where their pronunciation was most stable, as suggested by Ladefoged (2007: 105). In order to determine this part, the auditive analysis was combined with the visual representations of F1 and F2 in praat.

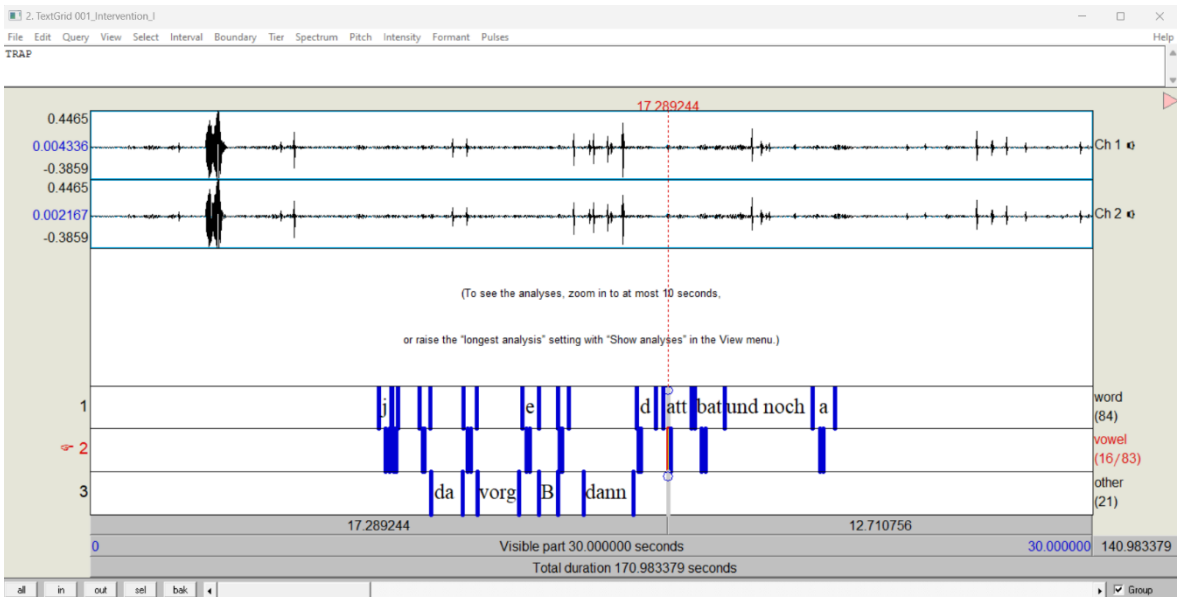

Figure 2. Screenshot of an annotated recording in praat.

The lexical set that was used for the annotation was the one that would be used in this position in RP, not the one that was perceived to actually have been used (because the curriculum proposes RP as target dialect, see 2.1). For German, the words *beten, betten, bäten, Rat, Ratte* were used in the annotation instead of the phonemes, since there are no standardised equivalents to lexical sets in German.

The third tier included words with voiced and voiceless dental fricatives, with the boundary again set only roughly around the whole word. A more detailed boundary was unnecessary, because the consonants were not analysed acoustically.

The second step of the analysis was to analyse the vowels acoustically using praat. The script that was used to extract all relevant information from

praat was written by this author and later edited by her and Lisa Scheiwe. The script ran through each tier and extracted the words and timings to create a list of all the words spoken in one recording as well as the time when each word started and ended. Additionally, it measured the F1 and F2 values for all vowels annotated in the second tier and calculated their mean values.

The settings for the acoustic analysis had to be manually adjusted and adapted to young speakers. The older the speaker, the lower the formant frequency (Huber et al. 1999: 1533). For infants, the settings for the maximum Hertz frequency lies at 8000 Hz, but since the vocal tract grows rapidly in the first two years, it is not possible to generically use this as the maximum formant setting for the participants of this study (Barbier et al. 2015). Since they are still growing, however, and sexual dimorphism has not yet set in, the settings for adult males or females can also not be used. Here, the average maximum frequency used is typically 5000 Hz (Boersma 2013: 390). This meant that the maximum frequency had to be determined manually and individually and that it had to lie within the range of 5000 Hz and 8000 Hz. For each speaker, the maximum frequency was determined by taking three vowels and adjusting the maximum frequency setting until five distinct formants could be visually identified in praat, as suggested by Schweinberger 2016: 8). The vowels DRESS, TRAP and BATH were used, and the frequency was found when five formants were visible for each of these vowels.

The third step involved 'tidying up' the results the script produced and merging the relevant ones in spreadsheets. The script created one textfile for each tier and one line per annotation in the tier. The textfiles of the first two tiers were merged in spreadsheets and manually adjusted. This was necessary for a better overview if there was more than one analysed vowel per word, for example in the case of self-correction.

Once these three steps had been completed for all recordings, the analysis was performed by creating individual, partial vowel charts, comparing F1 for DRESS and TRAP, calculating the standard deviations of F1 DRESS and TRAP, and by calculating the Euclidean distance of DRESS and TRAP. The vowel chart

was created for each recording by plotting the vowels that were analysed in a scatter plot. The x-axis represents F2 and the y-axis represents F1. F2 is correlated with backness and F1 negatively correlates with vowel height, or openness (Johnson 2012: 144). A separate vowel chart with the means of dress and trap per participant per recording was also created, meaning there were two vowel charts per participant per recording in total. They can all be seen in the appendix ('vowel plots intervention group' and 'vowel plots control group'). The English vowel chart highlighting DRESS and TRAP and an example for a participant's partial vowel space can be seen in Figure 3 and Figure 4 below. This allowed a visual comparison of TRAP to the other English vowels as well as the German ones. Since all participants were native speakers of German, it can be assumed that their pronunciation of German vowels does not deviate out of the ordinary. 'Ordinary' deviations stem from intra-speaker variation due to, for example, the sound environment of the vowel (Holmes & Wilson 2019: 271).

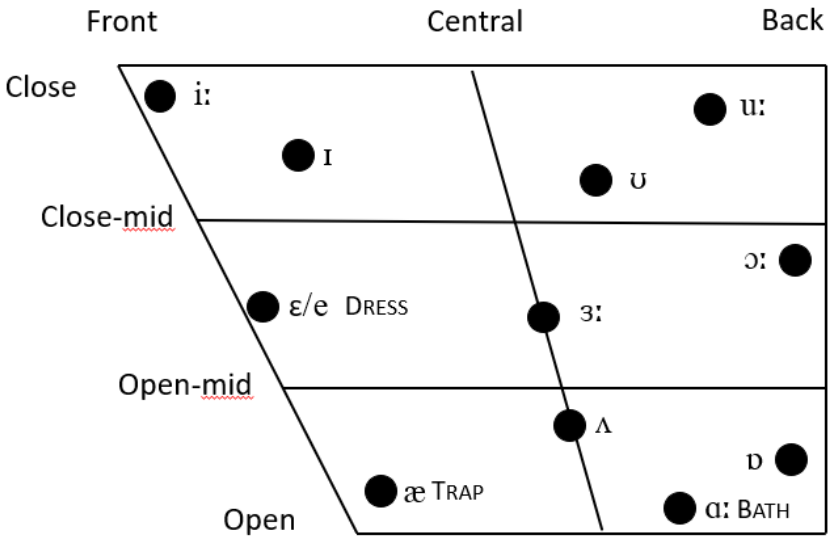

Figure 3. The English vowel chart. (Adapted from: Deterding 2015: 77).

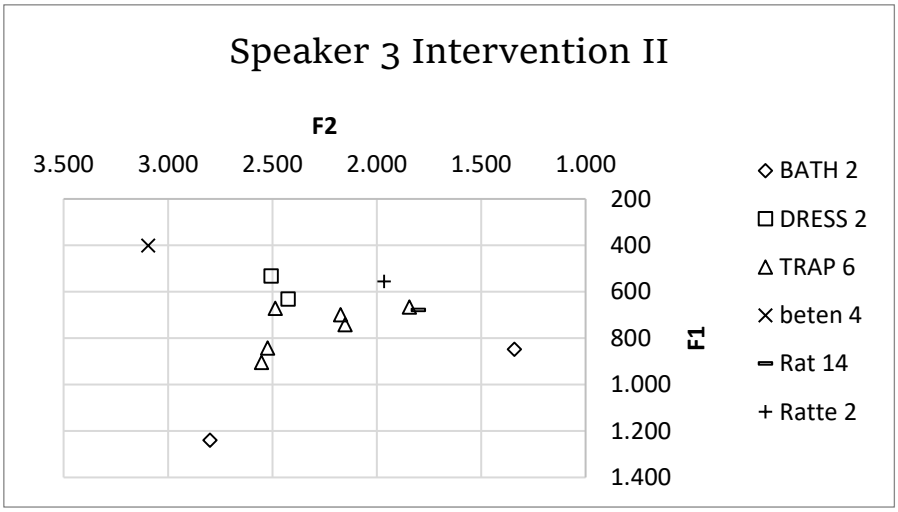

Figure 4. Example plot from Speaker 3 of the recording Intervention II.

Thus, in order to represent the German vowels so they could serve as anchor points as reliably as possible, the mean of all occurrences of each vowel was calculated. For each recording, two diagrams were made. One with the mean values of the German vowels and the mean values of the English vowels, and one with the mean values of the German vowels and all individual tokens of the English vowels. Based on the visualisation of the vowels, no, slight, some, or major differences between DRESS and TRAP could be seen. These were 'translated' into formant values. The difference between the mean values of F1 TRAP and DRESS was calculated for each speaker and recording in order to create a point of comparison. In combination with the vowel plots, ranges of 40 Hz were determined to help describe the development of the pronunciation of TRAP over the course of the recordings. The starting point used to determine the ranges was a difference between the mean F1 values of DRESS and TRAP was 0 Hz, because it was most important to determine whether or not the participants pronounced TRAP more or less open than DRESS and to what extent. An overview over the ranges that were created can be seen in Table 8 in section 6.1, where the results of TRAP are reported.

The standard deviations of the mean values of F1 DRESS and TRAP were also calculated. That helped seeing how much intra-speaker variation there

was for both phonemes. A particularly high standard deviation for F1 TRAP in comparison to F1 DRESS could be an indication for the participant trying out different ways of pronouncing TRAP while pronouncing DRESS rather the same.

In addition to comparing the formant frequencies of F1 numerically as well as the position within the individual vowel charts visually, the difference between DRESS and TRAP was measured by calculating the Euclidean distance. This measure helps to determine whether the distance between DRESS and TRAP increases or decreases, as it measures the distance between two points on a system of coordinates. The standard formula for Euclidean distance is as follows:

$$\sqrt{(x_B - x_A)^2 + (y_B - y_A)^2}$$

The difference that is being measured here is between two points within a two-dimensional graph with an x-axis and a y-axis (represented as X and Y in the formula above). Since F2 is represented on the x-axis and F1 on the y-axis, the formula to calculate the Euclidean distance of DRESS and TRAP within a recording is this:

$$\sqrt{(F2_{DRESS} - F2_{TRAP})^2 + (F1_{DRESS} - F1_{TRAP})^2}$$

Because the value of the Euclidean distance always includes the difference between F1 and F2, it cannot be used as the sole measurement to analyse the development of the pronunciation. F2 represents the frontedness of a vowel, and this is not what sets DRESS and TRAP apart. It is nevertheless a useful measurement to include, because it shows whether there is a change in the pronunciation at all. This can suggest that, even though the change may not be toward the target pronunciation, the participant is trying out different ways of producing the two vowels. The spreadsheet for one participant (Speaker 68) is attached in the appendix as an example ('Example spreadsheet TRAP speaker 68').

5. Results dental fricatives

In this chapter, the results of the study of the dental fricatives will be described. Each section will look at the results from different angles to ensure that all variables that can be taken into consideration without interplay through other variables are actually taken into consideration. These variables are voicing, age of participants and teacher of participants. First, a linear and more general perspective will be taken, looking at how the pronunciation of the dental fricatives changed throughout the duration of the study for the intervention group and the control group. Following that, the results will be presented differentiated by the teachers to see how the teacher influences the participants' pronunciation. To do this, the two year four classes involved taught by different teachers will be compared. The year 3 class will not be considered in that comparison to avoid interplay of age as a possible factor. Finally, the results will be compared by age, looking at the year 3 and year 4 class that were taught by the same teacher to see if this plays a role in the pronunciation instruction. Again, the other year 4 class will not be included in order to focus on the age as a factor without possible interplay by the factor 'teacher'.

DENTAL FRICATIVES: ALL PARTICIPANTS

Class	n Total	n intervention group		n control group	
		Complete	Incomplete	Complete	Incomplete
4A	15	8	1	3	3
3B	14	4	2	6	2
4B	17	9	2	2	4
Total	**46**	**21**	**5**	**11**	**9**

Table 4. Overview of all participants of the intervention study for dental fricatives, sorted by class.

5.1 General chronological overview

The intervention group consisted of 26 participants, 21 of which were present for all five recordings. The control group consisted of 20 participants, 11 of which were present for all three control recordings. For an overview over all participants involved, see Table 4. First, a general overview of how many instances of dental fricatives and their substitutes were produced will be presented before differentiating the results further according to voicing and the different types of substitutes the speakers used during each recording. The results will be presented in chronological order, i.e. first the pre-test, then interventions I and II, and finally post-test I and post-test II. For each recording, the results of the intervention group will be presented first, followed by the results of the control group. For the two intervention stages, only the results of the intervention group will be presented, since the control group did not participate in these stages.

The general overview that will be described in the following can also be seen in the bar chart in Figure 5. All bar charts have been printed in landscape format for better readability. Each bar chart summarises the findings from one particular angle, i.e. all participants or a comparison of classes 4A and 4B, or 3B and 4B. In each bar chart, there is one bar per recording and group and they appear in chronological order along the x-axis, starting with the pre-test on the left and ending in the delayed post-test (=post-test II) on the right. For each recording the results of the intervention group(s) are displayed first, followed by the control group(s). Blue represents the dental fricatives (either both, or the voiceless one or the voiced one, depending on the bar chart). The total amount of tokens and the amount of dental fricatives and substitutions used can be seen on the y-axis. In the bar charts that present the general overview of the results, where both dental fricatives are grouped together, as in the one displayed in this section, the substitutions are displayed in brown, and the cases which could not be resolved after three analyses are represented in black.

During the pre-test, the intervention group produced a total of 135 tokens that include the orthographic <th>, which is, in RP and GA, pronounced as either the voiceless dental fricative /θ/ or the voiced dental fricative /ð/. Of these 135 tokens, 67 (49.6 %) were pronounced as the voiced or voiceless dental fricative, /ð/ and /θ/ respectively, and 63 (46.7 %) with a substitute. Five cases (3.7 %) remained unclear after three rounds of judging. The control group produced a total of 56 tokens (this considerably smaller number can be explained by the fact that the control group did not participate in the interventions).

The control group produced a total of 56 tokens in the pre-test. Of those 56 tokens, 20 (35.7 %) were pronounced with either /θ/ or /ð/ and 36 (64.3 %) with a substitute. No cases remained unclear after three rounds of judging.

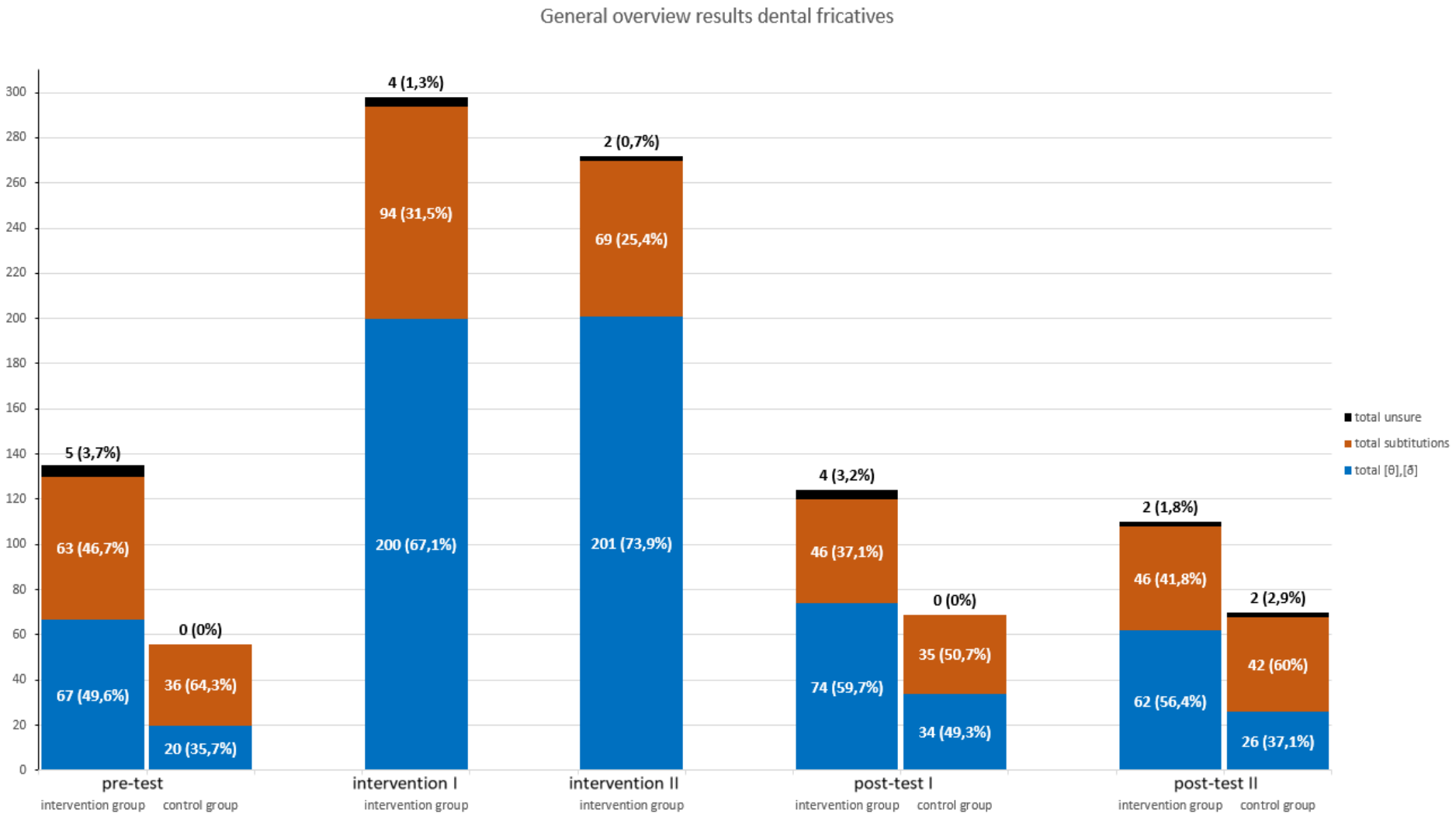

Figure 5. General overview of the results for the dental fricatives with all participants.

During intervention I, the speakers from the intervention group produced a total of 298 tokens containing an orthographic <th>. Of these, 200 (67.1 %) were pronounced with a dental fricative. 94 (31.5 %) were produced with a substitute and four cases (1.3 %) remained unclear after three rounds of judging.

During intervention II, the intervention group produced 272 tokens. Of these, 201 (73.9 %) were pronounced with a dental fricative. 69 (25.4 %) were produced with a substitute and two cases (0.7 %) remained unclear after three rounds of judging.

During post-test I, the intervention group a total of 124 tokens containing an orthographic <th>. Of these 124 tokens, 74 (59.7 %) were pronounced as the voiced or voiceless dental fricative and 46 (37.1 %) with a substitute. Four cases (3.2 %) remained unclear after three rounds of judging. The control group produced a total of 69 tokens. Of these 69 tokens, 34 (49.3 %) were pronounced as either the voiced or voiceless dental fricative and 35 (50.7 %) with a substitute. No cases remained unclear after three rounds of judging.

During post-test II, the intervention group produced a total of 110 words containing an orthographic <th>. Of these 109 tokens, 62 (56.4 %) were pronounced as the voiced or devoiced dental fricative and 46 (41.8 %) with a substitute. Two cases (1.8 %) remained unclear after three rounds of judging. The control group produced a total of 70 tokens. Of these 70 tokens, 26 (37.1 %) were pronounced with either /θ/ or /ð/ and 42 (60 %) with a substitute. Two cases (2.9 %) remained unclear after three rounds of judging.

In all recordings, the intervention group produced more dental fricatives than the control group. During the pre-test, the intervention group's production of dental fricatives ranged at nearly 50 % and that of substitutions at nearly 47 %, whereas the control group produced a dental fricative in 36 % of the cases and substitutes in 64 %. The intervention group's production of dental fricatives peaked at intervention II, when nearly 74 % of tokens were pronounced with a dental fricative. The control group's highest production was

during the first post-test, where approximately 49% of tokens were pronounced with a dental fricative. A comparison of the first and last time of recording reveals a 6.3 % increase of dental fricative production in the intervention group and a 1.3 % increase in the control group.

5.2 Chronological comparison differentiated by voicing

The previous section provided a general overview over the results for the dental fricatives. In this section, the focus will lie on the voicing of the dental fricatives, and the substitutes the participants used, if any. As in the previous comparison, the results will be presented in chronological order, reporting the results for the intervention group before reporting those of the control group for each recording. First, the results for the voiceless dental fricative, /θ/, will be presented, then the results for the voiced dental fricative, /ð/. After presenting general findings and the overview for all of the recordings, a closer look will be taken at the substitutes the speakers used. At this point it must be mentioned that there were no instances at all in which a dental fricative differed from the expected one through voicing (e.g. judges perceiving a /ð/ where a /θ/ would be expected). That means that any time a dental fricative was used, it corresponded to the one that would be expected to be used in that particular instance. The substitutes that were used also corresponded to the dental fricative in terms of voicing in nearly all cases. This means that, if the expected dental fricative was voiced, so was the substitute the speakers used and if the expected dental fricative was voiceless, the substitute the speakers used instead was also voiceless. There were few exceptions which will be reported at the end of this section. As mentioned previously, a total of 19 cases remained unclear after three rounds of judging. Since these cases cannot be evaluated in the analysis, they will be disregarded for all following results. Consequently, in the following, 100 % is the sum of the voiced and voiceless dental fricatives as well as all substitutions, excluding unclear cases.

The results will again be visualised in bar charts that have the same structure as the previous one. As with the general overview bar chart, blue represents the respective dental fricative. The most frequent substitutes (i.e. /s, t, f/ for the voiceless dental fricative and /z, d, v/ for the voiced one) will appear explicitly in the bar charts (orange for /s, z/, grey for /t, d/, yellow for /f, v/, and green for 'other'). There is an additional category termed 'other' to accommodate for any unforeseen substitutions. This category will appear as such in the diagrams and the specific substitutes used will be reported in the respective chapter.

5.2.1 The voiceless dental fricative

The results reported for the voiceless dental fricatives can be seen in Figure 6. In the pre-test, the intervention group produced a total of 97 words which include a voiceless dental fricative in RP and GA. In total, the intervention group produced a voiceless dental fricative 48 times (49.5 %), and used a substitute 49 times (50.5 %). The control group produced a total of 41 words which include a voiceless dental fricative in RP and GA. Of these 41 words, the control group produced a voiceless dental fricative 14 times (34.1 %) and produced a substitute 27 times (65.85 %).

During intervention I, the intervention group produced 152 tokens. Of these 152 tokens, the intervention group produced a voiceless dental fricative 104 times (68.4 %) and a substitute 48 times (31.6 %).

During intervention II, the intervention group produced 189 words containing a voiceless dental fricative in RP and GA. Of these 189 tokens, the intervention group produced a voiceless dental fricative 140 times (74.1 %) and a substitute 49 times (25.9 %).

In post-test I, the intervention group produced a total of 82 tokens. Of these 82 tokens, 48 (58.5 %) were a voiceless dental fricative, and 34 (41.4 %) were a substitute. The control group produced a total of 52 tokens, of which 26 (50 %) were a voiceless dental fricative and 26 (50 %) were substitutes.

In post-test II, the intervention group produced 79 tokens, of which 46 (58.2 %) were a voiceless dental fricative and 33 (41.8 %) were substitutes. The control group produced a total of 46 tokens, of which 17 (37 %) were voiceless dental fricatives and 29 (63 %) were substitutes.

The substitutes the speakers mainly used for the voiceless dental fricative were /s, t, f/. In a total of 12 cases, the speakers also used [ç, k, h, ts, n, d, l, ɬ]. The two instances in which [n] was used as a substitute for /θ/ were the only ones in which the voicing of the target phoneme and that of the substitute used did not match. Both instances of [n] were spoken by the same participant (Speaker 12) in the same recording (the pre-test), for the same word (*mouth*).

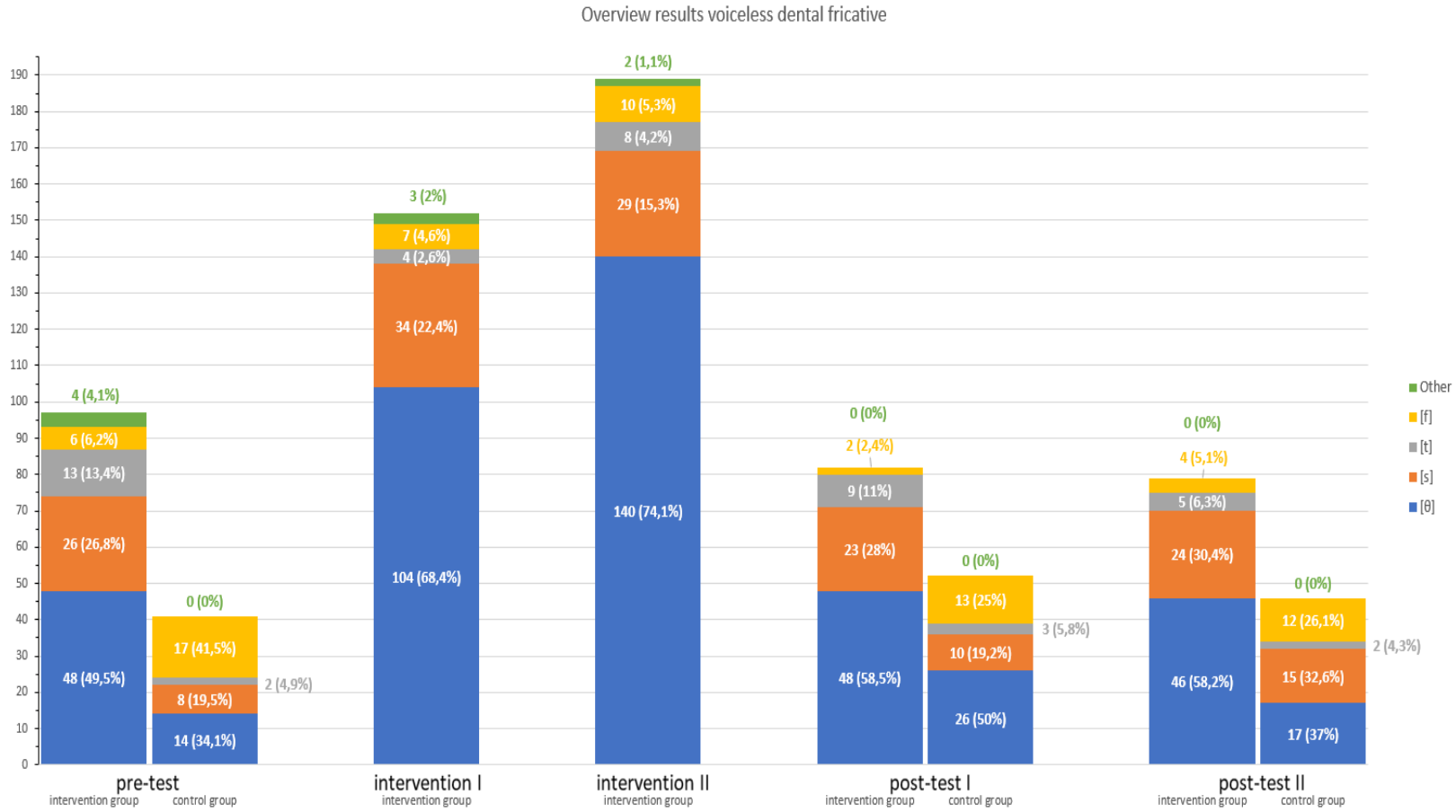

Figure 6. Overview of the results for the voiceless dental fricative /θ/.

5.2.2 The voiced dental fricative

The results for the voiced dental fricative, reported in the following, can be seen in Figure 7. In the pre-test, the intervention group produced 33 tokens in total. The voiced dental fricative was used 19 times (57.6 %) and substitutes were used 14 (42.4 %) times. Of those, ten were /d/ and four /z/. The control group produced 15 tokens in total of which 6 (40 %) were perceived as being a voiced dental fricative and 9 (60 %) were substitutes. One of those was /z/, the other eight were /d/.

During intervention I, the intervention group produced a total of 142 tokens of which 96 (67.6 %) were the voiced dental fricative and 46 (32.4 %) were substitutes. 36 of these were /z/ and seven /d/. Three were categorised as 'other'. All three of these were realized as [ɬ] by the same speaker.

During intervention II, the intervention group produced a total of 81 tokens, of which 61 (75.3 %) were voiced dental fricatives and 20 (24.7 %) were substitutes. Eleven of those were /z/, seven /d/ and two /v/.

In post-test I, the intervention group produced a total of 38 tokens, of which 26 (68.4 %) were voiced dental fricatives and 12 (31.6 %) were substitutes. Seven of the substitutes were /z/ and five /d/. The control group produced a total of 17 tokens, of which 8 (47.1 %) were voiced dental fricatives and 9 (53 %) were substitutes. One of those was /z/, the other eight were /d/.

In the delayed post-test, the intervention group produced a total of 29 tokens, of which 16 (55.2 %) were voiced dental fricatives and 13 (44.8 %) were substitutes. These were split into seven /z/ and six /d/. The control group produced 22 tokens, nine (40.9 %) of which were voiced dental fricatives and 13 (59 %) were substitutes. Three of these were /z/, nine /d/ and one /v/.

Overall, the amount of tokens produced by the intervention group was always higher than that of the control group, but so was the percentage of dental fricatives used. The substitutes the speakers mainly used for the voiced dental fricative were /z, d/, occasionally they also used /v, l/. No other phonemes were used as a substitute for the voiced dental fricative.

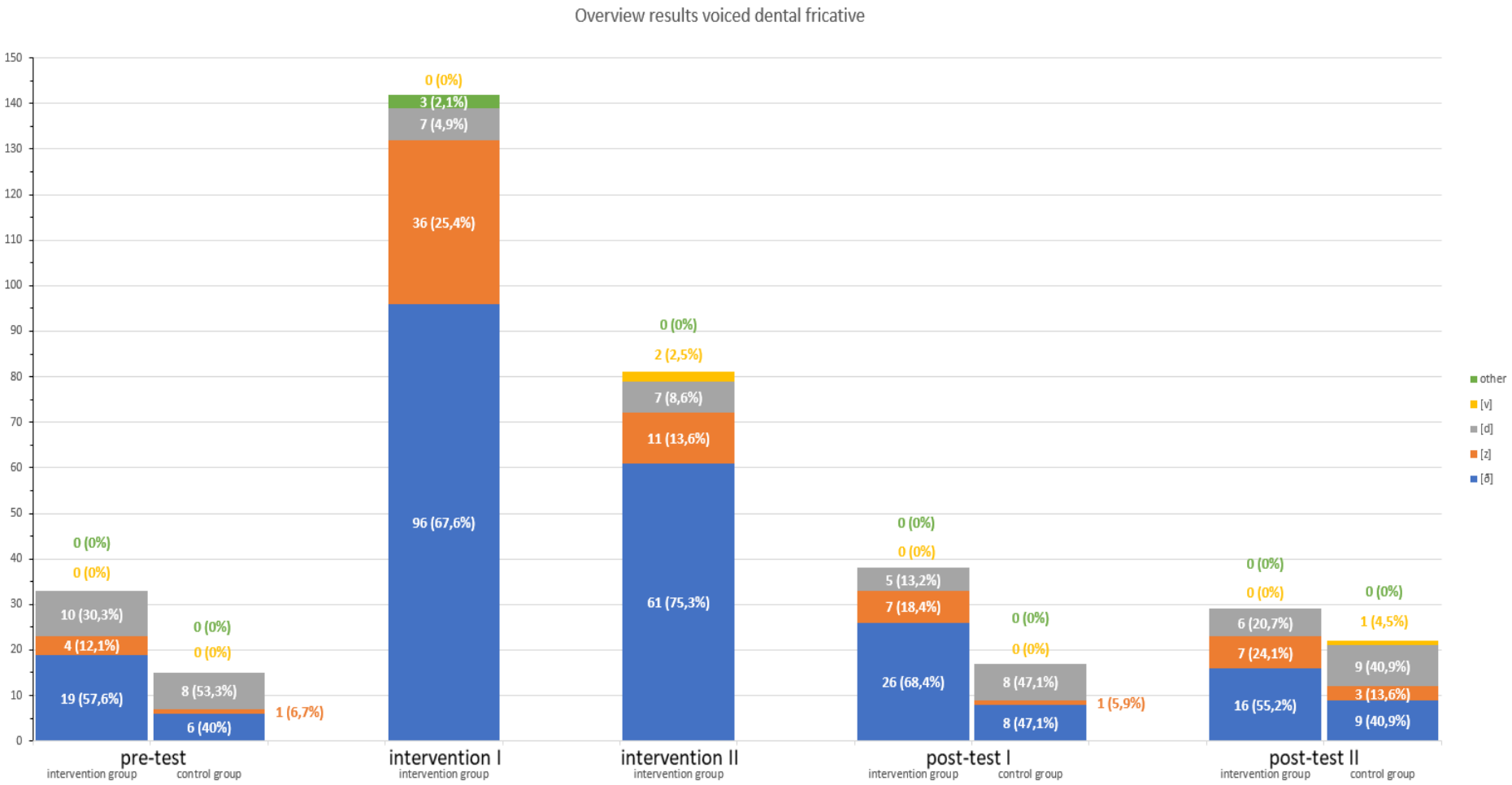

Figure 7. Overview of the results for the voiced dental fricative /ð/.

5.3 General overview of the comparison of year 4 classes with different teachers (4A & 4B)

This section reports the results of the comparison for the two year-4 classes with different teachers. As mentioned in 4.1, the classes will be named 4A and 4B, the letters corresponding to teachers A and B respectively. Before reporting the results of the participants, the teachers' pronunciation of the dental fricatives will be described. Then the results of the participants will be reported. First, an overview of the results for the total number of dental fricatives and the total number of substitutions will be provided before differentiating according to voicing and going into detail on which substitutions were used.

5.3.1 Pronunciation of the dental fricatives by the teacher

Teacher A produced 26 tokens for the dental fricatives. The analysis of the teachers' consonants can be seen in the appendix ('Teachers dental fricatives'). In 19 instances, Teacher A pronounced a dental fricative where one would be expected. In four cases, they used a substitute, /s/ three times and /z/ once. In the remaining three cases, a dental fricative was pronounced in the words *house, mouse* and *Thursday*, where a /s/ or /z/ would be expected. These may be cases of hypercorrection. Teacher B produced 13 tokens, all with the target-like dental fricatives, using no substitutions, as did the researcher. So, in the large majority of cases, both teachers used the target-like pronunciation. However, Teacher A showed some intra-speaker variation by occasionally using alveolar fricatives interchangeably.

DENTAL FRICATIVES: SAME SCHOOL YEAR, DIFFERENT TEACHERS (4A & 4B)					
Class	n Total	n intervention group		n control group	
		Complete	Incomplete	Complete	Incomplete
4A	15	8	1	3	3
4B	17	9	2	2	4
Total	**32**	**17**	**3**	**5**	**7**

Table 5. Distribution of participants involved in the comparison between classes 4A and 4B for the dental fricatives.

5.3.2 Results of 4A and 4B

The intervention group with a full set of recordings from class 4A consisted of eight participants. The control group with a full set of recordings for this class consisted of three participants. For class 4B the intervention group with a full set of recordings consisted of nine participants. The control group with a full set of recordings for this class consisted of two participants. This overview can be seen in Table 5.

The results described in the following can be seen in Figure 8. In the pre-test, intervention group 4A produced a total of 57 tokens, 33 (57.9 %) of which were dental fricatives and 22 (38.6 %) substitutions. Two cases (3.5 %) remained unclear after three rounds of judging. Intervention group 4B produced a total of 53 tokens, 20 (37.7 %) of which were dental fricatives and 31 (58.5 %) substitutions in the pre-test. Two cases (3.8%) remained unclear after three rounds of judging. Control group 4A produced a total of five tokens, one (20 %) of which was a dental fricative and four (80 %) substitutions. Control group 4B produced a total of 12 tokens, eight (66.7 %) of which were dental fricatives and four (33.3 %) substitutions. Neither control group had unclear cases in the pre-test.

In the first intervention, intervention group 4A produced a total of 91 tokens, 70 (76.9 %) of which were dental fricatives and 20 (22 %) substitutions with one (1.1 %) unclear case. Intervention group 4B produced a total of

160 tokens, of which 92 (57.5 %) were dental fricatives and 67 (41.9 %) substitutions with one (0.6 %) unclear case.

In the second intervention, intervention group 4A produced a total of 83 tokens, 71 (85.5 %) of which were dental fricatives and eleven (13.3 %) substitutions with one (1.2 %) unclear case. Intervention group 4B produced a total of 156 tokens, 110 (70,5 %) of which were dental fricatives and 45 (28,8 %) substitutions with one (0,6 %) unclear case.

In the first post-test intervention group 4A produced a total of 42 tokens, of which 23 (54.8 %) were dental fricatives and 17 (40.5 %) substitutions with two (4.8 %) unclear cases. Intervention group 4B produced a total of 60 tokens, 37 (61.7 %) of which were dental fricatives and 22 (36.7 %) substitutions with one (1.7 %) unclear case. Control group 4A produced one (16.7 %) dental fricative and five (83.3 %) substitutions. Control group 4B produced a total of 16 (66.7 %) dental fricatives and eight (33.3 %) substitutions. Neither control group had any unclear cases in post-test I.

In the delayed post-test, intervention group 4A produced a total of 48 tokens, 30 (62.5 %) of which were dental fricatives and 16 (33.3 %) substitutions with two (4.2 %) unclear cases. Intervention group 4B produced a total of 42 tokens, 22 (52.4 %) of which were dental fricatives and 20 (47.6 %) substitutions with no unclear case. Control group 4A produced a total of five tokens, one (20 %) of which was a dental fricative and four (80 %) substitutions. Control group 4B produced eight (66.7 %) dental fricatives and four (33.3 %) substitutions. Neither control group had any unclear cases in the delayed post-test.

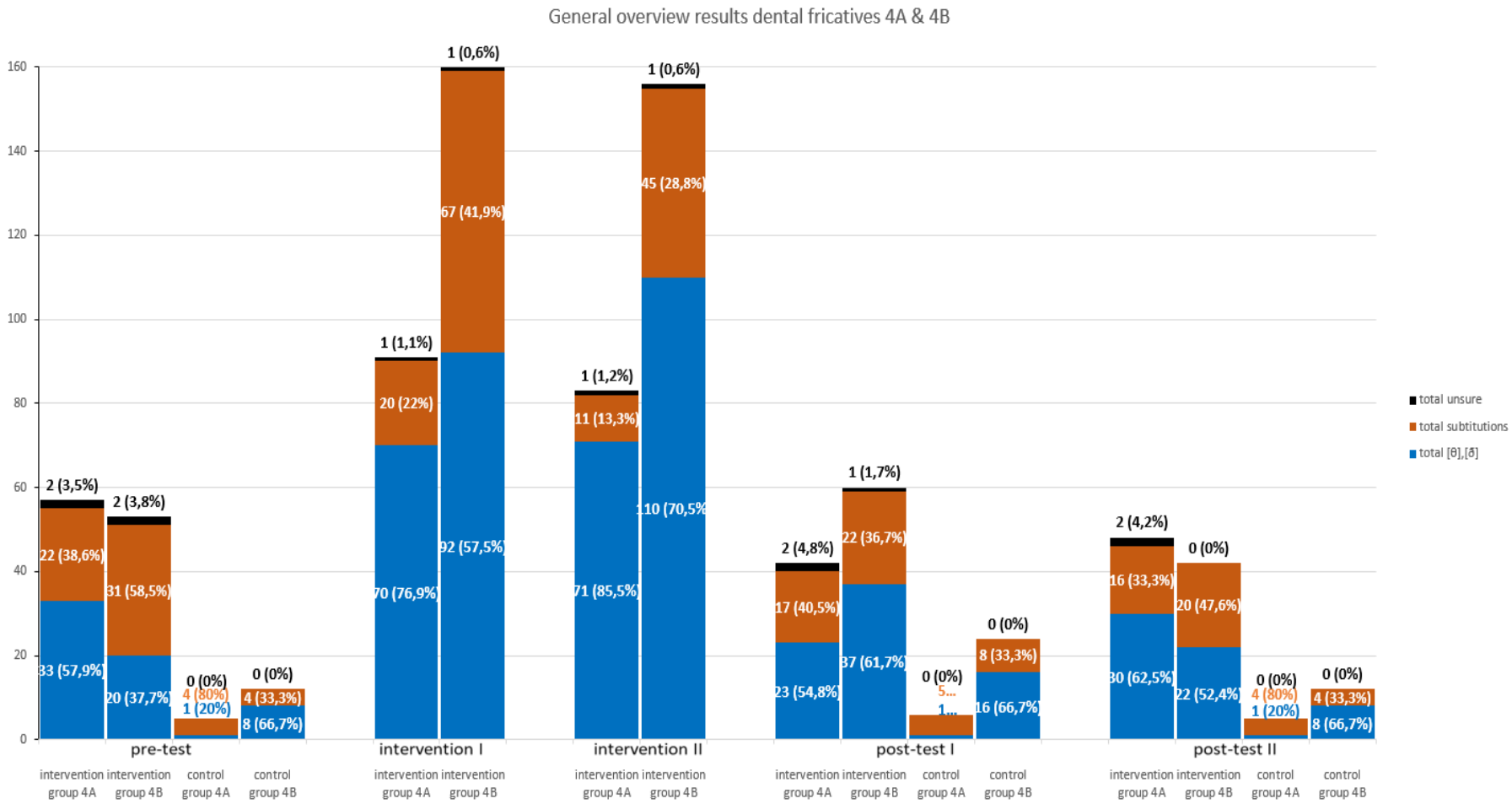

Figure 8. Overview of results for comparison of two Year 4 classes with different teachers.

5.4 Comparison year 4 differentiated by voicing

This section will provide a more detailed report on the results of the comparison between the two Year 4 classes, starting with the voiceless dental fricatives and its substitutions, followed by the voiced dental fricative and its substitutions. Again, the results will be presented in chronological order, reporting the results of the intervention groups first, starting with 4A followed by 4B, then the control group for each recording.

5.4.1 Results of comparison 4A and 4B for the voiceless dental fricative

The results for the voiceless dental fricative, reported in the following, can be seen in Figure 9.

In the pre-test, intervention group 4A produced 41 tokens in total that include the orthographic <th> which would be pronounced with a voiceless dental fricative in RP. The voiceless dental fricative was used 23 times (56.1 %) and substitutes were used 18 times (43.8 %). Of those substitutes 14 were /s/, one was /t/ and three were categorised as other. Of these three, two were /n/, thus being two of the few instances where the voicing of the target dental fricative and the produced substitute did not match, and one was [k]. Intervention group 4B also produced a total of 41 tokens. Of these, 17 (41.5 %) were pronounced as a voiceless dental fricative and 24 (58.5 %) as something else. 12 of the substitutes were /s/, eight were /t/, three were /f/ and one was categorised as other. In this case the orthographic <th> was realised as [ts]. Control group 4A produced five tokens in total of which one (20 %) was perceived as being a voiceless dental fricative and four (80 %) were substitutes, all of them /s/. Control group 4B produced nine tokens in total of which six (66.7 %) were dental fricatives and three (33.3 %) were substitutes, all of them /s/.

In intervention I intervention group 4A produced a total of 54 tokens of which 41 (75.9 %) were the voiceless dental fricative, and 13 (24.1 %) were substitutes. Of those, eleven were /s/ and two were categorised as other, both [ç]. Intervention group 4B produced a total of 80 tokens of which 50 (62.5 %) were the voiceless dental fricative and 30 (37.6 %) were substitutes. Of those, 21 were /s/, four were /t/, four were /f/ and one was categorised as other, which was realized as [h].

In intervention II, intervention group 4A produced a total of 48 tokens of which 40 (83.3 %) were voiceless dental fricatives and eight (16.7 %) were substitutes, all of them /s/. Intervention group 4B produced a total of 121 tokens of which 87 (71.9 %) were voiceless dental fricatives and 34 (28.1 %) were substitutes. 17 of these were /s/, seven were /t/ and eight were /f/. Two were categorised as other, both [ts].

In post-test I, intervention group 4A produced a total of 30 tokens of which 15 (50 %) were voiceless dental fricatives and 15 (50 %) were substitutes. 13 of these were /s/ and two were /t/. Intervention group 4B produced a total of 40 tokens of which 24 (60 %) were voiceless dental fricatives and 16 (40 %) were substitutes. Nine of these were /s/ and seven were /t/. Control group 4A produced a total of five tokens, all of which were /s/. Control group 4B produced a total of 21 tokens, of which 14 (66.7 %) were voiceless dental fricatives and seven (33.3 %) were substitutes. Four of these were /s/, two were /t/ and one was /f/.

In post-test II, intervention group 4A produced a total of 35 tokens of which 24 (68.6 %) were voiceless dental fricatives and 11 (31.4 %) were substitutes, all of which were /s/. Intervention group 4B produced a total of 31 tokens of which 15 (48.4 &) were voiceless dental fricatives and 16 (51.6 %) were substitutes. Ten of these were /s/, five /t/ and one /f/. Control group 4A produced a total of 10 tokens, all of which were /s/. Control group 4B produced a total of 14 tokens, of which ten (71.4 %) were voiceless dental fricatives and four (28.5 %) were substitutes. Of these, two were /s/, one was /t/ and one was /f/.

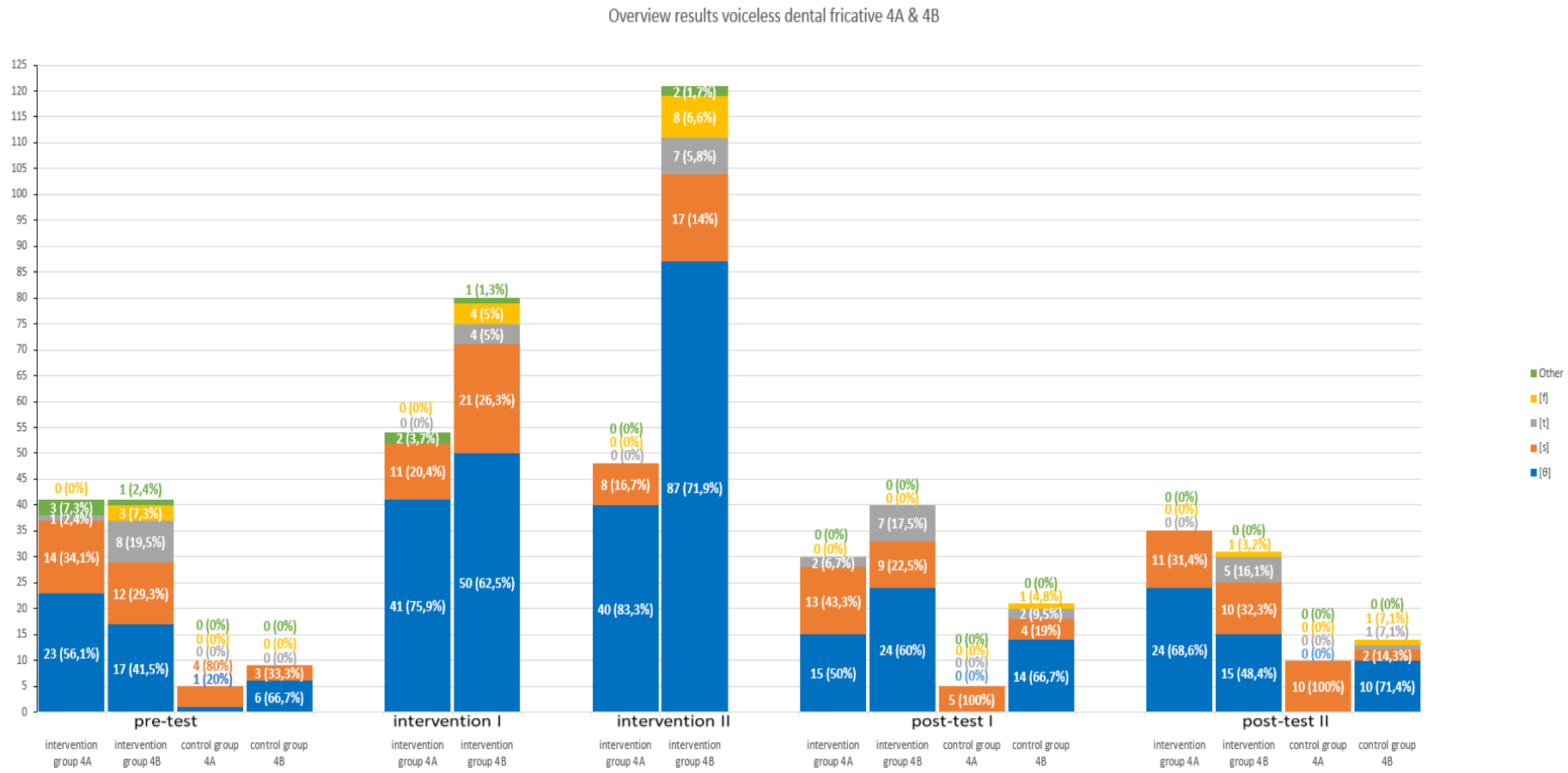

Figure 9. Overview of results of the voiceless dental fricative for comparison of two Year 4 classes with different teachers.

5.4.2 Results of comparison 4A 4B for the voiced dental fricative

The results for the voiced dental fricative, reported in the following, can be seen in Figure 10.

In the pre-test, intervention group 4A produced 14 tokens in total that include the orthographic <th> which would be pronounced with a voiced dental fricative in RP. The voiced dental fricative was used ten times (71.4 %) and substitutes were used four times (28.5 %). Of those substitutes one was /z/, and three were /d/. Intervention group 4B also produced a total of ten tokens. Of these, three (30 %) were pronounced as a voiced dental fricative and seven (70 %) as something else. Three of the substitutes were /z/, and four were /d/. Control group 4A produced no tokens for the voiced dental fricative. Control group 4B produced three tokens in total of which two (66.7 %) were dental fricatives and one (33.3 %) was a substitute, namely /d/.

In intervention I, intervention group 4A produced a total of 36 tokens of which 29 (80.6 %) were the voiced dental fricative, and seven (19.5 %) were substitutes. Of those, six were /z/ and one was /d/. Intervention group 4B produced a total of 79 tokens of which 42 (53.2 %) were the voiced dental fricative and 37 (46.8 %) were substitutes. Of those, 28 were /z/ and six were /d/ and three were categorised as other. All three of these were realized as [ɬ] by the same speaker.

In intervention II, intervention group 4A produced a total of 34 tokens of which 31 (91.2 %) were voiced dental fricatives and three (8.8 %) were substitutes, two were /z/ and one was /d/. Intervention group 4B also produced a total of 34 tokens of which 23 (67.6 %) were voiced dental fricatives and eleven (32.4 %) were substitutes. Nine of these were /z/ and two were /v/.

In post-test I, intervention group 4A produced a total of ten tokens of which eight (80 %) were voiced dental fricatives and two (20 %) were substitutes, both of them /z/. Intervention group 4B produced a total of 19 tokens of

which 13 (68.4 %) were voiced dental fricatives and six (31.6 %) were substitutes. Five of these were /z/ and one was /d/. Control group 4A produced one token, which was a voiced dental fricative. Control group 4B produced a total of three tokens, two (66.7 %) of which were voiced dental fricatives and one (33.3 %) a substitute, namely /d/.

In post-test II, intervention group 4A produced a total of eleven tokens, of which six (54.5 %) were voiced dental fricatives and five (45.5 %) were substitutes, four of which were /z/ and one /d/. Intervention group 4B produced a total of eleven tokens, of which seven (63.6 %) were voiced dental fricatives and four (36.4 %) were substitutes. Three of these were /z/ and one was /d/. Control group 4A produced two tokens, both substitutes, one /z/ and one /v/. Control group 4B produced a total of five tokens, four (80 %) of which were voiced dental fricatives and one (20 %) was a substitute, namely /d/.

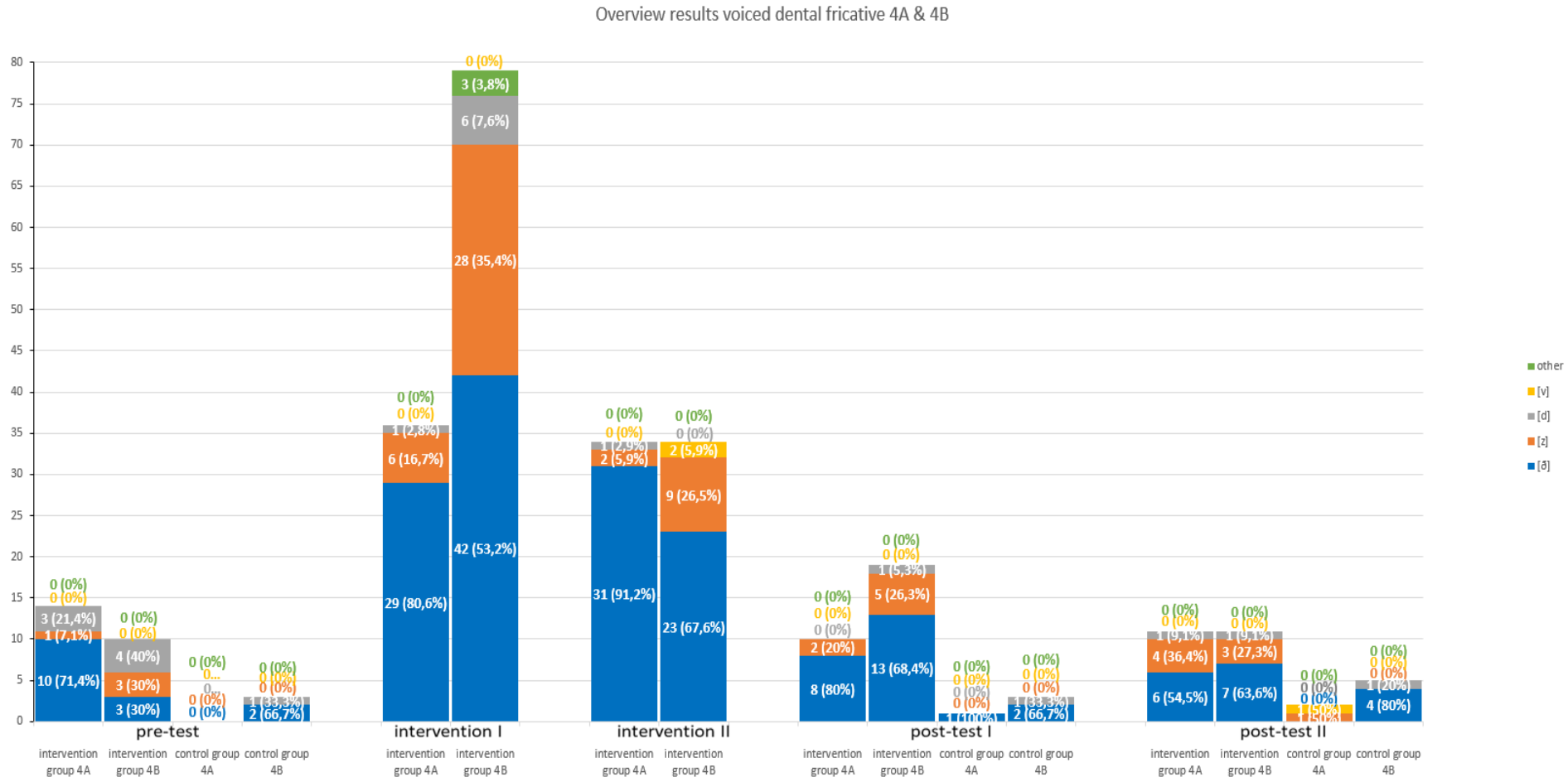

Figure 10. Overview of results of the voiced dental fricative for comparison of two Year 4 classes with different teachers (4A & 4B).

5.5 General overview of comparison year 3 and year 4 with the same teacher (3B and 4B)

This section describes the results of the comparison for the year 3 and year 4 class taught by the same teacher. The classes will be named 3B and 4B, the numbers corresponding to the school years and the letter to the teacher. First, an overview of the results for the total number of dental fricatives and the total number of substitutions will be provided before differentiating according to voicing and going into detail on which substitutions were used. The intervention group with a full set of recordings from class 3B consisted of four participants. The control group with a full set of recordings for this class consisted of six participants. For class 4B the intervention group with a full set of recordings consisted of nine participants. The control group with a full set of recordings for this class consisted of two participants. This overview can be seen in Table 6.

DENTAL FRICATIVES: SAME TEACHER, DIFFERENT SCHOOL YEAR (3B & 4B)					
Class	n Total	n intervention group		n control group	
		Complete	Incomplete	Complete	Incomplete
3B	14	4	2	6	2
4B	17	9	2	2	4
Total	**31**	**13**	**4**	**8**	**6**

Table 6. Distribution of participants involved in the comparison between classes 3B and 4B for the dental fricatives.

The results reported in the following can be seen in Figure 11. In the pretest, intervention group 3B produced a total of 25 tokens that would be pronounced with a dental fricative in RP. Of those 25 tokens 14 (56 %) were pronounced as a dental fricative and in ten (40 %) cases a substitute was used. One case (4 %) remained unclear after three rounds of judging. Intervention

group 4B produced a total of 53 tokens of which 20 (37.7 %) were a dental fricative and 31 (58.5 %) were a substitute. Two cases (3.8 %) remained unclear after three rounds of judging. Control group 3B produced 39 tokens, eleven (28.2 %) of which were dental fricatives and 28 (71.8 %) were substitutes. Control group 4B produced 12 tokens in total of which eight (66.7 %) were dental fricatives and four (33.3 %) were substitutes. There were no unclear cases in either of the control groups.

In intervention I, intervention group 3B produced a total of 47 tokens, 38 (80.9 %) of which were dental fricatives and seven (14.9 %) were substitutes. There were two cases (4.3 %) that remained unclear after three rounds of judging. Intervention group 4B produced a total of 160 tokens, 92 of which were dental fricatives and 67 were substitutes, one case remained unclear.

In intervention II, intervention group 3B produced a total of 33 tokens, 20 (60.6 %) of which were dental fricatives and 13 (39.4 %) were substitutes. There were no unclear cases. Intervention group 4B produced a total of 156 tokens, 110 (70.5 %) of which were dental fricatives and 45 (28.8 %) were substitutes. One (0.6 %) case was unclear.

In post-test I, intervention group 3B produced a total of 22 tokens, 14 (63.6 %) of which were dental fricatives and seven (31.8 %) were substitutes. There was one (4.6 %) unclear case. Intervention group 4B produced a total of 60 tokens, 37 (61.7 %) were dental fricatives and 22 (36.7 %) were substitutes, with one (1.7 %) unclear case. Control group 3B produced a total of 39 tokens, 17 (43.6 %) of which were dental fricatives and 22 (56.4 %) were substitutes. Control group 4B produced a total of 24 tokens, 16 (66.7 %) of which were dental fricatives and eight (33.3 %) were substitutes. There were no unclear cases in either control group.

In post-test II, intervention group 3B produced 20 tokens in total, ten (50 %) each as dental fricatives and substitutes. Intervention group 4B produced a total of 42 tokens, 22 (52.4 %) of which were dental fricatives and 20 (47.6 %) were substitutes. Control group 3B produced a total of 39 tokens,

eleven (28.2 %) of which were dental fricatives and 28 (71.8 %) were substitutes. Control group 4B produced a total of 12 tokens, eight (66.7 %) of which were dental fricatives and four (33.3 %) were substitutes. There were no unclear cases in any of the groups for post-test II.

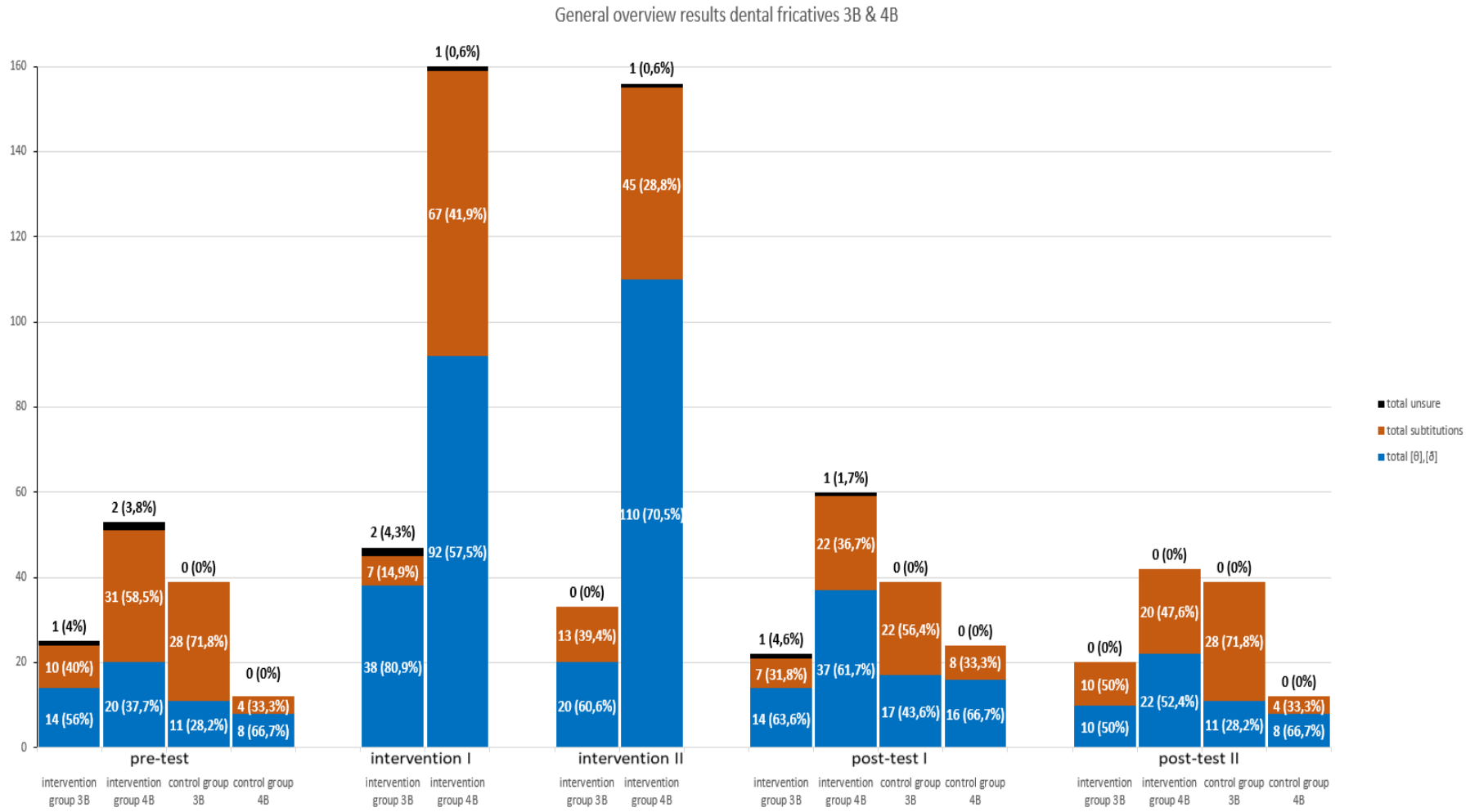

Figure 11. Overview of results for comparison of a year 3 and year 4 class with the same teacher (3B & 4B)

5.6 Comparison of Year 3 and 4 differentiated by voicing

This section will provide a more detailed report on the results of the comparison between the Year 3 and 4 classes taught by the same teacher, starting with the voiceless dental fricatives and its substitutions, followed by the voiced dental fricative and its substitutions. Again, the results will be presented in chronological order, reporting the results of the intervention groups first, starting with 3B followed by 4B, then the control groups for each recording.

5.6.1 Results of comparison 3B and 4B for the voiceless dental fricative

The results for the voiceless dental fricative, reported in the following, can be seen in Figure 12.

In the pre-test, intervention group 3B produced a total of 15 tokens that include the orthographic <th> which would be pronounced as a voiceless dental fricative in RP. Of those 15 tokens, eight (53.3 %) were pronounced as a voiceless dental fricative, and seven (46.7 %) with substitutes. Of those, four were pronounced with /t/ and three with /f/. Intervention group 4B produced a total of 41 tokens, 17 (41.5 %) of which were pronounced as a voiceless dental fricative and 24 (58.5 %) with substitutes. Of those, 12 were /s/, eight were /t/, three were /f/ and one was categorised as other, namely [ts]. Control group 3B produced a total of 27 tokens, seven (25.9 %) of which were pronounced as a voiceless dental fricative and 20 (74.1 %) with a substitute. Of those, one was pronounced as /s/, two as /t/ and 17 as /f/. Control group 4B produced a total of nine tokens, six (66.7 %) of which were pronounced as voiceless dental fricative, and three (33.3 %) as /s/.

In intervention I, intervention group 3B produced a total of 18 tokens, 13 (72.2 %) of which were pronounced as a voiceless dental fricative, and five (27.8 %) with substitutes. Of those, two were pronounced as /s/ and three as

/f/. Intervention group 4B produced a total of 80 tokens, 50 (62.5 %) of which were pronounced as voiceless dental fricatives and 30 (37.6 %) with substitutes. Of those, 21 were pronounced as /s/, four as /t/, four as /f/ and one was categorised as other. This was pronounced as [h].

In intervention II, intervention group 3B produced a total of 20 tokens, 13 (65 %) of which were pronounced as voiceless dental fricatives, and seven (35 %) substitutes. Of those, four were pronounced as /s/, one as /t/ and two as /f/. Intervention group 4B produced a total of 121 tokens, 87 (71.9 %) of which were pronounced as voiceless dental fricatives, and 34 (28.1 %) with substitutes. Of those, 17 were pronounced as /s/, seven as /t/, eight as /f/ and two were categorised as other. In both cases, the orthographic <th> was pronounced as [ts].

In post-test I, intervention group 3B produced a total of 12 tokens, nine (75 %) of which were pronounced as a voiceless dental fricative, and three (25 %) with substitutes. Of those, one was pronounced as /s/ and two as /f/. Intervention group 4B produced a total of 40 tokens, 24 (60 %) of which were pronounced as a voiceless dental fricative and 16 (25 %) as substitutes. Of those, nine were pronounced as /s/ and seven as /t/. Control group 3B produced a total of 26 tokens, 12 (46.2 %) of which were pronounced as a voiceless dental fricative and 14 (53.8 %) with a substitute. Of those, one each was pronounced as /s/ and /t/ and 12 as /f/. Control group 4B produced a total of 21 tokens, 14 (66.7 %) of which were pronounced as a voiceless dental fricative and seven (33.3 %) with a substitute. Of those, four were pronounced as /s/, two as /t/ and one as /f/.

In post-test II, intervention group 3B produced a total of 13 tokens, seven (53.8 %) of which were pronounced as a voiceless dental fricative and six (46.2 %) with a substitute. Of those, three were pronounced as/s/ and three as /f/. Intervention group 4B produced a total of 31 tokens, 15 (48.4 %) of which were pronounced as a voiceless dental fricative and 16 (51.6 %) with a substitute. Of those, ten were pronounced as /s/, five as /t/ and one as /f/. Control group 3B produced a total of 22 tokens, seven (31.8 %) of which were pronounced as

a voiceless dental fricative and 15 (68.1 %) with a substitute. Of those, three were pronounced as /s/, one as /t/ and eleven as /f/. Control group 4B produced a total of 14 tokens, ten (71.4 %) of which were pronounced as a voiceless dental fricative and four (28.5 %) with substitutes. Of those, two were pronounced as /s/ and one each as /t/ and /f/.

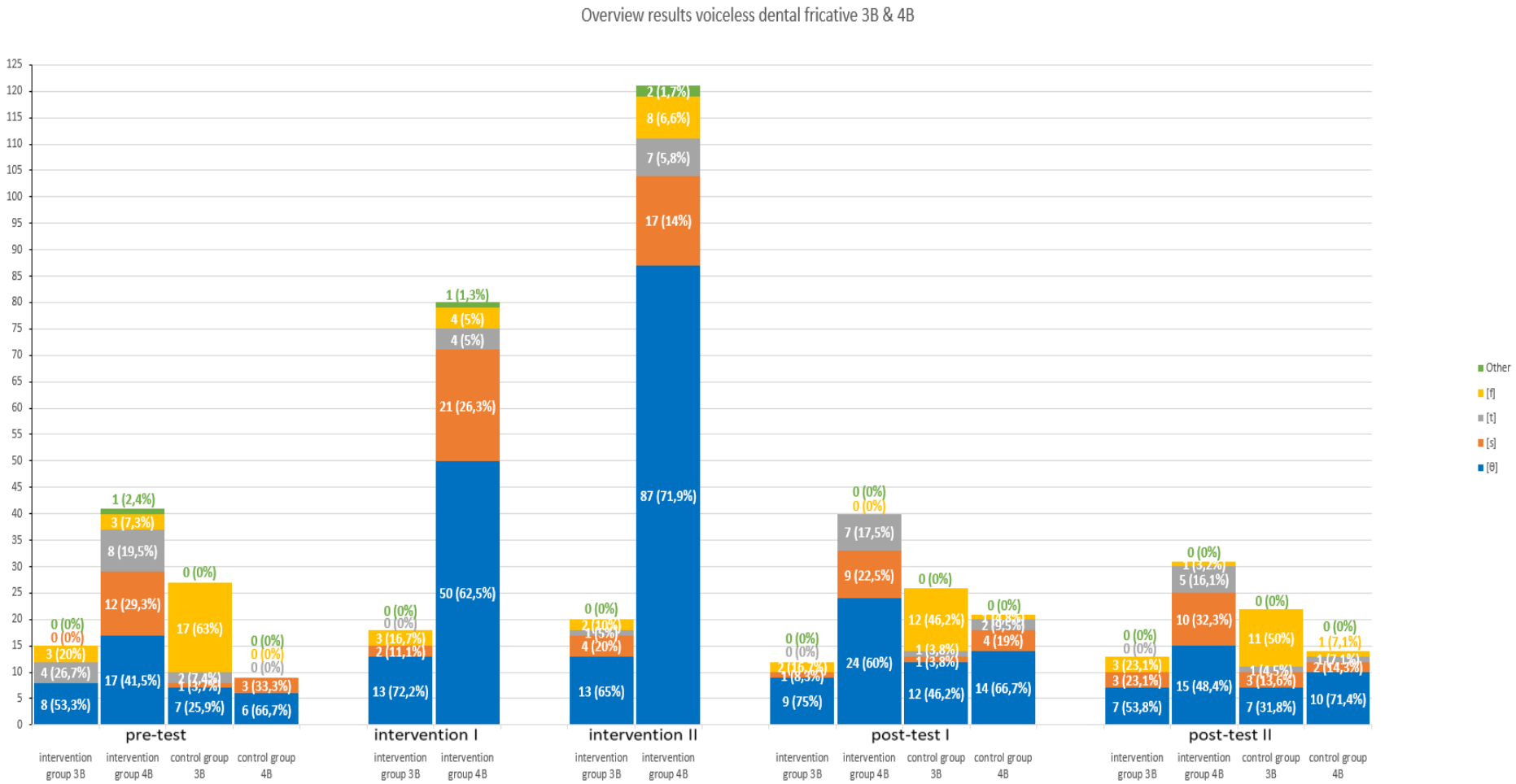

Figure 12. Overview of results of the voiceless dental fricative for comparison of a year 3 and year 4 class with the same teacher (3B & 4B).

5.6.2 Results of comparison 3B and 4B for the voiced dental fricative

The results for the voiced dental fricative, reported in the following, can be seen in Figure 13.

In the pre-test, intervention group 3B produced a total of nine tokens that include the orthographic <th> which would be pronounced as a voiced dental fricative in RP. Of those nine tokens, six (66.7 %) were pronounced as a voiced dental fricative, and three (33.3 %) as /d/. Intervention group 4B produced a total of ten tokens, three (70 %) of which were pronounced as a voiced dental fricative and seven (70 %) with a substitute. Of those, three were pronounced as /z/, and four as /d/. Control group 3B produced a total of 12 tokens, four (33.3 %) of which were pronounced as a voiced dental fricative and eight (66.7 %) with a substitute. Of those, one was pronounced as /z/, and seven as /d/. Control group 4B produced a total of three tokens, two (66.7 %) of which were pronounced as voiced dental fricative, and one (33.3 %) as /d/.

In intervention I, intervention group 3B produced a total of 27 tokens, 25 (92.6 %) of which were pronounced as a voiced dental fricative, and two (7.4 %) as /z/. Intervention group 4B produced a total of 79 tokens, 42 (53.2 %) of which were pronounced as voiced dental fricatives and 37 (46.8 %) with a substitute. Of those, 28 were pronounced as /z/, and six were /d/. Three were categorised as other. All three of these were realized as [ɬ] by the same speaker.

In intervention II, intervention group 3B produced a total of 13 tokens, seven (53.8 %) of which were pronounced as voiced dental fricatives, and six (46.2 %) as /d/. Intervention group 4B produced a total of 34 tokens, 23 (67.6 %) of which were pronounced as voiced dental fricatives and eleven (32.4 %) with a substitute. Of those, nine were pronounced as /z/, and two as /v/.

In post-test I, intervention group 3B produced a total of nine tokens, five (55.6 %) of which were pronounced as a voiced dental fricative, and four (44.4 %) as /d/. Intervention group 4B produced a total of 19 tokens, 13 (68.4 %) of which were pronounced as a voiced dental fricative and six (31.6 %) were pronounced with a substitute. Of those, five were pronounced as /z/ and one as

/d/. Control group 3B produced a total of 13 tokens, five (38.5 %) of which were pronounced as a voiced dental fricative and eight (61.5 %) with a substitute. Of those, one was pronounced as /z/, and seven as /d/. Control group 4B produced a total of three tokens, two (66.7 %) of which were pronounced as a voiced dental fricative, and one (33.3 %) as /d/.

In post-test II, intervention group 3B produced a total of seven tokens, three (42.9 %) of which were pronounced as a voiced dental fricative, and four (57.1 %) as /d/. Intervention group 4B produced a total of eleven tokens, seven (63.6 %) of which were pronounced as a voiced dental fricative and four (36.4 %) were pronounced with a substitute. Of those, three were pronounced as /z/, and one as /d/. Control group 3B produced a total of 15 tokens, five (33.3 %) of which were pronounced as a voiced dental fricative and ten (66.7 %) with substitutes. Of those, two were pronounced as /z/, and eight as /d/. Control group 4B produced a total of five tokens, four (80 %) of which were pronounced as a voiced dental fricative, and one (20 %) as /d/.

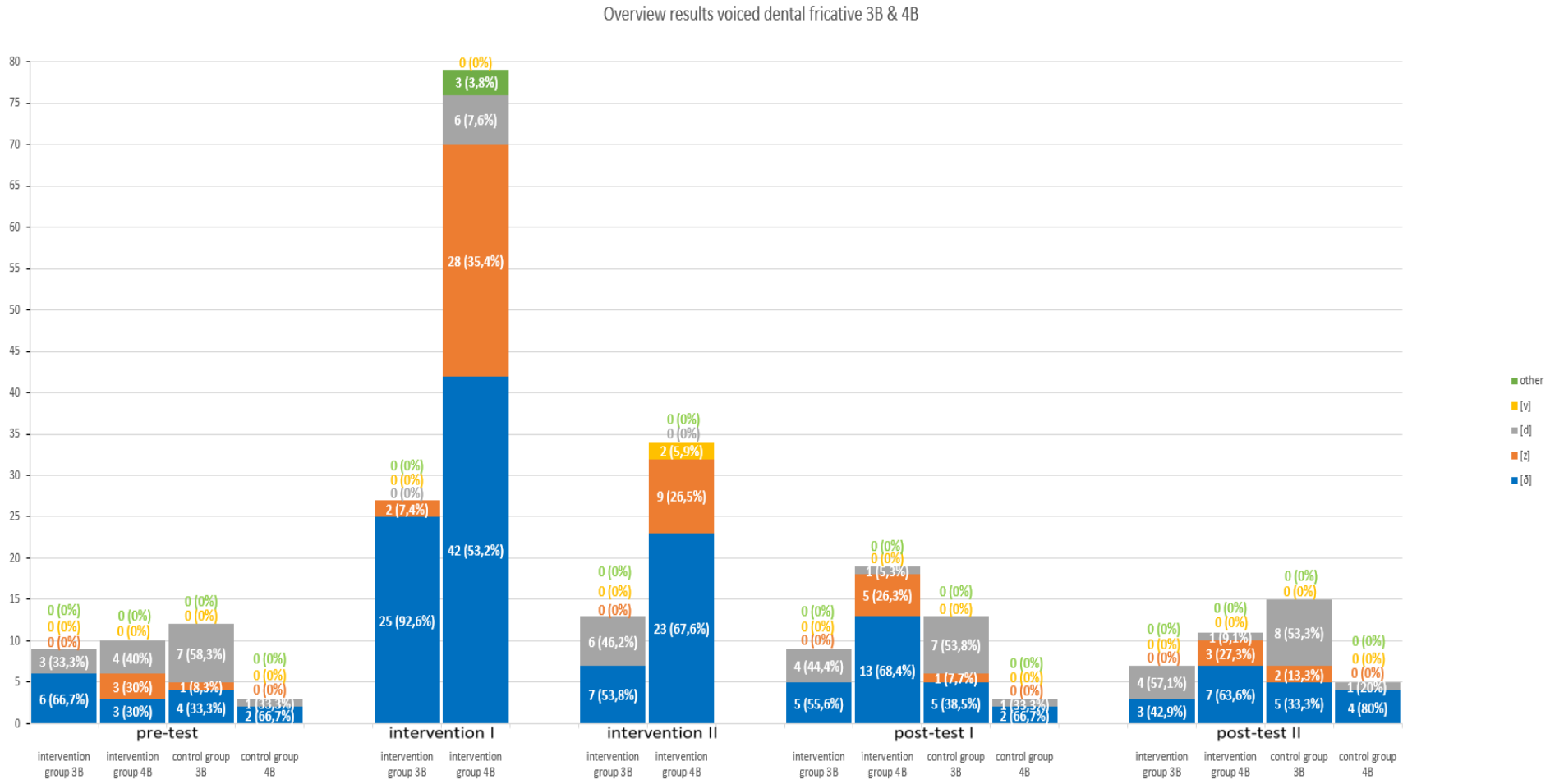

Figure 13. Overview of results of the voiced dental fricative for comparison of a year 3 and year 4 class with the same teacher (3B & 4B).

5.7 Summary of findings

This section sums up the previously reported findings. The participants of the intervention group produced most target-like tokens during intervention II, at approximately 75 %, compared to ~50% in the pre-test. The percentage of target-like tokens was similar in intervention I and the post-test at approximately 67 % in intervention I and 60% in post-test I and decreases to 56 % in the delayed post-test, still showing slightly more target-like tokens than in the pre-test. When differentiating the results by voicing, the results for the voiceless dental fricative are slightly lower in intervention I compared to the voiced dental fricative, but higher in the post-test. The results in the delayed post-test are similar for both, with 58 % target-like pronunciation of the voiceless dental fricative and 55 % of the voiced dental fricative.

The comparison between the two year 4 classes with different teachers showed a slight difference. In most recordings, the intervention group of 4A produced a higher percentage of dental fricatives than that of 4B, with the exception of the first post-test in which 4B produced a slightly higher percentage of dental fricatives than 4A. In the two control groups of these classes, the results are reversed, meaning that 4B produced a higher percentage of dental fricatives in all three recordings they participated in than 4A.

The comparison between the year 3 and year 4 classes with the same English teacher also showed slightly different results. The intervention group 3B produced a higher percentage of dental fricatives in the pre-test and in intervention I. After that, 4B produced a higher percentage of dental fricatives than 3B. This is particularly striking in intervention II and the delayed post-test. In intervention II, 3B produced 63.6 % dental fricatives, compared to 56 % in the pre-test. 4B produced 37.7 % dental fricative in the pre-test and 61.7 % in intervention II. In the delayed post-test, the production of dental fricatives in the intervention group of 3B decreased to 50 %, lower than in the pre-test, but that of the intervention group of 4B increased to 52.4 %, nearly 15 % more than in the pre-test.

6. Results for TRAP

In this chapter, the results of the intervention concerned with the explicit pronunciation instruction of the TRAP vowel will be reported. The overall goal was to measure the effect of explicit pronunciation instruction of the TRAP vowel, explicitly with regard to vowel openness. As presented in chapter 2.4, the main difference between DRESS and TRAP rather lies in the openness of the vowel with DRESS being and open-mid vowel and TRAP being a open vowel. Therefore, in acoustic terms, F2 can be expected to be similar for DRESS and TRAP, but F1 is typically higher for TRAP than for DRESS.

This intervention study was conducted with 45 participants, 16 of which were in the intervention group and eleven in the control group. 18 participants (nine in the intervention group and nine in the control group) were not present for all recordings, so their results are not reported here. An overview of the participants involved can be seen Table 7.

TRAP: ALL PARTICIPANTS					
Class	n Total	n intervention group		n control group	
		Complete	Incomplete	Complete	Incomplete
4A	14	5	3	3	3
3B	15	7	0	6	2
4B	16	4	6	2	4
Total	**45**	**16**	**9**	**11**	**9**

Table 7. Overview of all participants of the intervention study for TRAP, sorted by class.

In the following, the results will be presented from various different perspectives to establish in how far the intervention itself, but also other contributing factors might influence the outcome of this intervention study. First, a chronological and more general perspective will be taken looking at how TRAP is pro-

nounced during the different stages of the study focusing on overall developments rather than the progression of individual participants. This approach will not only give a first overview over the results of this part of the study, but also focus on the intervention itself as the first, and most important, variable to be considered. These results will be further elaborated by tracking the development of individual participants based on their initial pronunciations of TRAP.

Then further factors that might influence the results, such as the influence of the teacher's pronunciation and the age of the participants, will be taken into account. It must be noted, however, that the groups that will be compared based on the participants age or who their teacher is, are very small. So, although the results may indicate effects and contributing factors, they cannot be generalised for leaners beyond the scope of the groups. That is also why participants from all three classes with a similar initial pronunciation will be grouped together, knowing that there might be interplay through other factors. To report the influence of the teachers' pronunciation, the two year four classes involved taught by different teachers will be compared. Finally, the results will be compared by age, looking at the year 3 and year 4 class that were taught by the same teacher to see in how far age plays a role in the pronunciation instruction.

6.1 General chronological overview

This section presents an overview of how the TRAP vowel is pronounced in comparison to DRESS at the different intervention stages. The focus lies rather on the intervention- and control group as a whole, and not on the pronunciation development of individual participants.

Since German learners of English tend to merge DRESS and TRAP, the difference in F1 between DRESS and TRAP is of interest in this study. As presented previously, the two vowels do not differ in terms of backness but rather in

terms of openness. To translate this articulatory observation into numerical values, the difference between the mean F1 of DRESS and the mean F1 of TRAP was calculated for each participant and recording. Table 8 below displays each numerical range in hertz combined with the articulatory interpretation of this range, as well as an abbreviated version of each range for further reference. The mean F1 value of DRESS was subtracted from the mean F1 value of TRAP. If the difference was a negative number, F1 of DRESS was larger than F1 of TRAP which, in turn, meant that DRESS was more open than TRAP. If the value was close to zero, DRESS and TRAP were pronounced similarly in terms of openness. If the difference was a positive number, so the F1 of DRESS was smaller than the F1 of TRAP, this means that TRAP is more open than DRESS. To provide a first general overview of the results for TRAP, the difference in F1 was split into a number of ranges, based on differences seen in the vowel plots (see chapter 4.6.2).

Numerical Range in Hz	**Articulatory interpretation**	**Abbreviation**
<-100	DRESS is much more open than TRAP	D>T (much)
-60 to –100	DRESS is more open than TRAP	D>T (more)
-20 to -60	DRESS is slightly more open than TRAP	D>T (slightly)
-20 to 20	DRESS and TRAP are nearly the same	D=T
20 to 60	TRAP is slightly more open than DRESS	T>D (slightly)
60 to 100	TRAP is more open than DRESS	T>D (more)
>100	TRAP is much more open than DRESS	T>D (much)

Table 8. Numerical ranges of the difference between the F1 values of DRESS and TRAP with the respective articulatory interpretation.

The results will be presented in chronological order, i.e. first the pre-test, then interventions I and II, and finally post-test I and post-test II, i.e. the delayed post-test. For each recording the results of the intervention group,

consisting of 16 participants, will be presented first, followed by the results of the control group, consisting of eleven participants. For the two intervention stages only the results of the intervention group will be presented, since the control group did not participate in these stages. Although all participants whose results are presented here took part in all recordings, it is possible that the difference cannot be reported here because there was no token of DRESS for a particular recording.

The results for all participants and all recordings which will be described here can also be seen in Table 9, where the intervention group is abbreviated with IG and the control group with CG. In the pre-test, no speaker of the intervention group pronounced DRESS much more, or more open than TRAP. One speaker pronounced DRESS slightly more open than TRAP, and three participants pronounced DRESS and TRAP nearly the same. Four participants pronounced TRAP slightly more open than DRESS, four participants pronounced TRAP more open than DRESS, and three participants pronounced TRAP much more open than DRESS. One speaker did not produce DRESS in the pre-test. In the control group, one speaker pronounced DRESS much more open than TRAP, and one speaker pronounced DRESS slightly more open than TRAP. None of the participants of the control group pronounced DRESS and TRAP similarly in terms of openness. Two participants pronounced TRAP slightly more open than DRESS, three pronounced TRAP more open than DRESS, and two pronounced TRAP much more open than DRESS. For two participants the range calculation was not possible because there was no instance of DRESS.

In Intervention I, TRAP had a higher F1 value than DRESS for all 16 participants of the intervention group. Three of these participants pronounced TRAP slightly more open than DRESS, one pronounced TRAP more open than DRESS, and seven pronounced TRAP much more open than DRESS. For five participants the range calculation was not possible because there was no instance of DRESS. Unlike in the pre-test, all participants of the intervention group pronounced TRAP more open than DRESS, and seven of them pronounced TRAP much more open than DRESS, showing a clear distinction between the two mean F1 values.

In Intervention II, three participants pronounced TRAP and DRESS similarly in terms of openness. A total of five participants, TRAP had a higher F1 value than DRESS, two of those pronounced TRAP slightly more open than DRESS, one pronounced TRAP more open than DRESS, and two pronounced TRAP much more open than DRESS. For eight participants the range calculation was not possible. Overall, the pronunciation of TRAP was more open than DRESS in Intervention II compared to the pre-test, with only two participants pronouncing TRAP and DRESS similarly in terms of openness.

In Post-test I, one participant of the intervention group pronounced DRESS more open than TRAP. Three participants pronounced DRESS and TRAP similarly in terms of openness. A total of 12 participants had higher F1 value for TRAP than for DRESS, six of those pronounced TRAP slightly more open than DRESS, three pronounced TRAP more open than DRESS, and three pronounced TRAP much more open than DRESS. The results for the post-test are very similar to those of the pre-test in that four participants had either a lower mean F1 value for TRAP than for DRESS or similar mean F1 values for both phonemes. All other participants had higher mean F1 values of TRAP than of DRESS. One participant of the control group pronounced DRESS more open than TRAP, three participants had a very similar F1 value for TRAP and DRESS, meaning they pronounced DRESS and TRAP similarly in terms of openness. Seven participants had a higher F1 value for TRAP than for DRESS. Three of those pronounced TRAP slightly more open than DRESS, three pronounced TRAP more open than DRESS, and one pronounced TRAP much more open than DRESS. In comparison to the pre-test, where most participants had higher mean F1 values of TRAP than of DRESS, most participants of the control group had similar or slightly higher mean F1 values of TRAP than of DRESS in the post-test. The difference between the mean F1 values of TRAP and DRESS could not be calculated for one participant of the control group due to a lack of tokens for DRESS in the post-test.

	Pre-test		Inter-vention I	Inter-vention II	Post-test I		Post-test II	
	IG	**CG**	**IG**	**IG**	**IG**	**CG**	**IG**	**CG**
D>T (much)	0	0	0	0	0	0	1	0
D>T (more)	0	1	0	0	0	1	1	1
D>T (slightly)	1	1	0	0	1	0	3	1
T=D	3	0	0	2	3	3	6	1
T>D (slightly)	5	1	3	3	7	3	2	0
T>D (more)	3	4	1	0	3	2	3	7
T>D (much)	3	2	7	3	2	1	0	0
n/a	1	2	5	8	0	1	0	1
Total	16	11	16	16	16	11	16	11

Table 9. Overview of the difference between TRAP and DRESS for all participants and all recordings.

In Post-test II, the delayed post-test, five participants of the intervention group had a higher mean F1 value for DRESS than for TRAP. Three pronounced DRESS slightly more open than TRAP, and one each pronounced DRESS more open than TRAP and pronounced DRESS much more open than TRAP. Six participants pronounced DRESS and TRAP similarly in terms of openness, meaning their F1 values for DRESS and TRAP were nearly the same. Five participants had a higher mean F1 value for TRAP than for DRESS, thus pronouncing TRAP more open than DRESS, two of which pronounced TRAP slightly more open than DRESS, and three pronounced TRAP more open than DRESS. In comparison to the pre-test, where

most participants had a higher mean F1 value of TRAP than of DRESS, most participants of the intervention group had similar mean F1 values of TRAP and of DRESS in the delayed post-test. The delayed post-test also shows the largest amount of participants with higher mean F1 values of DRESS than of TRAP in comparison to all other recordings. In the control group, two participants produced higher mean F1 values for DRESS than for TRAP, thus pronouncing DRESS more open than TRAP. One of those pronounced DRESS more open than TRAP and the other pronounced DRESS slightly more open than TRAP. Two pronounced DRESS and TRAP similarly in terms of openness, meaning their mean F1 values for DRESS and TRAP were nearly the same. Six participants had higher mean F1 values for TRAP than for DRESS, thus pronouncing TRAP more open than DRESS. One of those pronounced TRAP slightly more open than DRESS, and five pronounced TRAP more open than DRESS. For one speaker the range calculation was not possible. The results for the control group are similar in the pre-test and in the delayed post-test, since the majority of participants have higher mean F1 values of TRAP compared to DRESS in both recordings and two participants have higher mean F1 values of DRESS than of TRAP.

In total, the vowels of 27 participants were considered in this comparison, since that is the total number of participants who took part in all stages of the study. A total of 18 participants, eleven of the intervention group and seven of the control group, pronounced TRAP more open than DRESS in the pre-test, before any pronunciation exercises focussing on this took place. The remaining nine participants either pronounced DRESS as open or more open than TRAP or did not use one of the two vowels during the recording. TRAP was pronounced more open or much more open than DRESS most during the first intervention, with the majority of participants pronouncing TRAP much more open than DRESS where the difference could be calculated. Both the control group and the intervention group show considerable differences in the relation between DRESS and TRAP in the delayed post-test compared to the pre-test. An overview over the developments can be found in Table 10 for the intervention group and Table 11 for the control group. These tables will also be basis for the next

section, in which the developments of different participants, grouped by their initial pronunciation of TRAP and DRESS, will be reported.

Speaker	Pre-test	Intervention I	Intervention II	Post-test I	Post-test II
1	T>D (slightly)	T>D (slightly)	T>D (slightly)	T=D	D>T (slightly)
3	T>D (much)	T>D (much)	T>D (much)	T>D (much)	T=D
4	T=D	T>D (slightly)	T=D	T>D (slightly)	T=D
7	T>D (much)	T>D (more)	T>D (much)	T>D (more)	D>T (slightly)
8	T=D	11 Hz	T>D (slightly)	D>T (slightly)	T>D (more)
29	T>D (much)	n/a	n/a	T>D (slightly)	D>T (slightly)
32	n/a	n/a	T>D (much)	T>D (much)	D>T (more)
33	T>D (slightly)	n/a	n/a	T>D (slightly)	T=D
34	T=D	T>D (slightly)	T>D (slightly)	T>D (slightly)	D>T (much)
54	D>T (slightly)	T>D (much)	T=D	T>D (slightly)	T=D
55	T>D (more)	T>D (much)	n/a	T>D (slightly)	T>D (more)
58	T>D (slightly)	T>D (much)	n/a	T=D	T>D (slightly)
61	T>D (more)	n/a	n/a	T>D (more)	T=D
62	T>D (more)	T>D (much)	n/a	T=D	T>D (slightly)
63	T>D (more)	T>D (much)	n/a	T>D (more)	T=D
68	T>D (slightly)	T>D (much)	n/a	T>D (slightly)	T>D (more)

Table 10. Development of difference between DRESS and TRAP for the intervention group across all five stages.

Speaker	Pre-test	Intervention I	Intervention II	Post-test I	Post-test II
9	T>D (more)	-	-	T=D	D>T (slightly)
21	n/a	-	-	D>T (more)	D>T (more)
23	T>D (much)	-	-	T>D (slightly)	T>D (more)
46	T>D (much)	-	-	T>D (more)	T>D (more)
47	n/a	-	-	n/a	n/a
52	T>D (more)	-	-	T>D (slightly)	T>D (more)
59	D>T (slightly)	-	-	T>D (more)	T>D (more)
60	T>D (more)	-	-	T>D (slightly)	T>D (more)
65	T>D (more)	-	-	T=D	T>D (more)
70	T>D (slightly)	-	-	T>D (much)	T>D (more)
72	D>T (more)	-	-	T=D	T=D

Table 11. Development of difference between DRESS and TRAP for the control group across all three stages.

6.2 Pronunciation developments

Although, typically, German learners of English tend to substitute TRAP with DRESS (Kautzsch 2014: 215), most participants in this study did not pronounce TRAP like that in the pre-test. This section will look at the starting points of different participants and follow their pronunciation development over the course of the study. In order to do this, the previously described ranges of the difference between the F1 values of DRESS and TRAP will be summed up into these three groups: DRESS is more open than TRAP (TRAP < DRESS), TRAP and DRESS are pronounced similarly in terms of openness (TRAP = DRESS), and TRAP is more open than DRESS (TRAP > DRESS). An overview of the number of participants in each of the three groups can be seen in Table 12 below. Of the 27 participants in this study, only three pronounced TRAP and DRESS similarly in terms of openness. Three other participants initially pronounced DRESS more open than TRAP. The majority of participants, 18 in total, pronounced TRAP more open than DRESS to varying degrees in the pre-test.

	TRAP – DRESS DIFFERENCE OF F1 IN THE PRE-TEST				
Group	TRAP < DRESS	TRAP = DRESS	TRAP > DRESS	n/a	**Total**
Interven-tion	1	3	11	1	**16**
Control	2	0	7	2	**11**

Table 12. Number of participants per range group differentiated by relation of TRAP to DRESS in the pre-test.

First, the developments of the largest group, which pronounced TRAP more open than DRESS in the pre-test, will be reported. Then, the developments of the group that pronounced DRESS more open than TRAP will be reported. Following that, the development in pronunciation of the group who pronounced DRESS and TRAP the same in terms of openness will be described. Finally, the development of the pronunciation of TRAP in relation to DRESS of the participants who did not pronounce any instance of either TRAP or DRESS in the pre-test, disallowing the calculation of a difference between the F1 values, will be reported.

For each group, an overview will be given first over how open TRAP was pronounced compared to DRESS in the recordings, before going into more detail. For both, the intervention- and the control group, as well as the participants within the groups, the range between F1 of DRESS and F1 of TRAP, the amount of times DRESS and TRAP were pronounced, the Euclidean distance between DRESS and TRAP, as well as the standard deviations of F1 of TRAP and F1 of DRESS will be reported. This will provide a detailed overview of how the pronunciation of TRAP developed for each participant.

As previously described, the difference in F1 shows how open the two phonemes were pronounced in comparison to each other. The Euclidean distance considers F1 and F2 and measures the overall distance between the two phonemes within the vowel space. The standard deviation of the F1 of DRESS and TRAP shows how widely the individual tokens are spread around the mean value. A high standard deviation can indicate high intra-speaker variation, in

turn indicating high flexibility in the pronunciation of the vowel in question, whereas a low standard deviation indicates that a vowel is always pronounced very similarly.

Because the first group is so large, not all participants will be described in detail. Instead, after the general overview, a selection of those participants will be described in detail. In most cases, the number of tokens of TRAP will be much higher than of DRESS, because the main focus of the elicitation tasks was to get tokens for TRAP. The other phonemes, i.e. DRESS, BATH/PALM/START and the German ones *beten, betten, bäten, Rat* and *Ratte* served as reference points for which fewer tokens were collected. Especially during Intervention I and Intervention II, the instances of TRAP were considerably higher than those of DRESS, because TRAP was explicitly practised, and DRESS and the other phonemes were not. During the next sections, the results for the participants of the intervention group will be reported before the results of the control group.

6.2.1 Development of TRAP after pronouncing TRAP more open than DRESS

The results that will be reported in the following can also be seen in Table 13. Most participants, a total of 18, pronounced TRAP more open than DRESS during the pre-test, eleven of which were in the intervention group and seven in the control group. Despite all of these participants having a higher mean F1 value of TRAP than of DRESS, there are large discrepancies in the difference between the mean F1 values of DRESS and TRAP. Within the intervention group, four participants (Speaker 1, Speaker 33, Speaker 58, and Speaker 68) pronounced TRAP slightly more open than DRESS in the pre-test. Another four (Speaker 55, Speaker 61, Speaker 62, and Speaker 63) pronounced TRAP more open than DRESS in the pre-test, and three (Speaker 3, Speaker 7, and Speaker 29) pronounced TRAP much more open than DRESS, i.e .had a difference of over 100 Hz between the mean F1 values of TRAP and DRESS. One participant of the control

group (Speaker 70) pronounced TRAP slightly more open than DRESS, four (Speaker 9, Speaker 52, Speaker 60, and Speaker 65) pronounced TRAP more open than DRESS and two (Speaker 23 and Speaker 46) pronounced TRAP much more open than DRESS.

Using these categories, a tendency can be found among the participants. In the intervention group, a total of eight participants showed a less target-like pronunciation, i.e. a smaller difference between the mean F1 values of TRAP and DRESS in the delayed post-test compared to the pre-test. Two participants (Speaker 55 and Speaker 58) showed no difference between the pre-test and the delayed post-test and one participant (Speaker 68) showed a more target-like pronunciation in the delayed post-test. Compared to the first post-test, five participants (Speaker 3, Speaker 33, Speaker 61, Speaker 63, and Speaker 68) showed no difference, a further five showed a less target-like pronunciation and one speaker, Speaker 7, showed more target-like pronunciation in the post-test compared to the pre-test. The results are slightly different when comparing the pre-test with Intervention I. Here, no participant showed less target-like pronunciation than in the pre-test, meaning that the difference between the mean F1 values of TRAP and DRESS was larger for all participants during Intervention I than during the pre-test. Two participants (Speaker 1 and Speaker 3) showed no difference in Intervention I compared to the pre-test. The results of three participants (Speaker 29, Speaker 33, and Speaker 61) could not be compared because there were no tokens of DRESS with which TRAP could be compared. The difference between the mean F1 values of TRAP and DRESS had grown even larger than in the pre-test in the speech of six participants (Speaker 7, Speaker 55, Speaker 58, Speaker 62, Speaker 63, and Speaker 68), meaning these participants showed a more target-like pronunciation in Intervention I compared to the pre-test.

Speaker	Pre-test	Intervention I	Intervention II	Post-test I	Post-test II
1	T>D (slightly)	T>D (slightly)	T>D (slightly)	T=D	D>T (slightly)
3	T>D (much)	T>D (much)	T>D (much)	T>D (much)	T=D
7	T>D (much)	T>D (more)	T>D (much)	T>D (more)	D>T (slightly)
29	T>D (much)	n/a	n/a	T>D (slightly)	D>T (slightly)
33	T>D (slightly)	n/a	n/a	T>D (slightly)	T=D
55	T>D (more)	T>D (much)	n/a	T>D (slightly)	T>D (more)
58	T>D (slightly)	T>D (much)	n/a	T=D	T>D (slightly)
61	T>D (more)	n/a	n/a	T>D (more)	T=D
62	T>D (more)	T>D (much)	n/a	T=D	T>D (slightly)
63	T>D (more)	T>D (much)	n/a	T>D (more)	T=D
68	T>D (slightly)	T>D (much)	n/a	T>D (slightly)	T>D (more)

Table 13. Development of the TRAP (T) – DRESS (D) relations for the participants of the intervention group who initially pronounced TRAP more open than DRESS.

In the following section the results of three participants will be reported in more detail and the values reported can also be seen in Table 14. They have been chosen to represent the three possible starting points in this group: slightly more open (Speaker 58), more open (Speaker 63), and much more open (Speaker 3). Speaker 58, who produced eleven tokens of TRAP and five of DRESS, started with a difference in F1 between DRESS and TRAP of 29.7 Hz, so for this speaker TRAP was slightly more open than DRESS in the pre-test. The standard deviation of F1 of TRAP was 112.7 Hz, that of F1 DRESS was 66.7 Hz. The Euclidean distance between DRESS and TRAP was 30.2. Speaker 63, who produced twelve tokens of TRAP and seven of DRESS, started with a difference of 73.4 Hz, so TRAP was more open than DRESS for Speaker 63. The standard deviations of F1 were similar for TRAP and DRESS with that of TRAP being 159.1 Hz, and that of DRESS 157.5 Hz. The Euclidean distance between DRESS and TRAP was 210.2, suggesting that there was also a large difference between the F2 values of DRESS and TRAP. Speaker 3, who produced three tokens of TRAP and four of DRESS, started with a difference between the F1 value of DRESS and the F1 value of TRAP of 184.5 Hz. The standard deviation of F1 TRAP was 146 Hz, and that of F1 DRESS 69.3 Hz, showing that there is more intra-speaker variation for TRAP than for DRESS for

Speaker 3 in the pre-test. The Euclidean distance between DRESS and TRAP was 190.7.

Recording	Speaker	Mean F1 TRAP	Mean F1 DRESS	F1 TRAP – F1 DRESS	SD mean F1 TRAP	SD mean F1 DRESS	Euclidean Distance
Pre-test	**3**	674.3 Hz	489.8 Hz	184.5 Hz	146 Hz	69.3 Hz	190.7
	58	905.7 Hz	876 Hz	29.7 Hz	112.7 Hz	66.7 Hz	30.2
	63	654.4 Hz	581 Hz	73.4 Hz	159.1 Hz	157.5 Hz	210.2
Intervention I	**3**	834.6 Hz	613 Hz	221.6 Hz	156.8 Hz	n/a	749.9
	58	1021.9 Hz	513 Hz	508.9 Hz	156 Hz	n/a	593.7
	63	702.4 Hz	464 Hz	238.4 Hz	135.6 Hz	n/a	927.6
Intervention II	**3**	754.3 Hz	582 Hz	172.3 Hz	98.5 Hz	70.7 Hz	247.4
	58	862.6 Hz	n/a	n/a	47.4 Hz	n/a	n/a
	63	705.1 Hz	n/a	n/a	104.7 Hz	n/a	n/a
Post-test I	**3**	624.6 Hz	485.7 Hz	138.9 Hz	82 Hz	139.5 Hz	140.3
	58	853.9 Hz	837.5 Hz	16.4 Hz	82.9 Hz	98.6 Hz	39.7
	63	630.6 Hz	535.7 Hz	94.9 Hz	74.2 Hz	60.5 Hz	113.6
Post-test II	**3**	627.6 Hz	643 Hz	-15.4 Hz	147.1 Hz	99.6 Hz	85.6
	58	733.3 Hz	676.8 Hz	56.5 Hz	107.7 Hz	99 Hz	231.1
	63	683.2 Hz	675.4 Hz	7.8 Hz	130.1 Hz	148.4 Hz	122.5

Table 14. Mean F1 values of TRAP and DRESS, standard deviations of the mean F1 values of TRAP and DRESS and the Euclidean distance between TRAP and DRESS for Speaker 3, Speaker 58 and Speaker 63 of the intervention group.

All three speakers showed a more target-like pronunciation in Intervention I compared to the pre-test, so the difference between F1 of DRESS and F1 of TRAP increased for these speakers. Speaker 58 increased the difference between the F1 values of TRAP and DRESS to 508.9 Hz compared to 29.7 Hz in the pre-test. The standard deviation of F1 TRAP was 156 Hz, an increase of 43.3 Hz compared to the pre-test. That of DRESS could not be calculated because the participant only produced one token of DRESS. The Euclidean distance between TRAP and DRESS increased from 30.2 to 593.7. Speaker 63 also pronounced TRAP much

more open than DRESS, with a difference of 238.4 Hz between the F1 values (compared to 73.4 Hz in the pre-test). The standard deviation of F1 TRAP was 135.6 Hz, compared to 159.1 Hz in the pre-test. That of DRESS could not be calculated because the participant only produced one token of DRESS. The Euclidean distance between TRAP and DRESS was 927.6, showing an increase of 717.4 compared to the pre-test, suggesting a large difference between the F2 values of DRESS and TRAP in addition to the difference in F1. Speaker 3 still pronounced TRAP much more open than DRESS and showed a slightly larger difference in the mean F1 values of DRESS and TRAP compared to the pre-test, namely 221.6 Hz. These values as well as the visual representation in the scatter plot suggests that TRAP and DRESS are distinct phonemes for Speaker 3. The standard deviation of F1 TRAP was slightly higher than in the pre-test at 156.8 Hz compared to 146 Hz. That of DRESS could not be calculated because the participant only produced one token of DRESS. The Euclidean distance between DRESS and TRAP was 749.9, again suggesting a large difference not only in F1 but also in F2.

In Intervention II, the differences between DRESS and TRAP could not be calculated for Speakers 58 and 63 because they did not produce any tokens of DRESS. The standard deviation of the mean value of F1 TRAP was 47.4 Hz for Speaker 58, lower than in both the pre-test (112.7 Hz) and Intervention I (156 Hz). The standard deviation of the mean value of F1 TRAP was 104.7 Hz for Speaker 63, again lower than in the pre-test (159.1 Hz) and Intervention I (135.6 Hz). The difference between F1 of DRESS and TRAP for Speaker 3 was slightly smaller than in the previous two recordings, at 172.3 Hz, meaning that TRAP was still pronounced much more open than DRESS. The standard deviation of F1 of TRAP was also smaller than in the previous two recordings, at 98.5 Hz, showing less intra-speaker variation yet a higher F1 value for TRAP. The standard deviation of F1 of DRESS was 70.7 Hz, and the Euclidean distance between DRESS and TRAP was 247.4.

In the post-test, Speaker 58 pronounced DRESS and TRAP similarly in terms of openness, the difference in F1 between DRESS and TRAP being 16.4 Hz and having decreased slightly in comparison to the pre-test. In comparison to

Intervention I, the difference is much more substantial, the difference in F1 between DRESS and TRAP in Intervention I being 508.9 Hz. The standard deviation of F1 of TRAP was 82.9 Hz, and that of F1 of DRESS 98.6 Hz. The Euclidean distance F1 between DRESS and TRAP was 39.7, which is similar to the pre-test (30.2) but much decreased compared to Intervention I (593.7). Speaker 63 pronounced TRAP more open than DRESS, like in the pre-test, the difference in F1 being 94.9 Hz in the post-test and 73.4 Hz in the pre-test. In comparison, the difference between the mean F1 values of DRESS and TRAP was 238.4 Hz in Intervention I. The standard deviation of F1 of TRAP was 74.2 Hz, that of F1 of DRESS was 60.5 Hz. Both were considerably lower than in the pre-test, where the standard deviation of F1 of TRAP was 159.1 Hz, that of F1 of DRESS was 157.5 Hz. The Euclidean distance between DRESS and TRAP was 113.6 (in comparison to 927.6 in Intervention I and 210.2 in the pre-test). Speaker 3 pronounced TRAP much more open than DRESS in the post-test, comparable to the difference in the pre-test (140.3 Hz in the post-test compared to 190.7 Hz in the pre-test). The difference in F1 of TRAP and DRESS was 138.9 Hz. The standard deviation of F1 of TRAP was 82 Hz, and that of DRESS was 139.5 Hz. The Euclidean distance between DRESS and TRAP was 140.3, which was slightly lower than the Euclidean distance measured in the pre-test (190.7) and considerably lower than that measured in Intervention I (749.9) and Intervention II (247.4).

In post-test II, Speaker 58 pronounced TRAP slightly more open than DRESS, with a difference between F1 DRESS and TRAP of 56.5 Hz, similar to the result in the pre-test (29.7 Hz). The standard deviation of F1 of TRAP was 107.7 Hz, again similar to the pre-test (112.7 Hz) and that of DRESS was 99 Hz, slightly higher than in the pre-test (66.7 Hz). The Euclidean distance between DRESS and TRAP was 231.1, suggesting a substantial difference between F2 of DRESS and TRAP, since the difference in the mean value of F1 was only 56.5 Hz. Speaker 63 pronounced DRESS and TRAP nearly the same in terms of openness, with a difference between the F1 values of 7.8 Hz. This is the smallest difference across all recordings for this participant, the greatest difference having been measured in Intervention I at 238.4 Hz. The standard deviation of F1 of TRAP

was 130.1 Hz, and that of DRESS was 148.4 Hz. Both standard deviations do not differ greatly from the ones calculated in previous recordings. The Euclidean distance between DRESS and TRAP was 122.5, comparable to the post-test (113.6). Since the difference in the mean F1 values of DRESS and TRAP was only 7.8 Hz, it can be assumed that F2 deviate greatly from each other for DRESS and TRAP in the delayed post-test. Speaker 3, who pronounced TRAP much more open than DRESS in all four previous recordings, pronounced them similarly in terms of openness in the delayed post-test with a difference in the F1 values of DRESS and TRAP of –15.4 Hz. The standard deviation of F1 of TRAP was 147.1 Hz, and that of DRESS was 99.6 Hz. Unlike the difference in the F1 values of DRESS and TRAP, the standard deviations in the delayed post-test were similar to all previous recordings. The Euclidean distance between DRESS and TRAP was 85.6, the lowest value across all recordings for this participant. These results suggest high intra-speaker variation for Speaker 3 in the delayed post-test, and a large difference in the mean F2 values of DRESS and TRAP.

The results of the control group can be seen in Table 15. Most of the participants of the control group, seven out of eleven, pronounced TRAP more open than DRESS in the pre-test. Of these seven participants, two participants pronounced TRAP much more open than DRESS, and one participant pronounced TRAP slightly more open than DRESS. The difference between the F1 values of TRAP and DRESS decreased for six participants in the post-test compared to the pre-test. Three of these participants pronounced TRAP slightly more open than DRESS and two pronounced them similarly in terms of openness. The remaining participant pronounced TRAP much more open in the pre-test compared to an only more open pronunciation in the post-test. The seventh participant of the control group pronounced TRAP much more open than DRESS in the post-test, after pronouncing it slightly more open in the pre-test.

When comparing the results of the pre-test to those of the delayed post-test, three participants of the control group (Speaker 52, Speaker 60, and Speaker 65) showed no difference in the openness-relation between DRESS and

TRAP, pronouncing TRAP more open than DRESS in both the pre-test and the delayed post-test. The difference between DRESS and TRAP decreased for a further three participants (Speaker 9, Speaker 23, and Speaker 46), one of them (Speaker 9) even pronouncing DRESS slightly more open than TRAP in the delayed post-test, after pronouncing TRAP more open than DRESS in the pre-test. The last participant (Speaker 70) in this group pronounced TRAP more open than DRESS after pronouncing it slightly more open in the pre-test. In sum, the pronunciation of TRAP became more target-like between the pre-test and the delayed post-test for one participant, indicated by an increase in the difference between F1 of DRESS and F1 of TRAP, remained the same for three participants and became less target-like for three participants.

Speaker	Pre-test	Intervention I	Intervention II	Post-test I	Post-test II
9	T>D (more)	-	-	T=D	D>T (slightly)
23	T>D (much)	-	-	T>D (slightly)	T>D (more)
46	T>D (much)	-	-	T>D (more)	T>D (more)
52	T>D (more)	-	-	T>D (slightly)	T>D (more)
60	T>D (more)	-	-	T>D (slightly)	T>D (more)
65	T>D (more)	-	-	T=D	T>D (more)
70	T>D (slightly)	-	-	T>D (much)	T>D (more)

Table 15. Overview of the development of the pronunciation of TRAP in relation to DRESS of the participants of the control group who initially pronounced TRAP more open than DRESS.

6.2.2 Development of TRAP after pronouncing it as open as DRESS

Of the 27 participants of this study, three participants, Speaker 4, Speaker 8 and Speaker 34 - all of them in the intervention group- pronounced TRAP as open as DRESS during the pre-test. The overview over the openness-relation between DRESS and TRAP across all recordings and for all participants can be seen in Table 16. The overview of the values from the pre-test can be found in Table 18.

Speaker	Pre-test	Intervention I	Intervention II	Post-test I	Post-test II
4	T=D	T>D (slightly)	T=D	T>D (slightly)	T=D
8	T=D	T=D	T>D (slightly)	D>T (slightly)	T>D (more)
34	T=D	T>D (slightly)	T>D (slightly)	T>D (slightly)	D>T (much)

Table 16. Overview of the development of the pronunciation of TRAP in relation to DRESS of the participants (all of the intervention) group who initially pronounced TRAP similarly open than DRESS.

Record-ing	Speak-er	Mean F1 TRAP	Mean F1 DRESS	F1 TRAP – F1 DRESS	SD mean F1 TRAP	SD mean F1 DRESS	Euclid. Distance
Pre-test	**4**	691.5 Hz	674 Hz	17.5 Hz	167.8 Hz	125.9 Hz	58
	8	797.1 Hz	816 Hz	-18.9 Hz	123.6 Hz	n/a	102.1
	34	669.3 Hz	676 Hz	-6.7 Hz	118 Hz	79.2 Hz	44.7
Interven-	**4**	806.8 Hz	759 Hz	47.8 Hz	87.1 Hz	n/a	373.6
tion I	**8**	781 Hz	770 Hz	11 Hz	n/a	n/a	26.4
	34	620.8 Hz	589.5 Hz	31.3 Hz	35.9 Hz	16.3 Hz	53.2
Interven-	**4**	705.6 Hz	706.7 Hz	-1.1 Hz	108.9 Hz	53 Hz	214.3
tion II	**8**	846.1 Hz	822.5 Hz	23.6 Hz	89.4 Hz	44.8 Hz	41.4
	34	640.2 Hz	601.7 Hz	38.5 Hz	91.7 Hz	70.6 Hz	131.8
Post-test	**4**	660.3 Hz	635.5 Hz	24.8 Hz	80.4 Hz	44.5 Hz	31.9
I	**8**	705.5 Hz	763 Hz	-57.5 Hz	59.9 Hz	72.1 Hz	77.8
	34	634.5 Hz	n/a	32.5 Hz	89.4 Hz	n/a	60.4
Post-test	**4**	681.4 Hz	677 Hz	4.4 Hz	99.7 Hz	24 Hz	215.3
II	**8**	847.2 Hz	766.7 Hz	80.5 Hz	70.7 Hz	39.3 Hz	100.2
	34	567 Hz	n/a	-358 Hz	57.7 Hz	n/a	361.3

Table 17. Mean F1 values of TRAP and DRESS, standard deviations of the mean F1 values of TRAP and DRESS and the Euclidean distance between TRAP and DRESS for Speaker 4, Speaker 8 and Speaker 34 of the intervention group.

Two participants, Speaker 4 and Speaker 34, pronounced TRAP slightly more open in the first intervention. The difference cannot be calculated for the third participant, Speaker 8. In the second intervention Speaker 4 went back to pronouncing TRAP and DRESS similarly in terms of openness, while the other

two, Speaker 8 and Speaker 34, pronounced TRAP slightly more open than DRESS. Speaker 4 and Speaker 34 pronounced TRAP slightly more open than DRESS, and Speaker 8 pronounced DRESS slightly more open than TRAP in the post-test. So, in comparison to the pre-test, two out of three participants were slightly more target-like in the post-test than in the pre-test. In the delayed post-test, one of these participants, Speaker 4, reverted back to pronouncing TRAP and DRESS similarly in terms of openness. The other pronounced DRESS much more open than TRAP and the last participant, who had pronounced DRESS slightly more open than TRAP in the post-test, pronounced TRAP more open than DRESS in the delayed post-test.

		pre-test TRAP = DRESS					
Group	Speaker	difference F1 TRAP DRESS	TRAP tokens	TRAP SD F1	DRESS tokens	DRESS SD F1	Euclidean distance
Interven-	4	17.5 Hz	4	167.8 Hz	2	125.9 Hz	58
Tion	8	-18.9 Hz	11	123.6 Hz	1	26.4	102.1
	34	-6.7 Hz	10	118 Hz	2	79.2 Hz	44.7

Table 18. Results from the pre-test of participants who initially pronounced TRAP as open as DRESS.

In the pre-test, the difference between the F1 values of DRESS and TRAP ranged between -6.7 Hz and 17.5 Hz, allowing the assumption, that DRESS and TRAP are pronounced similar in terms of openness. TRAP was produced four, eleven and ten times by the participants and DRESS was produced twice by two participants and once by the other. For this reason, it was not possible to calculate the standard deviation of DRESS for this speaker (Speaker 8). For this speaker the standard deviation of TRAP was 123.6 Hz and the Euclidean distance was 102.1. For Speaker 4, the standard deviation of TRAP was 167,8 Hz and of DRESS 125,9 Hz and the Euclidean distance was 58. The standard deviation of TRAP for Speaker 34 was 118 Hz and that of DRESS 79.2 Hz. The Euclidean distance was 44.7. For these participants the difference in F1 for DRESS and TRAP

suggests that DRESS is pronounced as open as TRAP, however, when taking the standard deviations into consideration it must be pointed out that all three participants show a high intra-speaker variation for both phonemes.

In Intervention I, two participants, Speaker 4 and Speaker 34, pronounced TRAP more open than DRESS displaying a minor movement toward a more target-like pronunciation. Lower standard deviation values for TRAP were calculated. The overview of the values from Intervention I can be seen in Table 19. Both participants produced TRAP six times. For Speaker 4, the difference of F1 between DRESS and TRAP increased by 30.3 Hz to 47.8 Hz. The standard deviation of TRAP decreased from 167.8 Hz to 87.1 Hz. There was only one instance of DRESS for this participant, so no standard deviation could be calculated for F1 of DRESS. The Euclidean distance between DRESS and TRAP was 373.6. Speaker 8 produced one token for TRAP[5] with an F1 value of 781 Hz, making the difference between DRESS and TRAP 11 Hz. For Speaker 34, the difference of F1 between DRESS and TRAP increased by 38 Hz to 31.3 Hz. The standard deviation of TRAP decreased by 82.1 Hz from 118 Hz to 35.9 Hz. The standard deviation of DRESS, which the speaker produced twice, was 16.3 Hz. The Euclidean distance between DRESS and TRAP was 53.2. Both participants who produced instances of TRAP pronounced them slightly more open than DRESS and both showed less intra-speaker variation. The high value of the Euclidean distance of Speaker 4 suggests that DRESS and TRAP differ more in F2 than in F1.

In Intervention II, two participants, Speaker 8 and Speaker 34, pronounced TRAP more open than DRESS, the other speaker pronounced them the same in terms of openness. The overview of the values from Intervention II can be seen in Table 20. Speaker 4 pronounced DRESS and TRAP the same in terms of openness, the difference in F1 being only -1.1 Hz. In total, Speaker 4 produced nine instances of TRAP and three of DRESS. The standard deviation for TRAP increased by 21.8 Hz to 108.9 Hz in comparison to Intervention I.

[5] The reason for the single token for TRAP is that Speaker 8 pressed the 'stop' button of the microphone at the beginning of the recording without noticing.

Intervention I TRAP = DRESS							
Group	Speaker	difference F1 TRAP DRESS	TRAP tokens	TRAP SD F1	DRESS tokens	DRESS SD F1	Euclid. distance
Interven-tion	**4**	47.8 Hz	6	87.1 Hz	1	n/a	373.6
	8	11 Hz	1	781	1	770	11 Hz
	34	31.3 Hz	6	35.9 Hz	2	16.3 Hz	53.2

Table 19. Intervention I results of those participants who pronounced TRAP as open as DRESS in Intervention I.

The standard deviation of DRESS was 53 Hz. The Euclidean distance between the two vowels was 214.3. Speaker 8 pronounced TRAP slightly more open than DRESS, the difference in F1 being 23,6 Hz. In total, participant 8 produced 12 instances of TRAP and four of DRESS. The standard deviation of TRAP was 89.4 Hz and that of DRESS was 44.8 Hz. The Euclidean distance was 41.4. Participant 34 showed the biggest difference in F1 of this group with 38.5 Hz. In total, Speaker 34 produced 12 instances of TRAP and three of DRESS. The standard deviation of TRAP increased by 55.8 Hz to 91.7 Hz and that of DRESS by 54.3 Hz to 70.6 Hz. The Euclidean distance was 131.8. While speaker 34 pronounced TRAP increasingly more open than DRESS, speaker 4 pronounced TRAP as open as DRESS. Both participants had a high Euclidean distance, suggesting a big difference in the F2 values of DRESS and TRAP. For speaker 8, a comparison with the previous intervention recording is not possible, however, compared to the pre-test, despite a lower Euclidean distance, the difference between the F1 values of DRESS and TRAP increased by 42.5 Hz.

Intervention II TRAP = DRESS							
Group	Speaker	difference F1 TRAP DRESS	TRAP tokens	TRAP SD F1	DRESS tokens	DRESS SD F1	Euclid. dist.
Inter-vention	4	-1.1 Hz	9	108.9 Hz	3	53 Hz	214.3
	8	23.6 Hz	12	89.4 Hz	4	44.8 Hz	41.4
	34	38.5 Hz	12	91.7 Hz	3	70.6 Hz	131.8

Table 20. Results from Intervention II of participants who initially pronounced TRAP as open as DRESS.

In the post-test, two participants, Speaker 8 and Speaker 34, pronounced TRAP slightly more open than DRESS, and the other pronounced DRESS more open than TRAP. The overview of the values from the post-test can be seen in Table 21. Compared to previous recordings, the standard deviations of F1 TRAP were fairly small, showing that each token of TRAP was pronounced similarly. Speaker 34 showed the biggest difference between the F1 values of DRESS and TRAP with 32.5 Hz. The standard deviation of F1 TRAP was 89.4 Hz, that of DRESS could not be calculated because there was only one token of DRESS. The Euclidean distance between DRESS and TRAP was 60.4, indicating little difference between the two phones. Speaker 4 pronounced TRAP only slightly more open than DRESS with a difference in F1 of 24.8 Hz. The standard deviation of F1 of TRAP was 80.4 Hz, that of DRESS 44.5 Hz. The Euclidean distance between the two phones was 31.9. The last participant, Speaker 8, pronounced DRESS more open than TRAP with a difference in F1 of -57.5 Hz. The standard deviation of F1 TRAP was 59.9 Hz, that of DRESS 72.1 Hz. The Euclidean distance between the two phones was 77.8. In all three cases, little difference was measured between the two phonemes.

Post-test I TRAP = DRESS							
Group7	Speaker	difference F1 TRAP DRESS	TRAP tokens	TRAP SD F1	DRESS tokens	DRESS SD F1	Euclid. distance
Inter	4	24.8 Hz	10	80.4 Hz	2	44.5 Hz	31.9
vention	8	-57.5 Hz	8	59.9 Hz	5	72.1 Hz	77.8
	34	32.5 Hz	8	89.4 Hz	1	n/a	60.4

Table 21. Results of the post-test of participants who initially pronounced TRAP as open as DRESS.

In the delayed post-test, each of the three participants had quite different results. Most striking was that of Speaker 34, who pronounced DRESS much more open than TRAP. The plotted vowels can be seen in Figure 14. The difference between DRESS and TRAP was -358 Hz in comparison to -6.7 Hz in the pre-test and 31.3 Hz, 38.5 Hz and 32.5 Hz in Interventions I and II and the post-test. The Euclidean distance was 361.6. The standard deviation of F1 TRAP was relatively small at 57.7 Hz. That of DRESS could not be calculated. A look at the F1 mean values explains the difference between the two phonemes in this recording. Firstly, the mean F1 value of TRAP is lower than in the other four recordings (567 Hz compared to 669.3 Hz, 620.3 Hz, 640.1 Hz and 634.5 Hz in the previous recordings). Secondly, the participant only produced one token of DRESS for which an F1 value of 925 Hz was measured. The participant produced a particularly long DRESS vowel in this case which may, in part, explain the unusually high F1 value for DRESS. It is not perceived as being pronounced unusually open.

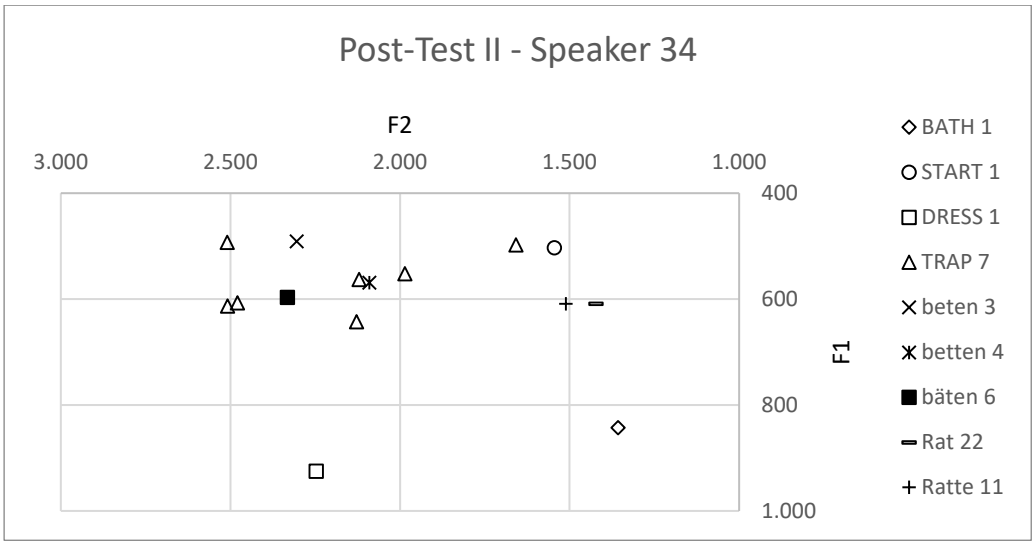

Figure 14. The vowels plotted for Speaker 34 in the delayed post-test.

The other two speakers showed less unusual results. Speaker 4 pronounced TRAP and DRESS nearly the same in terms of openness, with a difference in F1 of 4.4 Hz. The standard deviation of F1 of TRAP was 99.7 Hz and that of DRESS was 24 Hz. The Euclidean distance between the two phonemes was 215.3, suggesting a substantial difference in F2. The last participant, Speaker 8, pronounced TRAP more open than DRESS in the delayed post-test, with a difference in F1 of 80.5 Hz. The standard deviation of F1 TRAP was 70.7 Hz, that of DRESS 39.3 Hz. The Euclidean distance between the two phonemes was 100.2. The results for these three participants in the delayed post-test can be seen in Table 22.

		post-test II TRAP = DRESS					
Group	Speaker	difference F1 TRAP DRESS	TRAP tokens	TRAP SD F1	DRESS tokens	DRESS SD F1	Euclid. distance
Interven-	4	4.4 Hz	10	99.7 Hz	2	24 Hz	215.3
tion	8	80.5 Hz	9	70.7 Hz	3	39,3 Hz	100.2
	34	-358 Hz	7	57.7 Hz	1	n/a	361.3

Table 22. Results from the delayed post-test of participants who initially pronounced TRAP as open as DRESS.

6.2.3 Development of TRAP after pronouncing DRESS more open than TRAP

Three participants pronounced DRESS more open than TRAP in the pre-test. These were Speaker 54 of the intervention group, and Speaker 59 and Speaker 72 of the control group. The values for the pre-test can be seen in Table 23, an overview over the values across all recordings for these participants can be seen in Table 26 at the end of the section.

One of these participants, Speaker 54 was in the intervention group, the other two, Speaker 59 and Speaker 72 in the control group. No participant pronounced DRESS more open than TRAP again after the pre-test. The participant of the intervention group, Speaker 54, pronounced TRAP much more open than DRESS during Intervention I. TRAP and DRESS were pronounced similarly in terms of openness during Intervention II and the delayed post-test. The difference increased slightly during the post-test. The third participant, Speaker 59, initially pronounced DRESS more open than TRAP. Speaker 54, from the intervention group, started with an F1 difference between DRESS and TRAP of -37.2 Hz and standard deviations of 67.1 Hz for the F1 of TRAP and 99.1 Hz for the F1 of DRESS. Speaker 54 produced eight tokens for TRAP and three for DRESS. The Euclidean distance between the two phonemes during the pre-test was 46, so DRESS and TRAP were quite close together. Speaker 59 of the control group pronounced DRESS slightly more open than TRAP with a difference in F1 of -26 Hz. Speaker 59 produced eight tokens of TRAP and five of DRESS during the pre-test. The standard deviation of the F1 of TRAP was 110.3 Hz and that of DRESS was 103.9 Hz. The Euclidean distance between the two phonemes was 123.7, suggesting a bigger difference in F2 than in F1. Considering this and the high standard deviation of F1 for the mean of both phonemes, one can conclude that there is a high degree of overlap between the two phonemes, and a high degree of intra-speaker variation, which can be seen in the vowel plot in Figure 15. Speaker 72 pronounced DRESS more open than TRAP with the F1 difference being

-61.8 Hz. In total, there were ten instances of TRAP and four of DRESS. The standard deviation for F1 TRAP was 63.4 Hz and for F1 DRESS 80.3 Hz. The Euclidean distance between the two phonemes was 153.

		pre-test TRAP < DRESS					
Group	Speaker	difference F1 TRAP DRESS	TRAP to-kens	TRAP SD F1	DRESS to-kens	DRESS SD F1	Euclid. distance
Intervent.	54	-37.2 Hz	8	67.1 Hz	3	99.1 Hz	46
Control	59	-26 Hz	8	110.3 Hz	5	103.9 Hz	123.7
	72	-61.8 Hz	10	63.4 Hz	4	80.3 Hz	153

Table 23. Results of the pre-test for the group with the starting point F1 DRESS > TRAP.

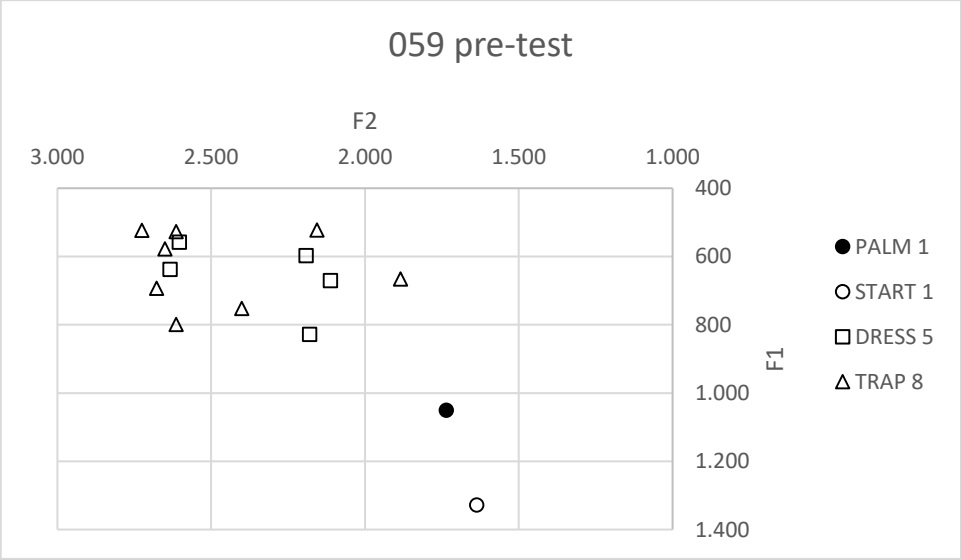

Figure 15. The vowels plotted for Speaker 59 in the pre-test.

During Intervention I, Speaker 54 produced a total of five instances of TRAP, and only one of DRESS. The difference between F1 of DRESS and F1 of TRAP was 208.6 Hz. When considering the individual tokens, it can be seen that the F1 value of TRAP is much lower for one particular token than the others. This particular one (within the word *attic*) was spoken within a German context, while describing the perceived difference between DRESS and TRAP, and before

the actual intervention took place. The other tokens for TRAP were produced during the intervention and show a considerably higher F1 value than the first token. The standard deviation for the F1 of TRAP is 275.7 Hz, that of DRESS could not be calculated, because there was only one token for DRESS. If the token for TRAP that was produced before the actual intervention were left out, the standard deviation would be lowered to 163.1 Hz. The Euclidean distance between DRESS and TRAP was 421.4. Without the first, pre-intervention TRAP token, it would change to 482.71. So, except for the first token, TRAP is pronounced considerably more open than DRESS by Speaker 54.

In Intervention II, the openness-relation between DRESS and TRAP changes considerably, and the values are comparable to those of the pre-test in which DRESS was pronounced more open than TRAP. There are a total of seven tokens for TRAP and one for DRESS. The difference in F1 was -5.6 Hz, so DRESS and TRAP were pronounced roughly the same in terms of openness. The standard deviation of TRAP was 58.2 Hz, while that of DRESS could not be calculated. The Euclidean distance between the two phonemes was 12.9, showing that there was also hardly any difference in F2 and meaning that TRAP and DRESS were pronounced virtually the same.

In Post-test I, Speaker 54 pronounced TRAP slightly more open than DRESS, with a difference in F1 of 20.9 Hz. The values for the post-test can be seen in Table 24 below. There were eight tokens of TRAP and four of DRESS. The standard deviation of TRAP was 88.8 Hz, that of DRESS was 80.4 Hz and the Euclidean distance between the two was 137.2.

Interestingly, the two participants of the control group, Speaker 59 and Speaker 72, also produced TRAP more open than DRESS in the post-test. While this difference still resulted in DRESS and TRAP being pronounced similarly in terms of openness for Speaker 72, with a difference of 18 Hz, Speaker 59 pronounced TRAP more open than DRESS with a difference of 69 Hz. Speaker 59 produced nine tokens of TRAP and four of DRESS. The standard deviation of TRAP was 107.1 Hz and that of DRESS was 119.7 Hz, comparable to the standard deviations calculated in the pre-test. The Euclidean distance between DRESS and

TRAP was also similar to the pre-test with a value of 134.8, compared to the initial 123.7.

post-test I TRAP < DRESS							
Group	Speaker	difference F1 TRAP DRESS	TRAP tokens	TRAP SD F1	DRESS to-kens	DRESS SD F1	Eucli. distance
Intervention	54	20.9 Hz	8	88.8 Hz	4	80.4 Hz	137.2
Control	59	68 Hz	9	107.1 Hz	4	119.7 Hz	134.8
	72	18 Hz	10	46.4 Hz	5	83.5 Hz	134.1

Table 24. Results of the post-test for the group with the starting point F1 DRESS > TRAP.

Speaker 72 produced a total of ten tokens of TRAP and five of DRESS. The two vowels were pronounced similarly in terms of openness, and the F1 value of TRAP was higher in the post-test than in the pre-test. The standard deviations and the Euclidean distance between DRESS and TRAP remain similar in comparison to the previous recordings. The standard deviation of F1 TRAP was slightly lower than in the pre-test, namely 46.4 Hz, that of DRESS was nearly the same as in the pre-test at 83.5 Hz. The Euclidean distance was 134.1, so 18.9 lower than in the pre-test.

The values for the delayed post-test can be seen in Table 25. During this delayed post-test, Participant 54 pronounced TRAP and DRESS , similar to the results of the pre-test, nearly the same in terms of openness, with the difference being -6.5 Hz. Compared to the pre-test, the difference between the F1 values of TRAP and DRESS is bigger by 30.7 Hz. In total, Participant 54 produced ten tokens of TRAP and six of DRESS. The standard deviation of TRAP was 87.1 Hz, that of DRESS 53 Hz. The Euclidean distance between the two was 26.7, 19.3 lower than in the pre-test. Participant 59 pronounced TRAP slightly more open than DRESS, the difference being 53 Hz. In total, Participant 59 produced nine tokens of TRAP and five of DRESS. The standard deviation of TRAP was 74.1 Hz

and that of TRAP 123.3 Hz, the Euclidean distance between DRESS and TRAP was 92.8. Participant 72, who produced ten tokens of TRAP and seven of DRESS, pronounced DRESS nearly as open as TRAP. The standard deviations for both F1 of DRESS (54.5 Hz) and TRAP (76.6 Hz) are comparable to the other two recordings. The Euclidean distance was particularly high in the delayed post-test, at 213, suggesting a big difference in F2 values.

post-test II TRAP < DRESS							
Group	Speaker	difference F1 TRAP DRESS	TRAP tokens	TRAP SD F1	DRESS tokens	DRESS SD F1	Euclid. dist.
Intervent.	54	-6.5 Hz	10	87.1 Hz	6	53 Hz	26.7
Control	59	53 Hz	9	74.1 Hz	5	123.3 Hz	92.8
	72	15 Hz	10	54.5 Hz	7	76.6 Hz	213

Table 25. Results of the delayed post-test for the group with the starting point F1 DRESS > TRAP .

Recording	Speaker	Mean F1 TRAP	Mean F1 DRESS	F1 TRAP – F1 DRESS	SD mean F1 TRAP	SD mean F1 DRESS	Euclid. Distance
Pre-test	**54**	585.9 Hz	623 Hz	-37.1 Hz	67.1 Hz	99.1 Hz	46
	59	632 Hz	658 Hz	-26 Hz	110.3 Hz	103.9 Hz	123.7
	72	562.2 Hz	624 Hz	61.8 Hz	63.4 Hz	80.3 Hz	153
Intervention I	**54**	818.6 Hz	610 Hz	208.6 Hz	275.7 Hz	n/a	421.4
	59	n/a	n/a	n/a	n/a	n/a	n/a
	72	n/a	n/a	n/a	n/a	n/a	n/a
Intervention II	**54**	687.4 Hz	693 Hz	-5.6 Hz	58.2 Hz	n/a	12.9
	59	n/a	n/a	n/a	n/a	n/a	n/a
	72	n/a	n/a	n/a	n/a	n/a	n/a
Post-test I	**54**	542.9 Hz	522 Hz	20.9 Hz	88.8 Hz	80.4 Hz	137.2
	59	699 Hz	631 Hz	68 Hz	107.1 Hz	119.7 Hz	134.8
	72	653.2 Hz	635.2 Hz	18 Hz	46.4 Hz	83.5 Hz	134.1
Post-test II	**54**	671.8 Hz	678.3 Hz	-6.5 Hz	87.1 Hz	53 Hz	26.7
	59	681 Hz	628 Hz	53 Hz	74.1 Hz	123.3 Hz	92.8
	72	521.1 Hz	506.1 Hz	15 Hz	54.5 Hz	76.6 Hz	213

Table 26. Mean F1 values of TRAP and DRESS, standard deviations of the mean F1 values of TRAP and DRESS and the Euclidean distance between TRAP and DRESS for Speaker 54 of the intervention goup, and Speaker 59 and Speaker 72 of the control group.

6.2.4 Development of TRAP after the pre-test difference could not be calculated

For a total of three participants, Speaker 21, Speaker 32 and Speaker 47, it was not possible to determine their initial pronunciation of TRAP due to there not being enough data points. Of these three participants, one (Speaker 32) was from the intervention group and two (Speaker 21 and Speaker 47) were from the control group None of the three speakers produced DRESS during the pre-test. This was simply due to the fact that the speakers did not know any of the

words that contained DRESS.. Because the difference cannot be reported, the F1 mean values of TRAP will be reported instead, as well as the standard deviation. The Euclidean distance cannot be calculated without instances of DRESS either. The overview over all measured and calculated values for these three participants across all recordings can be seen in Table 30.

An overview of the values from the pre-test can be found in Table 27. Speaker 32 produced a total of six tokens for TRAP, with a mean F1 value of 693 Hz. The standard deviation of that was 81.1 Hz. Speaker 21 produced a total of four tokens for TRAP, with a mean F1 value of 694 Hz. The standard deviation of that was 42.5 Hz. Speaker 47 produced a total of eight tokens for TRAP with a mean F1 value of 661 Hz. The standard deviation of that was 64.9 Hz.

pre-test difference not calculated							
Group	Speaker	difference F1 TRAP DRESS	TRAP tokens	TRAP SD F1	DRESS tokens	DRESS SD F1	Euclidean distance
Intervention	32	n/a	6	81.1 Hz	1	91.9 Hz	n/a
Control	21	n/a	4	42.5 Hz	0	n/a	n/a
	47	n/a	8	64.9 Hz	0	n/a	n/a

Table 27. Results of the pre-test for the group where the initial difference F1 TRAP-F1 DRESS could not be calculated.

In Intervention I, Speaker 32 produced no tokens for DRESS either, but eight tokens for TRAP. The mean F1 value of TRAP was 933.4 Hz, so considerably higher than in the pre-test. The standard deviation, however, was also considerably higher at 291, showing great variation in F1 across the individual tokens.

In Intervention II, Speaker 32 produced two tokens for DRESS and 20 for TRAP. The difference between the F1 values of DRESS and TRAP was 236.2 Hz. The standard deviation for the F1 values of TRAP was 108.7, showing less variation

than in the previous intervention. The standard deviation of the F1 values of DRESS was higher, at 251.6.

In Post-test I, Speaker 32 produced eight tokens for TRAP and one for DRESS. An overview of the values from Post-test I can be found in Table 28. The difference between the F1 values of DRESS and TRAP was 119.1 Hz. The standard deviation of F1 of TRAP was 92.7, that the standard deviation of DRESS could not be calculated. The Euclidean distance between the two phonemes was 179.1.

The speakers of the control group showed quite different results. Speaker 21 produced DRESS more open than TRAP, the difference between the F1 values being -90.2 Hz. In total, Speaker 21 produced five tokens of TRAP and one of DRESS, so it was not possible to calculate the standard deviation of DRESS. The standard deviation of the F1 values of TRAP was 41.3 Hz. The Euclidean distance between the two phonemes was 123.

The last speaker, Speaker 47, produced nine tokens of TRAP, but no tokens of DRESS, so it was not possible to calculate the difference between the two values. The mean F1 value for TRAP was 759 Hz, which was 98 Hz higher than in the pre-test. The standard deviation was 64.1 Hz. The Euclidean distance could not be calculated. For the two speakers of the control group, the standard deviation of the F1 values of TRAP was nearly the same in the pre-test and in post-test I. That of the speaker from the intervention group was slightly higher in post-test I compared to the pre-test.

Post-test I - difference not calculated							
Group	Speaker	difference F1 TRAP DRESS	TRAP tokens	TRAP SD F1	DRESS tokens	DRESS SD F1	Euclidean distance
Intervention	32	119.1 Hz	8	92.7 Hz	1	n/a	179.1
Control	21	-90.2 Hz	5	41.3 Hz	1	n/a	123
	47	n/a	9	64.1 Hz	0	n/a	n/a

Table 28. Results of the post-test for the group where the initial difference F1 TRAP-F1 DRESS could not be calculated.

In Post-test II, Speaker 32 produced nine tokens for TRAP and two for DRESS. An overview of the values from Post-test II can be found in Table 29. The difference between the meanF1 values for DRESS and TRAP was -60.3 Hz, so DRESS was produced more open than TRAP. The standard deviation of TRAP was slightly higher than in Post-test I, at 115.3 Hz; that of DRESS was 60.8. The Euclidean distance between the two phonemes was 64.3, 114.8 lower than in post-test I.

The participants of the control group showed, as far as a comparison can be made, slightly different results to post-test I. Speaker 21 produced seven tokens for TRAP and one for DRESS. The difference in the mean values for F1 between the two phonemes was -89 Hz, so DRESS was pronounced more open than TRAP. The standard deviation of TRAP was 115.3 Hz, that of DRESS could not be calculated. The Euclidean distance between the two phonemes was 128.5, comparable to Post-test I. Speaker 47 produced nine tokens of TRAP, but none of DRESS, so neither the standard deviation for DRESS nor the Euclidean distance could be calculated. The standard deviation of the F1 values of TRAP was 75.5 Hz, slightly higher than in post-test I and the pre-test.

Due to the partially missing tokens, a full description of the development of these three participants' pronunciations is not possible. The standard deviations of TRAP are higher for all three participants in post-test II compared to the pre-test, but the mean values for F1 are comparable for Speaker 32 of the intervention group and Speaker 47 of the control group. Speaker 21 of the control group shows a slightly higher F1 in the pre-test than in post-test II.

		Post-test II - difference not calculated					
Group	Speaker	difference F1 TRAP DRESS	TRAP tokens	TRAP SD F1	DRESS tokens	DRESS SD F1	Euclidean distance
Inter-vention	32	-60.3 Hz	9	115.3 Hz	2	60.8 Hz	64.3
control	21	-89 Hz	7	83.5 Hz	1	n/a	128.5
	47	n/a	9	75.5 Hz	0	n/a	n/a

Table 29. Results of the delayed post-test for the group where the initial difference F1 TRAP-F1 DRESS could not be calculated.

Record-ing	Speak-er	Mean F1 TRAP	Mean F1 DRESS	F1 TRAP – F1 DRESS	SD mean F1 TRAP	SD mean F1 DRESS	Euclid. Dis-tance
Pre-test	**32**	693 Hz	n/a	n/a	81.1 Hz	n/a	n/a
	21	694 Hz	n/a	n/a	42.5 Hz	n/a	n/a
	47	661 Hz	n/a	n/a	64.9 Hz	n/a	n/a
Inter-ven-tion I	**32**	933.4 Hz	n/a	n/a	291.7 Hz	n/a	n/a
	21	n/a	n/a	n/a	n/a	n/a	n/a
	47	n/a	n/a	n/a	n/a	n/a	n/a
Inter-ven-tion II	**32**	777.7 Hz	541.5 Hz	236.2 Hz	108.7 Hz	251 Hz	296.6
	21	n/a	n/a	n/a	n/a	n/a	n/a
	47	n/a	n/a	n/a	n/a	n/a	n/a
Post-test I	**32**	697.1 Hz	578 Hz	119.1 Hz	92.7 Hz	n/a	179.1
	21	610.8 Hz	701 Hz	-90.2 Hz	41.3 Hz	n/a	123
	47	759 Hz	n/a	n/a	64.1 Hz	n/a	n/a
Post-test II	**32**	691.7 Hz	752 Hz	-60.3 Hz	115.3 Hz	60.8 Hz	64.3
	21	599 Hz	688 Hz	-89 Hz	83.5 Hz	n/a	128.5
	47	642 Hz	n/a	n/a	75.5 Hz	n/a	n/a

Table 30. Mean F1 values of TRAP and DRESS, standard deviations of the mean F1 values of TRAP and DRESS and the Euclidean distance between TRAP and DRESS for Speaker 32 of the intervention goup, and Speaker 21 and Speaker 47 of the control group.

6.3 Comparison of year 4 classes with different teachers

Two of the classes participating in this intervention study were in year 4, but had different teachers. Again, the classes will be referred to 4A and 4B in the following. The teachers' pronunciation of DRESS and TRAP will be reported before the results of the participants will be reported. Since the numbers of participants that can be grouped together within a class are particularly small, the results are not representative. Nevertheless, they can give an indication as to whether the factor 'teacher' may play a role in the effect of the intervention.

6.3.1 Pronunciation of TRAP by the teachers

Teacher A recorded a total of 19 words. Eleven words contained TRAP, four contained DRESS. The plot for Teacher A's vowel plot can be seen in Figure 16. For both DRESS and TRAP, the standard deviations of F1 (47.07 Hz and 70.22 Hz) are considerably lower than those of F2 (251.91 Hz and 315.66 Hz). For TRAP, there seems to be one outlier in F2 which might affect the overall score, however, because of the small amount of tokens per vowel per speaker, outliers could not be calculated and thus were always included in analyses. The difference between the F1 values of TRAP and DRESS was 62.18 and the Euclidean distance between DRESS and TRAP for Teacher A was 95.39. Except for one instance each of DRESS and TRAP, there seems to be much overlap between the vowels. TRAP is slightly more open than DRESS in six of the eleven cases.

Teacher B, whose vowel plot can be seen in Figure 18, produced 25 words in total, 13 of which included TRAP and eight DRESS. As with teacher A, the standard deviations for the F1 values of DRESS and TRAP were much lower than those of F2 (75.67 Hz and 50.58 Hz vs 342.24 Hz and 243.21 Hz). The means of both F1 values differ only by 2.19 Hz, so DRESS and TRAP are pronounced nearly the same in terms of openness. The tokens for both phonemes are spread widely in terms of the F2 value. The Euclidean distance between both phonemes is 82.17. No measurable difference can be made out between the overall production of DRESS and TRAP.

The researcher, whose vowel plot can be seen in Figure 18, produced 25 words in total, 13 of which included TRAP and eight DRESS. The pattern that could be found in the standard deviations of both teachers, namely that those of F1 were lower than those for F2 of DRESS and TRAP, cannot be found here. Instead, the standard deviation of the F1 of TRAP is highest at 194.79. The standard deviation of the F2 values of TRAP is 53.42. Those of DRESS are 52.62 for F1 and 97.53 for F2. The difference between the F1 values of DRESS and TRAP lies at 129.39 Hz and the Euclidean distance is 177.3. Here, too, there seems to be one outlier in the F1 of trap, which was measured at 202 Hz (compared to the mean

of 739.64 Hz). This token as well as two others overlap with those of DRESS in their F1 values, the other 13 are distinct.

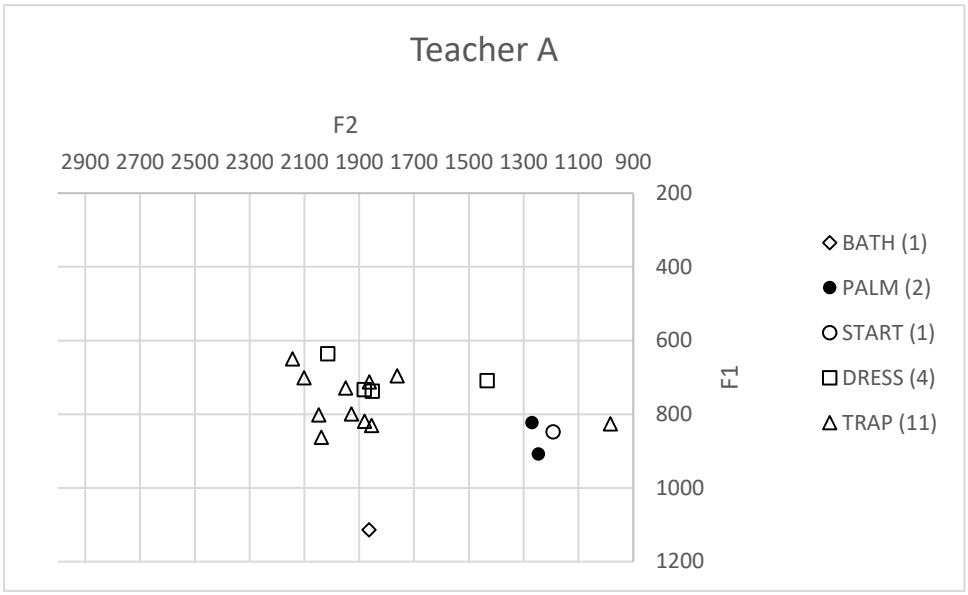

Figure 16. Vowel plot of Teacher A

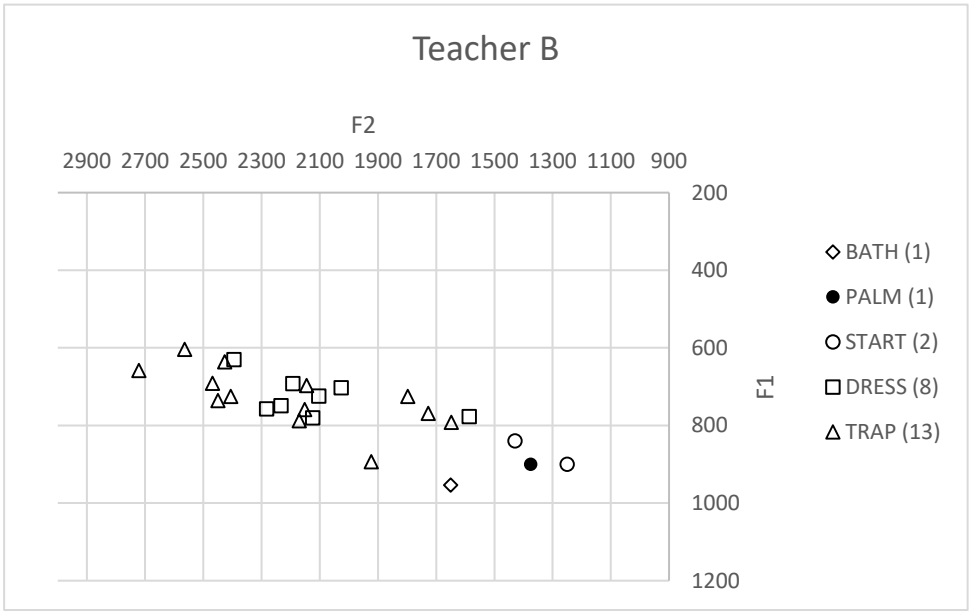

Figure 17. Vowel plot of Teacher B.

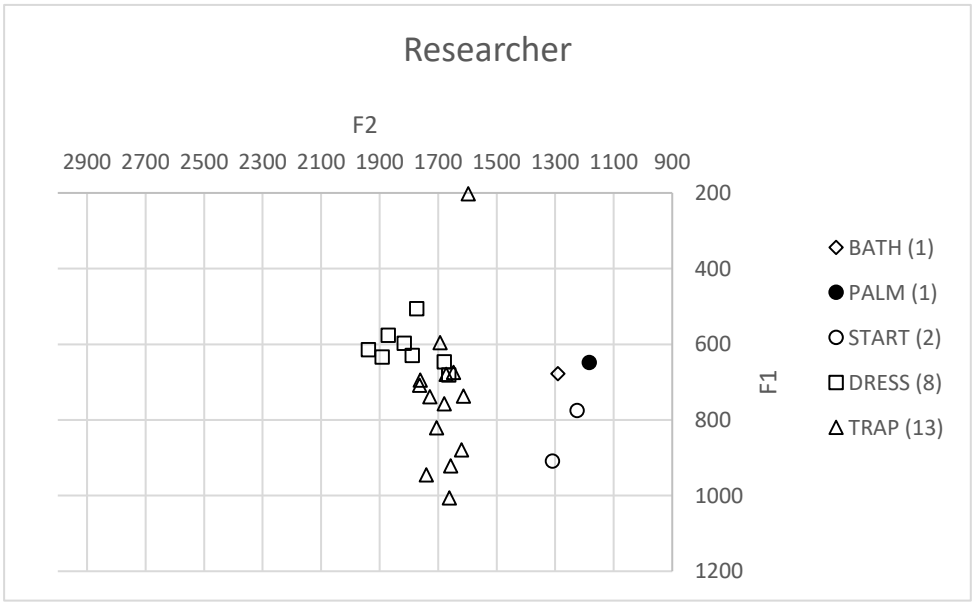

Figure 18. Vowel plot of the researcher.

6.3.2 Results of 4A and 4B

The results of this comparison can be seen in Table 31 for the intervention group and in Table 32 for the control group. The intervention group of class 4A consisted of five participants, that of 4B of four. In the pre-test, three participants of 4A, Speaker 1, Speaker 3, and Speaker 7, pronounced TRAP more open than DRESS to different degrees; one slightly more open and two more open than DRESS. The other two participants pronounced DRESS and TRAP similarly in terms of openness. The results are similar for the participants of 4B in the pre-test. One participant pronounced TRAP slightly and one much more open than DRESS, one pronounced them similarly in terms of openness. One participant did not produce any tokens for DRESS in the pre-test, so a comparison was not possible.
The control group of 4A consisted of three participants, that of 4B of two participants. Two participants of 4A pronounced TRAP more open than DRESS in the pre-test, one of them more open and one much more open. The other participant produced no instance of DRESS, so the difference could not be calculated, which must also be said for one participant of 4B. The other participant of 4B pronounced TRAP much more open than DRESS in the pre-test.

In Intervention I, two participants of 4A, Speaker 1 and Speaker 3, showed no changes compared to the pre-test, and one, Speaker 4, who had previously pronounced DRESS and TRAP similarly in terms of openness, pronounced TRAP slightly more open than DRESS. The remaining participant pronounced TRAP less open than in the pre-test, and now pronounced it only more open compared to much more open in the pre-test. For class 4B, the results of only one participant, Speaker 46, can be reported, since the other three did not produce any tokens of DRESS. The one participant who did, Speaker 34, pronounced TRAP slightly more open than DRESS in Intervention I after pronouncing them similarly in terms of openness in the pre-test.

	Speaker	Pre-test	Intervention I	Intervention II	Post-test I	Post-test II
Teacher A	**1**	T>D (slightly)	T>D (slightly)	T>D (slightly)	T=D	D>T (slightly)
	3	T>D (much)	T>D (much)	T>D (much)	T>D (much)	T=D
	4	T=D	T>D (slightly)	T=D	T>D (slightly)	T=D
	7	T>D (much)	T>D (more)	T>D (much)	T>D (more)	D>T (slightly)
	8	T=D	n/a	T>D (slightly)	D>T (slightly)	T>D (more)
Teacher B	**29**	T>D (much)	n/a	n/a	T>D (slightly)	D>T (slightly)
	32	n/a	n/a	T>D (much)	T>D (much)	D>T (more)
	33	T>D (slightly)	n/a	n/a	T>D (slightly)	T=D
	34	T=D	T>D (slightly)	T>D (slightly)	T>D (slightly)	D>T (much)

Table 31. Pronunciation of TRAP in relation to DRESS for the participants of the intervention groups of 4A and 4B.

	Speaker	Pre-test	Intervention I	Intervention II	Post-test I	Post-test II
Teacher A	**9**	T>D (more)	-	-	T=D	D>T (slightly)
	21	n/a	-	-	D>T (more)	D>T (more)
	23	T>D (much)	-	-	T>D (slightly)	T>D (more)
Teacher B	**46**	T>D (much)	-	-	T>D (more)	T>D (more)
	47	n/a	-	-	n/a	n/a

Table 32. Pronunciation of TRAP in relation to DRESS for the participants of the control groups of 4A and 4B.

In Intervention II, the difference between DRESS and TRAP did not change for four of the five participants of 4A. The fifth participant, Speaker 8, pronounced TRAP slightly more open than DRESS in Intervention II, after pronouncing them similarly in terms of openness in the pre-test. Again, the development of three participants of 4B cannot be reported since they did not produce any tokens of DRESS either during Intervention II or the pre-test. Speaker 32, who pronounced no instance of DRESS in the pre-test, pronounced DRESS much more

open than TRAP in Intervention II. The mean F1 value of TRAP in the pre-test was 693 Hz, and in Intervention II it was 778 Hz. The remaining participant of 4B, Speaker 34, pronounced TRAP slightly more open than DRESS in Intervention II, during the pre-test DRESS and TRAP were similar in terms of openness.

In the first post-test, one participant of 4A, Speaker 3, did not show a change in the difference between F1 of DRESS and TRAP in comparison to the pre-test. One participant, Speaker 1, pronounced DRESS and TRAP similarly in terms of openness in the post-test and had pronounced TRAP slightly more open than DRESS in the pre-test. One participant, Speaker 4,who had pronounced DRESS and TRAP similarly in terms of openness in the pre-test, pronounced DRESS slightly more open than TRAP in the post-test. Two speakers showed an increased difference between the F1 values of DRESS and TRAP in the post-test compared to the pre-test. Three participants of 4B pronounced TRAP slightly more open than DRESS in the post-test. For one of these participants this meant a less target-like pronunciation than in the pre-test, where they had pronounced TRAP much more open than DRESS. For another participant it meant that there was no difference in comparison to the pre-test, and the last participant of these three showed a more target-like pronunciation than in the pre-test. The fourth participant, Speaker 32, pronounced TRAP much more open than DRESS, as they had already done in Intervention II. A comparison to the pre-test is not possible for this participant since they did not produce any tokens of DRESS in the pre-test. Of the three participants of the control group of class 4A, two showed less target-like pronunciation in the post-test in comparison to the pre-test, one of them pronouncing TRAP and DRESS similarly in terms of openness after pronouncing it more open in the pre-test, and one pronouncing TRAP slightly more open than DRESS after pronouncing it much more open in the pre-test. The third participant of this group, Speaker 21, pronounced DRESS more open than TRAP in the post-test. A comparison to the pre-test is not possible since this participant produced no tokens of DRESS in the pre-test. Of the control group of 4B, one participant, Speaker 47, produced no tokens of DRESS throughout the study. The mean F1 of TRAP was measured at 661 Hz in

the pre-test, and was higher in the post-test at 759 Hz. The difference between the first formant of TRAP and DRESS was slightly lower for the other participant, Speaker 46, in the post-test compared to the pre-test. Initially, they had pronounced TRAP much more open than DRESS and pronounced it more open than DRESS in the post-test.

In the delayed post-test, three of the five participants of 4A showed less target-like results compared to the pre-test. None of these participants showed target-like pronunciation, TRAP being pronounced similarly to DRESS in terms of openness by one speaker and less open than DRESS by the other two. One participant showed no difference in comparison to the pre-test, pronouncing TRAP and DRESS the same in terms of openness in both recordings. The fifth participant, Speaker 8, pronounced TRAP more open than DRESS in the delayed post-test, after having pronounced them similarly in terms of openness in the pre-test. None of the four participants of 4B produced target-like pronunciation of TRAP in the delayed post-test. One participant, Speaker 33, pronounced TRAP and DRESS similarly in terms of openness, after having pronounced TRAP slightly more open than DRESS in the pre-test, and the other three pronounced DRESS more open than TRAP to varying degrees. Speaker 34, who pronounced DRESS much more open than TRAP, only produced one instance of DRESS in the delayed post-test, with a particularly high F1 value in comparison to the other recordings (925 Hz compared to the means of 676 Hz, 589,5 Hz, 601,7 Hz and 602 Hz in the previous recordings). In this case, the contrast of TRAP and DRESS is particularly stark not necessarily because of how the participant pronounced TRAP, but because of how they pronounced DRESS in this case. A comparison to the German vowels is also not conclusive, since the F1 values of *Rat, Ratte, bäten* and *betten* are all very similar to each other.

Two participants of the control group of 4A pronounced DRESS more open than TRAP, one slightly more open, one more open, the other pronounced TRAP more open than DRESS. A comparison to the pre-test is possible to two participants, and in both cases the pronunciation is less target-like in the delayed post-test. The other participant, Speaker 21, did not produce a token of DRESS

in the pre-test. Compared to the post-test, Speaker 21 showed no difference in the delayed post-test. Speaker 46 of class 4B pronounced TRAP more open than DRESS, after having pronounced it slightly more open in the post-test, but much more open in the pre-test. Again, a comparison for Speaker 47 is not possible, but the mean F1 value of TRAP is similar to that of the pre-test at 642 Hz (compared to 661 Hz in the pre-test).

Overall, most participants in the intervention groups from both classes showed most target-like pronunciations during Intervention I and tended to be less target-like in the delayed post-test in comparison to the pre-test. As already mentioned, it is not possible to draw any conclusions from these results due to the small number of participants for each group and small amount of tokens per participant. However, the results indicate that there is no substantial difference depending on the teacher.

6.4 Comparison of year 3 and year 4 class with the same teacher (3B and 4B)

The two classes that can be compared in this section are classes 3B and 4B. All children attended the same school and had the same English teacher, but were one school year apart. The intervention group of 3B consisted of seven participants, that of 4B of four participants. The control group of 3B consisted of two participants, that of 4B of six participants. The overview over the results for the intervention group can be seen in Table 33, those of the control group in Table 34. Again, the groups that will be compared are small and not representative, but may give an indication as to whether age influences the effect of the intervention.

In the pre-test, six out of seven participants of the intervention group of 3B pronounced TRAP more open than DRESS to various degrees. The other par-

ticipant, Speaker 54, pronounced DRESS slightly more open than TRAP. One participant of 4B, Speaker 33, pronounced TRAP slightly more open than DRESS in the pre-test. Speaker 29 pronounced TRAP much more open than DRESS in the

pre-test and Speaker 34, pronounced them similarly in terms of openness and the final one, Speaker 32, did not produce any instance of DRESS. The mean value of F1 TRAP for this participant, Speaker 32, was 693 Hz.

	Speaker	Pre-test	Intervention I	Intervention II	Post-test I	Post-test II
Year 3	**54**	D>T (slightly)	T>D (much)	T=D	T>D (slightly)	T=D
	55	T>D (more)	T>D (much)	n/a	T>D (slightly)	T>D (more)
	58	T>D (slightly)	T>D (much)	n/a	T=D	T>D (slightly)
	61	T>D (more)	n/a	n/a	T>D (more)	T=D
	62	T>D (more)	T>D (much)	n/a	T=D	T>D (slightly)
	63	T>D (more)	T>D (much)	n/a	T>D (more)	T=D
	68	T>D (slightly)	T>D (much)	n/a	T>D (slightly)	T>D (more)
Year 4	**29**	T>D (much)	n/a	n/a	T>D (slightly)	D>T (slightly)
	32	n/a	n/a	T>D (much)	T>D (much)	D>T (more)
	33	T>D (slightly)	n/a	n/a	T>D (slightly)	T=D
	34	T=D	T>D (slightly)	T>D (slightly)	T>D (slightly)	D>T (much)

Table 33. Pronunciation of TRAP in relation to DRESS for the participants of the intervention groups of 3B and 4B.

	Speaker	Pre-test	Intervention I	Intervention II	Post-test I	Post-test II
Year 3	**52**	T>D (more)	-	-	T>D (slightly)	T>D (more)
	59	D>T (slightly)	-	-	T>D (more)	T>D (more)
	60	T>D (more)	-	-	T>D (slightly)	T>D (more)
	65	T>D (more)	-	-	T=D	T>D (more)
	70	T>D (slightly)	-	-	T>D (much)	T>D (more)
	72	D>T (more)	-	-	T=D	T=D
Year 4	**46**	T>D (much)	-	-	T>D (more)	T>D (more)
	47	n/a	-	-	n/a	n/a

Table 34. Pronunciation of TRAP in relation to DRESS for the participants of the control groups of 3B and 4B.

All participants whose difference between F1 of DRESS and TRAP could be calculated in the intervention showed a more target-like pronunciation in Intervention I compared to the pre-test. These were six out of seven participants from class 3B and one participant from class 4B. In the remaining four cases, the difference could not be calculated due to a lack of tokens of DRESS. Speaker 61, of group 3B, had a lower mean value of F1 TRAP in Intervention I compared to the pre-test (622 Hz compared to 735 Hz). Of the three participants whose TRAP-DRESS difference could not be calculated, two measured lower F1 mean values for TRAP in Intervention I compared to the pre-test, while the other had a higher F1 value.

In Intervention II, one participant of each class showed a more target-like pronunciation compared to the pre-test. A comparison was not possible for the other participants, since they did not produce a token of DRESS in Intervention II. For the participants of 3B, two of those participants had a lower mean F1 value for TRAP than in the pre-test, and four had a higher mean F1 value. For the participants of 4B, all three other participants had higher mean F1 values in Intervention II compared to the pre-test. In the post-test, six out of seven participants of the intervention group of 3B pronounced TRAP more open than DRESS to some extent. The difference had become bigger for one of those participants in comparison to the pre-test, smaller for two and remained the same for three. Two participants pronounced TRAP similarly to DRESS in terms of openness after having pronounced it more open than DRESS in the pre-test. All four participants of 4B pronounced TRAP more open than DRESS in the post-test. When comparing this to the pre-test, the difference decreased for one participant, stayed the same for one and increased for another. A comparison was not possible for the fourth participant, who did not produce a token of DRESS in the pre-test. The mean F1 value of TRAP was nearly identical to that of the pre-test (697 Hz in the post-test and 693 Hz in the pre-test). In comparison, four out of six participants of the control group of 3B pronounced a measurable difference between DRESS and TRAP in the post-test. Of those, the difference had decreased for three participants in comparison to the pre-test and

increased for the other three. The participant of the control group of 4B pronounced TRAP more open than DRESS in the post-test, but had pronounced it much more open in the pre-test. A comparison of the difference between DRESS and TRAP was not possible for the other participant, Speaker 47, because there were no tokens for DRESS throughout the recordings. However, the mean F1 value of TRAP was higher in the post-test compared to the pre-test (759 Hz in the post-test compared to 661 Hz in the pre-test).

In the delayed post-test, four participants of the 3B intervention group pronounced TRAP more open than DRESS to varying degrees. Of those, one speaker had decreased the difference compared to the pre-test, two showed no difference and one had increased the difference in comparison to the pre-test. The other three pronounced TRAP and DRESS similarly in terms of openness. Of those three, two had pronounced TRAP more open than DRESS in the pre-test, the remaining participant had initially pronounced DRESS slightly more open than TRAP. No participant of the intervention group of 4B pronounced TRAP more open than DRESS in the delayed post-test. One participant pronounced TRAP and DRESS similarly in terms of openness, the other three pronounced DRESS more open than TRAP. The difference between DRESS and TRAP decreased for all participants in comparison to the pre-test. Three out of six participants of the control group of 3B showed no difference in the relation of TRAP and DRESS in comparison to the pre-test, while the other three showed more target-like results in the delayed post-test in comparison to the pre-test. For the participants of 4B, one participant of the control group pronounced TRAP more open than DRESS in the delayed post-test after pronouncing it much more open than TRAP in the pre-test. Speaker 47, who did not produce any tokens of DRESS, had a similar F1 mean value of TRAP in the delayed post-test in comparison to the pre-test (642 Hz in the delayed post-test in comparison to 661 Hz in the post-test).

All in all, the intervention group of class 3B showed slightly more target-like results than that of 4B. However, the imbalance between the group sizes might play a role here. For both groups, most increased target-like pronunciation can be seen in Intervention I.

7. Discussion

The aim of this intervention study was to answer the question how explicit exercises for specific segmental phonetic features affect the pronunciation of those features. The segmental features chosen for this study were the TRAP vowel and the voiced and voiceless dental fricative. The interventions consisted of several steps. First, the perceived difference between the phoneme at hand and similar ones was described by the participants. Then, they described the production of that phoneme or, if they were unable to do so, they watched me pronounce the phone and then described what they saw. After this perception-based first step, the participants were introduced to a movement designed to help them check their own pronunciation of the phoneme at hand. They used this movement to practise the sound in isolation and then within the context of a practise word. Afterwards, the pronunciation was practised within the context of other words familiar to the pupils from the pre-test. The results of the study were reported in chapters 5 and 6. The main findings were that there were no positive long-term effects on the pronunciation of TRAP, and a positive long-term effect on the pronunciation of the dental fricatives in a small number of cases. The pronunciation of TRAP was pronounced target-like by most speakers in the first intervention, that of the dental fricatives in the second intervention. After reflecting on the methodology, this section will discuss how these results contribute to answering the research question at hand and what they mean for the EFL classroom.

7.1 Critical reflection of the methodology

The aim of this study was to find out how explicit pronunciation exercises influenced primary school pupils' pronunciation of TRAP and the dental fricatives. One important objective was to be able to transfer the findings from this study to day-to-day classroom settings without requiring much alteration of the exercises themselves. Planning and preparing English lessons for primary school already requires much time and effort, thus any suggestions for additional content should be as concrete as possible and cost teachers next to no additional time. This is the main reason why so much care was taken to create a study design that focussed on the pupils' needs, built on their prior knowledge and the expectations outlined in the curriculum. Such a study design also has its limitations which will be reflected upon in the following.

For reasons of time, the intervention was split into two separate sessions, each lasting around three minutes. The first intervention focussed on the perception of the target phoneme and its production in isolation, while the second focussed on the production of the phoneme within familiar words. Although the contents of the first intervention were repeated by the participants at the beginning of the second intervention, the main focus was different, making it hard to compare the results for the two intervention recordings. One aspect, which may have influenced the acoustic and the auditive analyses alike, is the phenomenon of coarticulation (for more details on how coarticulation affects TRAP and the dental fricatives, see chapter 2.5). Since most language used consists of connected speech, coarticulation is ubiquitous in most communicative settings inside and outside of the EFL classroom. Concerning the two intervention recordings in this study, however, an imbalance can be detected, since the first intervention focussed on producing the sound in isolation. This is the only recording of the five in which coarticulation may only have occurred in a few instances. The other aspect that may have affected the results of Interventions I and II is the involuntary shift from the physical task

of producing a specific phoneme in Intervention I to the cognitive task of remembering the vocabulary elicited through the picture cards in Intervention II. Although the participants' focus on vocabulary retrieval was unintentional, this seemed to dominate, rather than the pronunciation of the words they did know. An indication for this is that, despite the participants being told that all of the words for the objects they were shown included the target phoneme, participants tended to say a word that did not include the target phoneme rather than not say a word at all (e.g. '*mum'* instead of '*mother'*). This may have resulted in some participants switching to the pronunciation auto-pilot, which Pennington and Rogerson-Revell suggest is switched on subconsciously in order to allow more brainpower to flow into the cognitive tasks at hand (2019: 35). It is highly unlikely that the pronunciation auto-pilot overwrote the previous pronunciation of the target phoneme based on an intervention of three minutes. Instead, it will probably have used what had been stored in muscle memory for the past few years since the participant began their EFL learning journey.

In this study, the words elicited using the picture cards were all familiar to the participants. This means that the interventions already fall into the category of remedial pronunciation training, which costs more time and effort while yielding less satisfactory results than when pronunciation training focusses on becoming accurately target-like from the beginning (Böttger 2020: 98, Ellis & Brewster 2014: 37). The results of this study may be different if unfamiliar words or nonsense words were used. Gethin and Gunnemark found that L1 French learners of English were able to pronounce a supposedly English nonsense word target-like so long as they did not see how the word was spelled (1996). Although reading did not play a role in this study, working with unfamiliar words may have yielded fruitful results. Taking this approach, however, would require more time, since the words and their meaning would have to be introduced as part of the recording.

7.2 Interpretation of the results

The following sections will interpret the previously reported results. First, the results specific to the dental fricative and TRAP will be interpreted, followed by the interpretation of more general results.

7.2.1 Dental fricatives

In the pre-test, the most frequently used substitution was not, as expected, /s/ or /z/, but in fact /t/ and /d/. The teachers did not display this substitution pattern. German speakers of English replacing the alveolar fricatives as typical substitutions by alveolar plosives is a trend also observed by Schmitt (2016: 98). One possible explanation for the dataset analysed in this study is that there were certain words that seemed to include the plosive substitution more often than others, as mentioned above. It seemed to be the case that the sound environment played an important role in the substitution that was used. If the word was *Thursday*, /f/ was often used as a substitute. This might be because, in many cases, the pupils did not say this word in isolation, like most others elicited during the recorded stages, but said it as one of all days of the week named in rapid succession. The reason it was elicited this way was because initial, isolated elicitation attempts largely failed. Since there is no picture to describe this word, a timetable was used and the respective words, *Tuesday, Thursday*, and *Saturday*, were pointed out. Many pupils struggled with this elicitation and often repeated *Tuesday* rather than saying *Thursday*[6]. When asked to name all days of the week, the pupils were able to do so with less hesitation. This, however, lead to them naming all days of the week in quick

[6] A possible explanation might be that the pupils were, as previously mentioned, not able to read and write in English. However, they saw that *Tuesday* and *Thursday* both start with a <t>, and may have assumed that it is the same word or that the word may sound the same at the beginning. Another possible explanation might be that they were unsure about the word *Thursday* and instead chose to say a word that they knew before pronouncing *Thursday* wrong or not saying anything at all.

succession, and might have had a kind of regressive assimilation effect in that the word-initial /f/ pronounced in *Friday* also affected the word-initial pronunciation of *Thursday*. The words *brother, mother,* and *father* most frequently included the substitution /d/. A possible explanation here might be an L1 transfer from the German cognates. The German words *Bruder, Mutter*, and *Vater*, all include an alveolar plosive which may have had an effect on how they pronounce the words in English. Finally, the voiceless dental fricative in *three* was often substituted with a voiceless alveolar fricative. A reason for this might be that the pronunciation not only of that consonant, but of the consonant combination /θr/ is especially difficult. In many cases the word was pronounced [swi:]. At first ,this is quite surprising, since German syllables cannot start with /s/ (Schmitt 2016: 158) and the bilabial approximant /w/ does not exist in the German phoneme inventory and is typically substituted with the labiodental fricative /v/ (Schmitt 2016: 103). However, these two substitutions in combination might simply be much easier to pronounce, because there is less overall movement involved than in the target-like /θr/.

When looking at the results of the dental fricatives, and at the use of the substitutions in particular, a development can be observed with regards to the types of consonants used to substitute the dental fricatives. While hardly any change can be observed throughout the recordings of the control group for the voiced and voiceless dental fricatives, a change can be observed for the intervention group. In the pre-test, the voiced dental fricative was most often substituted with the voiced alveolar plosive. The words that were intended to be elicited were *father, mother, brother* which in German are *Vater, Mutter, Bruder*. Occasionally, the participants also said *the* or *this*. The voiced alveolar plosive was used ten times as a substitute for the voiced dental fricative during the pre-test, and the voiced alveolar fricative was used four times. This ratio changes during the first intervention recording, where the voiced alveolar plosive is used seven times and the voiced alveolar fricative is used 36 times. Although target pronunciation was not achieved, the shift from plosive to fricative

shows that the participants pronounce <th> differently. In terms of the distinctive features, the pronunciation became more target-like, since two of three features now match, namely voicing and manner of articulation. The ratio changes again during the second intervention, when the pronunciation is not practised in isolation or with only one practise word, but with all words elicited during the pre-test. During intervention II, the voiced alveolar fricative is used eleven times, and the voiced alveolar plosive is used seven times. The voiced labiodental fricative is also used twice – the only two times it is used to substitute the voiced dental fricative. For both post-tests, while the control group still predominantly uses the voiced alveolar plosive instead of the voiced dental fricative, the intervention group predominantly uses the voiced alveolar fricative. Although the voiced alveolar plosive is used seven times each during the intervention recordings and only five and six times during the post-tests, it must be said that the ratio shifted more towards a 50/50 substitution of the voiced dental fricative through the voiced alveolar plosive and the voiced alveolar fricative. It can be assumed that, without more exercises on the production of the voiced dental fricatives, habitual patterns of the pronunciation would be resumed after some time.

7.2.2 TRAP

In the case of TRAP, the year 4 pupils' practice word was *attic*. Target-like pronunciation was achieved most often during intervention I. Overall, however, the results for TRAP did not show a long-term pronunciation change. Nevertheless, some interesting conclusions can be drawn from the results of the analysis.

There are two particularly interesting findings for TRAP that will be addressed in this section. Firstly, when comparing how DRESS and TRAP changed over the course of the study, DRESS was more stable than TRAP. This indicates that even if the target pronunciation could not be achieved within this intervention study, the pronunciation of TRAP had not been stabilised or fossilised

at the point of recording. This assumption is also supported by the standard deviations of the F1 values of TRAP, when compared to DRESS measured in the study. F1 was the central focus of the analysis, because it represents openness. The standard deviations for DRESS are much smaller than for TRAP, indicating that the speakers have understood that their pronunciation of DRESS can remain stable and that that of TRAP must be adapted. It also means that they are actually working on their pronunciation of TRAP, especially during the two intervention recordings, which creates such a fluctuation in the standard deviation and F1 values of TRAP.

It was initially assumed that most speakers merge DRESS and TRAP in their pronunciation (Kautzsch 2014: 215). This, however, was not the case if looking solely at the F1 frequencies of DRESS and TRAP. When comparing the F1 means of DRESS and TRAP, only three of the total 27 participants produced them within 20 Hz of each other and three others pronounced DRESS more open than TRAP, but 17 participants pronounced TRAP more open than DRESS, 14 of those with more than 60 Hz difference. This of course means that any movement of F1 DRESS and TRAP away from each other after the pre-test starts at a different point than initially assumed. During the intervention itself, I used my perception of the participants' pronunciation of TRAP as a starting point for giving feedback during the intervention and it must be said here that TRAP was more often perceived as being between half-close and half-open than as being a half-open or open vowel. This is, however, only the perception of one person and it would be interesting to see whether this would be perceived similarly by others. As was previously mentioned, these ranges were used to describe how DRESS and TRAP were pronounced in relation to each other in terms of openness, knowing that they must be read with caution, since the formant frequencies were not normalised and are thus not comparable between different participants. The low number of tokens did not allow for a statistical calculation that might determine how one phoneme was pronounced compared to the other, such as a confidence interval. The difference between DRESS and TRAP could only be evaluated in relation to each other within a speaker. For this reason, it

would be interesting to test how TRAP, as pronounced by the participants, is perceived by English and German native speakers. Since the data was not normalised and statistical significance was not calculated due to the small sample size, generalisations cannot be made by the Hz frequencies and standard deviations alone. A combination of these measurements and listeners' perceptions might yield more conclusive results.

Another observation that can be made is that TRAP tends to be produced in a similar area of the vowel space in the post-tests as in the pre-test, even if it was produced in a different area during the intervention. This shows that, although many participants are able to produce a change and although this change is more target-like than their original pronunciation of TRAP, the time of the intervention is not enough to bring about a permanent change. This is more so the case with TRAP than with the dental fricatives, indicating that vowels are harder to learn (and possibly teach) than consonants. One explanation might be that the distinctive features of consonants are more clear-cut than those of vowels. From a teacher's perspective, it is easier to explain a place or manner of articulation that is clearly defined, as e.g. dental and fricative is, than to explain exactly how open the mouth should be for a near-open vowel and how the tongue should be positioned in the mouth if the vowel is between front and central. From a learner's perspective, those clearly-defined places and manners of articulation of consonants are easier to translate into target-like movement than the less clearly-defined articulations of vowels. This result is also an indication for the increased time and effort that must be made for remedial pronunciation training, as Ellis and Brewster (2014: 37) suggest, particularly when it comes to vowels.

The fact that TRAP is not perceived as being a challenging phoneme to pronounce may also have an effect here. "The <th>" is notorious among German learners of English. Even during the time the study took place, when primary school pupils were not systematically taught to read or write in English (QUA-LiS 2022c), they had heard of the <th>. As soon as they do start to learn the English orthographical system, they will be able to see the <th> and know

how to pronounce the corresponding phonemes, especially since voicing proved not to be a problem. TRAP however, is not an issue frequently addressed in German EFL classrooms. The grapheme-phoneme relation is not as clear as it is for the dental fricatives and its distinctive features are much harder to describe and feel in the mouth. Thus, it is particularly hard for the learner to feel if they are producing TRAP in a target-like way. Additionally, if learners do not perceive TRAP as being a difficult phoneme or one that requires training, they will not pay it any attention. If teachers also see TRAP that way, then there is no need to practice the pronunciation of TRAP in that classroom setting at all. This finding coincides with SLM-r's main idea that perception is the key to effective pronunciation instruction (Flege & Bohn 2021: 23).

7.2.3 General observations

Despite not participating in the interventions, the control group showed a change in their pronunciation in the post-tests compared to the pre-test, most prominently in the pronunciation of TRAP. Since no statistical calculations were possible, simple chance cannot be ruled out, especially since intra-speaker variation is particularly high in children (Rose 2014: 267). One other explanation, especially for the influx of target-like pronunciation of TRAP in the control group may be that the participants discussed what they did in the recordings with their peers. The overall experience of somebody taking individual pupils out of class and for them to hold a microphone and speak into it was out of the ordinary for a typical school day. Some pupils may have found it exciting enough to discuss their experience with their friends any may then have found out that, sometimes, some pupils did different things than others, and the participants of the intervention groups were taken out of class more often than those of the control group. Intervention group participants may have shown those of the control group the exercises they had done, resulting in the control group becoming more aware of target-like pronunciation of the phonemes or trying out the exercises.

Many participants showed most target-like results in intervention I, even more so for TRAP than for the dental fricatives, where the focus lay on pronouncing the phoneme in isolation or within the designated practice word. As soon as the phoneme was spoken within other words, as was done in intervention II, the pronunciation became less target-like again. Additionally, participants of the intervention group for the dental fricatives often said the words *Tuesday* and *dad* during intervention II, despite knowing that the words would all contain a dental fricative[7]. This might be explained by the participants eagerness to show what they know, even if it means not following the instructions. So the participants, on not knowing a word that included the target phoneme, would rather say a word without that phoneme than pass. There can, of course, in turn, be several reasons for this. One might be the eagerness and competitiveness inherent to many children to show off what they can do (Korte 2010: 37; Deci & Ryan 1985: 245). Another might be that they had not grasped the concept of the phoneme at hand and could thus not tell whether or not the word they had said included the phoneme or not. A third possible reason might be the school setting in which all recordings took place. Despite the teacher not being present, the participants will most likely not view themselves as participants of a study, but as English pupils of their school and their teacher. They are used to being marked for participation and for being able to answer questions (KLP 2021: 49), so passing on a word they did not know may have been 'translated' into getting bad marks or even failing. In this case, it is possible that the participants subconsciously switched from focussing on their pronunciation to focussing on knowing words, in which case they would have also switched to pronunciation auto-pilot (Pennington & Rogerson-Revell 2019: 35). In this case, it goes without saying that the previous intervention, that lasted only around two minutes, was not sufficient for the auto-pilot to reprogram the pronunciation of a certain feature. The same can be argued for

[7] The instructions for this part of intervention II were: 'All the words for the objects on the pictures include <th>, when you say the words, focus on how you pronounce the <th>. If you don't know a word, I'll show you the next one, it is not a test.'

the post-test and delayed post-test. While the words should have been more familiar in the post-tests than in the pre-test, the participants may have been concentrating primarily on vocabulary, not on pronunciation. There is no way this could have been avoided without interfering with their pronunciation outside of their usual classroom setting. I, as the researcher, did not say any of the words before they were first elicited and tried to say them as little as possible outside of the interventions themselves (e.g. when explaining the next step). All other options which would have included the teacher and/or peers, would have involved even more classroom time, which was not possible due to time constraints set by the schools. This also might have affected the pronunciation, because the teacher knew that the study would focus on pronunciation, and may have paid special attention to the pronunciation of the words, had they known which ones would be elicited. If they had practised the words in peer groups it may have also affected their pronunciation, especially if they were not used to speaking English to or practising vocabulary with each other.

In this study, the age difference seemed to have more of an effect on the intervention group for the dental fricatives than for that of TRAP. While the results between classes 3B and 4B were not substantially different for the vowel, an interesting development could be observed for the dental fricatives. Class 3B started with a higher number of tokens being pronounced with a dental fricative rather than a substitute in the pre-test in comparison to class 4B. However, over time, class 4B 'overtook' 3B in the relative amount of dental fricatives produced. The overall results were more target-like at the end of the study than at the beginning, but the increase of target-like pronunciation was higher for 4B than for 3B. This aligns with results of Jäkel et al.'s study which found out that receptive skills are acquired faster by older pupils (2017). However, since pronunciation is a motor skill that must be developed and trained, it cannot be argued to start pronunciation training at a later stage of the pupils' EFL journey. Pronunciation becomes habitual as soon as the speech organs have grasped how to produce the sound (or an approximation of it) that any

delay in pronunciation instruction will probably lead to the remedial pronunciation training that takes so much effort and yields so few results (Ellis & Brewster 2014: 37).

7.3 Implementations

7.3.1 For teachers

The results show that speakers are able to change their pronunciation, at least for a short amount of time, and that their pronunciation has not become fossilised. This means that English teachers can continue working on pronunciation during lessons, even after a word or sound has been learned. As Ellis & Brewster note (2014: 37), remedial pronunciation training yields less satisfactory results despite requiring much more time and effort, but it is not an entirely fruitless affair. It seems that, although probably quite hazardous in later years, fossilisation is not such a risk for primary school children, possibly due to the sensitive periods that arise between the ages of six and ten (Bleyhl 2003: 7, Korte 2010: 169). As primary school English teachers tend to not have to do any remedial work, they can make the most of the opportunity to start off their young EFL learners' language learning experience with a sense of achievement. This would, of course, mean an adaptation of the curriculum, which is discussed in section 7.3.3.

The pronunciation, especially of TRAP, was most target-like during intervention I which may imply that, although producing target-like pronunciation is possible, doing so while focussing on more than just the pronunciation of this one phoneme proves challenging. Teachers should bear this in mind when teaching the pronunciation of a new phoneme or word. One way to stay focussed on pronunciation for a slightly longer amount of time may be to adapt the PPP approach used for the introduction of grammatical structures (Scrivener 2011: 159). In its original format, *PPP* stands for *Presentation, Practise,*

Production. In this case, *presentation* could be expanded by including *perception*. That way, the results of this study and those of the SLM-r model could be combined to create an approach to pronunciation teaching that provides a solid foundation upon which to build a target-like pronunciation auto-pilot that is relied on whenever the learner must focus on other things, such as lexis or grammar.

The fact that the pronunciation of TRAP was less target-like in the post-tests than in the intervention also shows the effect teachers have on the performance of their pupils. Neither teacher made a clear distinction between DRESS and TRAP, and did not correct pupils or make them aware of the difference e.g. when introducing new words including a TRAP vowel. It was previously argued that the school setting may have influenced what the pupils focussed on during the recordings, preferring to say something potentially wrong before not saying anything at all. This may also, in part, be because of the teacher's influence. This can also be seen in the results of the dental fricatives. While the teachers' pronunciations of the dental fricatives showed no direct influence on the pronunciation of the participants, the influence of the instructions given by the teachers could explain the different developments of the classes 4A and 4B. In the lessons observed before the start of the study, Teacher B, who always pronounced the dental fricatives as and when expected, did not explain to their pupils how the dental fricatives are produced. Teacher A, however, who at times used dental and alveolar fricatives interchangeably, did explain the place of articulation repeatedly during the lessons observed. During the intervention of this study, class 4A showed a more rapid increase in the target-like pronunciation of dental fricatives than class 4B. These results tie in with what Hattie found out in his meta-study, namely that "teachers are among the most powerful influences of learning" (2009: 238). In order to have a substantial positive effect on their pupils, teachers must establish good relationships with their pupils as well as "have proficient knowledge and understanding of their content to provide meaningful and appropriate feedback" (ibid.). Hattie's findings and the ones from this study go against the state curriculum's vision of an

EFL classroom in which pupils learn the language independently from the teacher's language abilities (KLP 2021: 37).

7.3.2 For teacher training

As mentioned before, awareness for challenging phonemes is key to focussing on their pronunciation. In many cases, the participants of this study were aware that dental fricatives are challenging to learn but were unaware of TRAP and its pronunciation. While pupils should not explicitly be made aware of the difficulty of a phoneme so as not to discourage them to try pronouncing it, they should be made aware of differences in their own pronunciation and that of the target accent which, according to the curriculum, is RP (KLP 2021: 37). This balancing act can only be accomplished if the teacher is not only well versed in teaching methods, but also has a solid knowledge of linguistics to fall back on. This, of course, means that teachers must, at some point, acquire this linguistic knowledge. Ideally, this is done during their studies, before they enter teacher training at school. For pronunciation in particular it is important to not only have theoretical knowledge of phonemes, what they are and how they are produced, but also for the teachers to be able to transfer this knowledge to their own perceptive and productive language skills. Not every teacher has to be a speaker of RP, but every teacher should be aware of certain accent features. That being said, not every study programme for future teachers offers insights into pronunciation or phonetics and phonology. A look at the universities' websites reveals that, of the eight universities in NRW that offer a Bacherlor of Education degree for primary schools with English as a subject, only four list specific courses for pronunciation or phonetics and phonology. In three others, this is dealt with within other courses (such as the Introduction to Linguistics or Language Practice I) or offered as an optional course, and in the one remaining handbook it is not mentioned at all (Bergische Universität Wupptertal 2021: 1; Technische Universität Dortmund 2020: 1 & 5; Universität Bielefeld 2022; Universität Duisburg Essen 2020: 2; Universität Paderborn

2022: 5; Universität Siegen 2021: 4; Universität zu Köln 2022: 11; Westfälische Wilhelms-Universität Münster 2018, 1552). Of course, phonetics and phonology or pronunciation may be part of another course and is simply not mentioned in the handbook, but the fact that only half of the universities in NRW make pronunciation a mandatory course for future primary school teachers is an indication of the role pronunciation currently plays in teacher training.

7.3.3 For curriculum developers

The new curriculum states that the teacher should no longer be the main language model. The results of this study have shown that, regardless of what the curriculum envisions, the teacher serves as a language model to pupils. This will probably remain the case, even if other language models are introduced in form of audio or audiovisual input by English native speakers, because, in the end, the teacher is the one to mark the pupils' performance and give corrective feedback. For that reason, the pupil must assume that whatever the teacher does is 'right' and can be used as a target to aim for in learning the pronunciation.

In the new curriculum, writing is seen as an important supportive device for learning English as a foreign language ("Die Schülerinnen und Schüler verstehen Schrift von Beginn an als Merk- und Lernhilfe") (KLP 2021: 37). Some of the results suggested that orthography was used as an aide during this study, to identify both words and sounds. In the case of the dental fricatives, *Thursday* was sometimes replaced by *Tuesday*, possibly because the pupils saw the word started with <t> and automatically connected this with the day of the week that starts with a /t/. Similarly, when asked about their perception of the vowels in *bed, bath* and *attic*, some pupils said they thought *bath* and *attic* sounded more like an /A:/, and βεδ more like an /e:/, despite pronouncing none of the words with those phonemes. These results indicate that, if English orthography really should be used to facilitate language learning, it should be used with caution and very systematically when it comes to pronunciation

training. Since the pupils are confronted with acquiring spoken and written skills as soon as they start learning English, the relationship between English spelling and pronunciation must be addressed. The complicated grapheme-phoneme relationship is even explicitly mentioned by the curriculum developers in the additional material they offer, where they quote Bleyhl, who says that, in German, a phoneme can be represented by an average of 3.7 phonemes, while, in English, this number is more than tripled to 12.8 (2000: 87; qtd. In QUA-LiS 2021). In addition, the pupils only started to learn to write in German two years previously to when they are expected to write in English, and in German this is often done by showing a fairly straightforward correspondance between phonemes or phonotactics and orthography ("das Lautprinzip der deutschen Orthogrpahie" (KLP 2021: 22)) and learning the exceptions. If this approach were used for English spelling, remedial work may be necessary in pronunciation and in spelling, since the grapheme-phoneme correspondence is less straightforward. One option to avoid too much confusion might be to include the introduction of phonics to the curriculum and to the classroom. As mentioned previously in section 2.4, phonics are used in some English-speaking countries (Campbell 2018: 783). They connect phonemes to graphemes and grapheme-combinations in order to provide support when trying to initially grasp the various rules that need to be applied when initially trying to understand phoneme-grapheme correspondences in English (Read with Phonics 2023).

7.4 Ideas for classroom activities

Although the long-term results were not as initially hoped, the study shows that even short exercises focussing on pronunciation can alter the pronunciation of segmental features. An idea might be to introduce pronunciation spotlights in which one segmental feature is focussed on for 5 mins of a session.

These spotlights can be repeated or even turned into games and used as a bonus at the end of a lesson. They could also be integrated into the morning circle. This is common practise in primary schools, and serves several purposes. On the one hand, it serves as part of the daily routine to start the day at school. On the other hand, it serves as a less formal setting in which the pupils can learn the days of the week or practise counting, or apply some other concept that is currently being learned, e.g., a particular letter of the alphabet, etc. Some teachers conduct their daily morning circle in English, others add a second one to be held at the start of every English lesson. The loose and less strict structure of these morning circles can easily accommodate for a pronunciation spotlight. Similar to letters being introduced, phonemes that are currently being discussed in English lessons could also be focussed on during this time.

If the control group did change their pronunciation due to informal and unguided peer teaching, it would be an indication that peer teaching is a valuable resource for pronunciation training. This would take the pressure and focus off the teacher as a language model and the pupils would be able to gain a deeper understanding of the production of certain segmental features when they are not only able to produce them but can also explain how they produce them to others and evaluate how others produce those features. This aligns two findings from research in TEFL, namely the benefits of constructivist learning and of peer teaching. Constructivist learning states that learning is most effective if the learners put what is to be learned into context themselves, based on what they already know, what they have just learned, and what they have experienced up until that point (Springer 2012). In his ground-breaking study, Hattie described the positive effects of peer teaching. Both the teaching and the learning pupils benefit from peer teaching, especially when used in addition to teacher-student teaching and when the peer teaching is largely controlled by the pupils (Hattie 2009: 187). That the results of the control group in this study might partly be due to a form of peer teaching is also supported by the finding that peer teaching is particularly effective “in the acquisition

rather than the proficiency phase of learning and when there were clear criterion measures (success criteria) used as targets" (Hattie 2009: 187).

As mentioned in the introduction to this chapter, if speakers were not able to explain how they produce <th>, they were asked to observe me pronouncing a dental fricative and then describe what they had observed afterwards. This alone seemed to have an effect on their own pronunciation of <th> which was, however, not analysed systematically since it was not possible to take notes on this while the intervention took place. However, if this close observation does already affect a change in the pupils' pronunciation, it might be useful to include such an observational exercise, e.g., when a sound is newly introduced. Pupils could first observe their teacher or look at MRI scans of speakers pronouncing individual phonemes, before trying to pronounce the phoneme themselves. If preceded by perception and this observation, the much-used drilling exercises might also be included as well as judging pronunciation of peers by observing their pronunciation of sounds in isolation.

The movements used in this study to help participants check their pronunciation of the target phoneme were remembered well. They even served as a mnemonic, since often simply showing the participants the movement helped jog their memory, coinciding with neurological research stating that movement makes cognitive tasks easier (Hannaford 2013: 130) and with studies that investigated the effect movement has on learning vocabulary (Soden-Fraunhofen et al. 2007; Toumpaniari et al. 2015). Although the movement was primarily intended to help the pupils check their pronunciation, it had the additional positive effect that the cognitive task of remembering previous meetings was facilitated by repeating the movement. This connection between movement, cognition and muscle memory could be used in a more playful manner to practice pronunciation. One pupil could come to the front of the class and silently perform the movement of a phoneme. The others must guess the phoneme by pronouncing it. The pupil in front must judge whether it was the right phoneme and pronounced in a target-like way. The teacher should always be attentive but remain in the background. That way, all pupils can participate and practice

their perception as well as their production skills without much input through the teacher.

7.5 Ideas for future research

This study was the first that measured the effects of explicit pronunciation instruction on the pronunciation of TRAP and the dental fricatives by German primary school pupils. If target-like pronunciation is to play a role in primary school English lessons, this study should be the first of many. Apart from a study that focusses on the introduction of new words and their pronunciation, as mentioned in section 7.1, the combination of perception and production should feature prominently in future research. This study included an exercise on the perception of the target phonemes but did not include this part of the intervention in the analysis in any depth. This gap could be filled by replicating the study and adding a systematic analysis of the perception-based part of the intervention. Flege-Bohn & Ocke-Schwen (2021) as well as Lee et al. (2020) recommend perception-based exercises, so it may be possible to develop exercises based on the SLM-r model that cater for the needs of primary school pupils.

The results of this study indicate that the pronunciation of vowels and consonants poses different challenges for the learners. Since it is not possible to make such a claim based on the analysis of TRAP and the dental fricatives alone, a study focussing on the difference between the learnability of consonants and vowels could provide more insight.

To cater for one of the major alterations in the new curriculum, more research on the interplay between pronunciation and reading in German EFL lessons at primary schools is necessary. The curriculum merely states that reading should play a central role in EFL lessons ab initio, not only for the pupils to become literate in English, but also to use reading as a tool for language learning. As is typical for primary school curricula in NRW, the aims of the English lessons are stated, but how these aims are to be achieved is up to

the teachers. Since the grapheme-phoneme relations of German and English are so dissimilar (see section 7.3.3 for details), different approaches to teaching reading and writing can be necessary, and reading-related strategies that help pupils learn German may not help when learning English. Researchers such as Stefanie Frisch (2013, 2019, 2021) or Victoria Scheeren (2022) have extensively researched ways and effects of literacy among young learners of English. However, the connection between learning to read and to pronounce words in English by young German learners remains to be explored.

8. Conclusion

The aim of this intervention study was to find out how explicit exercises for specific segmental phonetic features affect the pronunciation of those features of primary school pupils. The features chosen in this study were the TRAP vowel and the voiced and voiceless dental fricative, because all three cause well-documented difficulties to German learners of English (e.g. Kautzsch 2015; Schmitt 2013; Schmitt 2016). In order to test the effect, an intervention study was conducted with three primary school classes, two in year 4 and one in year 3. Each class was split into three groups: an intervention group for TRAP, an intervention group for the dental fricatives and a control group which received no intervention. The intervention was split into two separate sessions, a week apart, to focus first on the perception and production of the phoneme in isolation, and then on the production of the phoneme within the context of familiar words. The participants were recorded in a pre-test, during both interventions, in a post-test one week after the second intervention, and in a delayed post-test eight to ten weeks after the first post-test. In total, 72 participants took part in the study, of which 49 were present for all stages of the study. The dental fricatives were analysed auditively by two judges, and by a third if the results from the first two analyses differed. TRAP was analysed using praat. The focus lay on the change in F1 and the position of TRAP in comparison to DRESS. For TRAP, target-like pronunciation peaked during intervention I and became less target-like with each following recording, showing no long-term effect. The results for the dental fricatives showed a less prominent peak in the intervention, but a slightly larger amount of target-like pronunciations in the post-tests compared to the pre-test. The teachers' pronunciation was also analysed and showed that both teachers pronounced TRAP and DRESS similarly in terms of openness. Teacher A occasionally substituted the voiced dental fricative with a voiced alveolar fricative and the voiceless one with a voiceless alveolar fricative, or substituted the alveolar fricatives with dental ones. The

pupils showed similar tendencies in their pronunciation as the teachers, but the results of the intervention did not seem to be affected by the teachers or the school year of the participants.

The research question "What effect do explicit pronunciation exercises have on the pronunciation of primary school children in Germany?" can therefore, in short, be answered with "It depends.". The effect seemed to depend, for one, on what was being practised. The effect on the vowel was immediate, but short-lived, while the effect on the consonant was not achieved for as many participants, but lasted longer for those that did achieve target-like pronunciation. It must be highlighted that the exercises used in this study did have a measurable effect for all three phonemes, even though the exercises lasted no longer than two or three minutes. This indicates that they could be integrated into the English lessons without much extra time and effort. It would be particularly interesting to apply this study design to a larger group to test the significance of the effects and the possible correlations between factors such as age or teachers of the participants by conducting, for example, a regression analysis.

The effect might also depend on how the exercises are integrated into the lessons. Lee et al. (2020) found that perception-based instruction was most effective. The exercises in this study combined perception and production and also showed an effect, despite the short amount of time that was invested. This suggests that integrating such exercises more consistently rather than only once might have a more permanent effect on the pupils' pronunciation. Pennington and Rogerson-Revell state that speakers have a "pronunciation auto-pilot" that allows them to focus on other things while speaking, e.g., structuring speech (2019: 35). Most learners, rather than having a target-like pronunciation auto-pilot for their L2 instead have one that is heavily influenced by the L1. Because of the automaticity of motor skills, any work on pronunciation after the initial introduction of the feature requires more time and effort while being less successful (ibid.). If short but consistent exercises that combine perception and production indeed have a permanent effect on pronunciation, the

pupils' pronunciation auto-pilot could be set up at the beginning of their EFL journey, allowing them to focus on other aspects of language learning and saving teachers time in the long run by avoiding future remedial work on pronunciation. This study showed that most target-like pronunciation occurred when the phoneme was produced in isolation. Transferring the target-like pronunciation of a phoneme in isolation to its pronunciation in words proved difficult for the participants of this study, possibly because the words were elicited rather than presented to the participants and they had to focus on word retrieval rather than pronunciation. Most pronunciation exercises for primary school focus on suprasegmental features such as intonation or practise a phoneme within the context of words as in a song. Even here, the same problem would occur if they had practised the phoneme in a song and then moved on to other words. The whole process – from trying out the pronunciation of an unfamiliar sound to saying previously unknown words and sentences – requires support by an understanding and knowledgeable teacher (Hattie 2009: 238). One of the major limitations of this study was the small number of participants due to many schools' refusals to participate. Apart from schools generally being exceptionally busy, a reason many teachers were unwilling to participate in this study was their own insecurity regarding pronunciation. They were worried that their own, in their opinion lacking, pronunciation would be under scrutiny. This shows that not only teachers, but also teacher trainers need to be aware of the impact subjective pronunciation skills have on the speakers. If speakers feel their pronunciation is not target-like, they may feel less confident in speaking the target language.

For this reason, it may be worth thinking about the aim of teaching English within the German school system. The CEFR and the curriculum seem to want a mix of EFL and ELF, focussing on message before accuracy on the one hand, but suggesting authentic materials and demanding native-like competencies in pronunciation on the other (COE 2022: 234 and KLP 2021: 41). These at times conflicting aims were not discussed in any depth in this study, and no

concluding answer can be given here. Maybe the intention is to achieve a compromise between both approaches, allowing pupils to be widely understood by speakers of the outer and expanding circles, but also to achieve native-like proficiency if they so wish. The intentions may be good and seem to accommodate most learner goals in that, whatever the pupils will use English for outside of school, they will have been given the tools to accomplish this. However, it also seems that, in order to fulfil these aims, teachers are put in a position in which more is expected of them than they can possibly achieve. The new curriculum for primary schools in NRW accommodates for this by making pronunciation learning independent from the teacher (KLP 2021: 37). While this seems a good idea to take the pressure off teachers to be language models, it is only possible in theory. Although the effect of the intervention study presented in this paper did not seem to depend on whether their teacher was Teacher A or Teacher B, their pronunciation did seem to depend on the teacher. While authentic material can be provided through audio or audio-visual media, corrective feedback cannot. The results of this study suggest that pupils can achieve target-like pronunciation, even with little more time than is currently being invested, as long as the teacher can themselves perceive target-like pronunciation, describe how target-like production is achieved and give feedback on the pupils' pronunciation.

For the best results for long-term accuracy, segmental pronunciation is best mastered at elementary level, to establish a target-like pronunciation auto-pilot. Since the primary goal of the curriculum and CEFR is successful communication (COE 2020: 28; KLP 2021: 36), pronunciation is not a priority in early EFL classrooms in Germany. This results in teachers at secondary school and university lecturers having to integrate remedial pronunciation training to allow their learners to achieve the pronunciation targets set by the CEFR for their more advanced proficiency levels. At this point in learning, remedial pronunciation training can become a frustrating experience both for the teacher and the learner, because of the time and effort put into it compared to its outcome (Ellis & Brewster 2014: 37). Although it would also take some

time and effort to focus more on pronunciation in primary school, the results would be more permanently target-like, and would leave more time later on in the learning process to focus on other areas.

This is why it is so important for teachers at primary school to grasp the opportunity to give their pupils confidence in speaking, not only by helping them become fluent and showing them how effectively they can communicate, but also by being confident communicators themselves who are not afraid to speak. Rather than being the type of instructor that pushes their pupils into the water hoping they will not drown, teachers should give them confidence and allow them to practise with water wings first. Once the pupils have established their pronunciation auto-pilot and they can speak with confidence, their teacher can remove the water wings and they can focus on what they want to say rather than how they should say it.

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Appendix

Examples of picture cards

Excerpt auditive analysis dental fricatives 1st and 2nd judge

Excerpt analysis of dental fricatives

Tagging and abbreviations in auditive analysis dental fricatives

Auditive analysis of dental fricatives 3rd judge

Praat script

Example spreadsheet Speaker 68

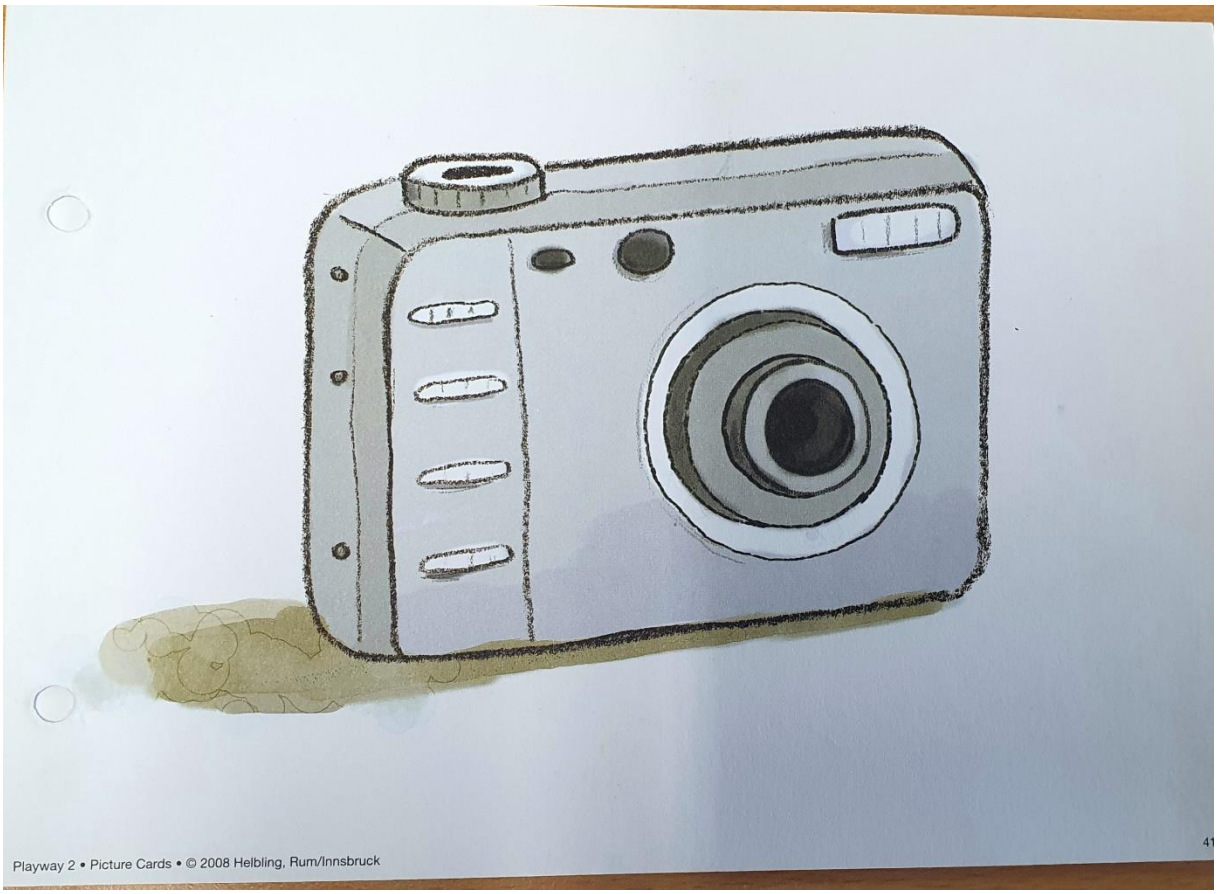
Vowel plots intervention group

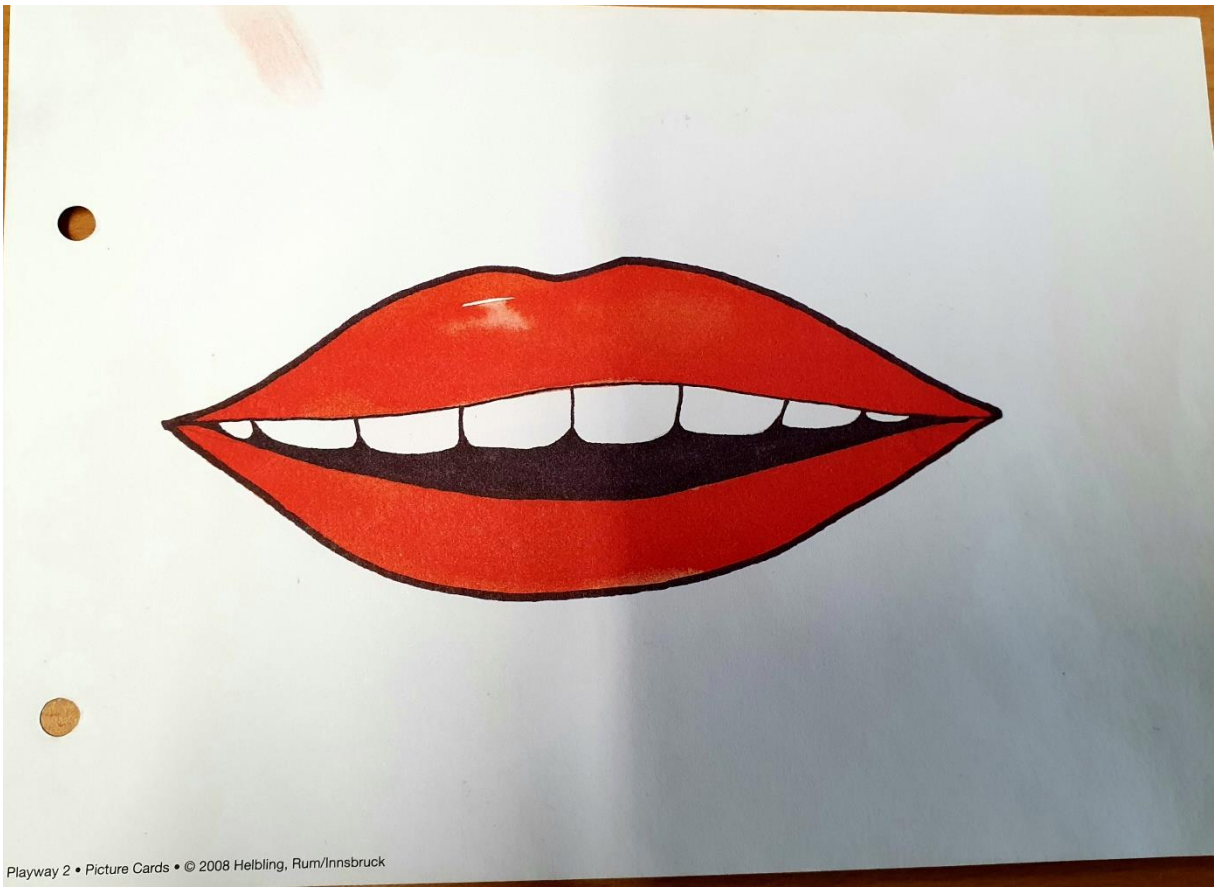
Vowel plots control group

Teachers' dental fricatives

Teachers and researcher vowel plots

Examples of picture cards





1 Apple. Source: https://pixabay.com/photos/apple-red-fruit-food-fresh-ripe-1834639/

2 Days of the week. Source https://i.pinimg.com/originals/65/fe/f9/65fef9d09a63c65e60b1acffd4555036.png

Excerpt from analysis of dental fricatives by 1st and 2nd judge

speaker	group	class	word	1st time	2nd time	3rd	4th	5th	6th	7th	comments	<r> is pronou	th from the s	aware of voi	can describe	Description r	lisp?	check t, d, f,
12	2	4A	brother	/	/	/	/	/	/	/								
12	2	4A	three	th	/	/	/	/	/	/								
12	2	4A	thirteen	s	/	/	/	/	/	/								
12	2	4A	the	th	/	/	/	/	/	/								
12	2	4A	this	/	/	/	/	/	/	/								
12	2	4A	th unvoiced	/	/	/	/	/	/	/								
12	2	4A	th voiced	/	/	/	/	/	/	/								
12	2	4A	other	Master:/ Control:s (thirty)	/	/	/	/	/	/								
13	2	4A	mouth	Master:th Control:f 3rd judge: th	/	/	/	/	/	/			Master:no Control:mostly no	yes	no		Master: Control:no	Master: Control:Checked, ok
13	2	4A	bathroom	/	/	/	/	/	/	/								
13	2	4A	Thursday	s	/	/	/	/	/	/								
13	2	4A	mother	/	/	/	/	/	/	/								
13	2	4A	father	/	/	/	/	/	/	/								
13	2	4A	brother	Master:z Control:th 3rd judge: z	/	/	/	/	/	/								
13	2	4A	three	s	/	/	/	/	/	/								
13	2	4A	thirteen	s	/	/	/	/	/	/								
13	2	4A	the	/	/	/	/	/	/	/								
13	2	4A	this	/	/	/	/	/	/	/								
13	2	4A	th unvoiced	/	/	/	/	/	/	/								
13	2	4A	th voiced	/	/	/	/	/	/	/								
13	2	4A	other	/	/	/	/	/	/	/								
14	2	4A	mouth	Master:th Control:f 3rd judge: th	Master:th Control:f 3rd judge: th	/	/	/	/	/			Master:yes Control:mostly yes	no	Master:/ Control:no		Master: Control:no	Master: Control:Checked, except v
14	2	4A	bathroom	th	/	/	/	/	/	/								
14	2	4A	Thursday	th	/	/	/	/	/	/								
14	2	4A	mother	/	/	/	/	/	/	/								
14	2	4A	father	/	/	/	/	/	/	/								
14	2	4A	brother	/	/	/	/	/	/	/								
14	2	4A	three	th	/	/	/	/	/	/								

pre-test | Intervention I | Intervention II | post-test | delayed post-test

Analysis of dental fricatives

Excerpt from spreadsheet with results

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
1	Test	Speaker	th v	th unv	s	z	f	v	t	d	unc	uns	Other	Total	Group	Complete	class	Comments	SFT	zvd	unc&uns	other v	Other unv
2	Pre Test	11	5	6	2	0	0	0	0	0	0	0	0	13	2	yes	4A		2	0	0	0	0
3	Pre Test	12	1	1	1	0	0	0	1	0	0	0	2	6	2	yes	4A	other n	2	0	0	0	2
5	Pre Test	14	0	6	0	0	0	0	0	0	0	0	0	6	2	yes	4A		0	0	0	0	0
6	Pre Test	15	0	0	4	0	0	0	0	1	0	1	0	6	2	yes	4A	uns th or f or s	4	1	1	0	0
7	Pre Test	16	1	1	2	1	0	0	0	2	0	1	0	8	2	yes	4A		2	3	1	0	0
8	Pre Test	17	0	1	1	0	0	0	0	0	0	0	1	3	2	yes	4A	other = k	1	0	0	0	1
9	Pre Test	18	1	7	1	0	0	0	0	0	0	0	0	9	2	yes	4A		1	0	0	0	0
10	Pre Test	19	2	1	3	0	0	0	0	0	0	0	0	6	2	yes	4A		3	0	0	0	0
11	Pre Test	21	0	0	4	0	0	0	0	0	0	0	0	4	3	yes	4A		4	0	0	0	0
12	Pre Test	23	0	1	0	0	0	0	0	0	0	0	0	1	3	yes	4A		0	0	0	0	0
13	Pre Test	35	0	2	0	0	0	0	2	2	0	0	1	7	2	yes	4B	other = ts	2	2	0	0	1
15	Pre Test	37	0	3	3	1	2	0	0	0	0	1	0	10	2	yes	4B	uns th or f or uns	5	1	1	0	0
16	Pre Test	38	0	1	3	0	0	0	0	0	0	1	0	5	2	yes	4B	uns uns th unc (d)	3	0	1	0	0
17	Pre Test	39	0	2	2	0	0	0	1	1	0	0	0	6	2	yes	4B		3	1	0	0	0
18	Pre Test	40	0	1	0	0	0	0	3	0	0	0	0	4	2	yes	4B		3	0	0	0	0
19	Pre Test	41	0	3	1	1	0	0	1	0	0	0	0	6	2	yes	4B		2	1	0	0	0
20	Pre Test	42	3	3	1	0	0	0	0	0	0	0	0	7	2	yes	4B		1	0	0	0	0
21	Pre Test	43	0	0	2	1	1	0	0	0	0	0	0	4	2	yes	4B		3	1	0	0	0
22	Pre Test	44	0	2	0	0	0	0	1	1	0	0	0	4	2	yes	4B		1	1	0	0	0
24	Pre Test	46	2	5	0	0	0	0	0	0	0	0	0	7	3	yes	4B		0	0	0	0	0
25	Pre Test	47	0	1	3	0	0	0	0	1	0	0	0	5	3	yes	4B		3	1	0	0	0
26	Pre Test	52	3	4	0	0	1	0	0	0	0	0	0	8	3	yes	3B		1	0	0	0	0
28	Pre Test	56	4	7	0	0	0	0	0	0	0	0	0	11	2	yes	3B		0	0	0	0	0
29	Pre Test	57	0	0	0	0	2	0	2	3	0	1	0	8	2	yes	3B	uns h th f	4	3	1	0	0
30	Pre Test	59	0	0	0	0	2	0	0	4	0	0	0	6	3	yes	3B		2	4	0	0	0
31	Pre Test	60	0	0	0	0	3	0	1	3	0	0	0	7	3	yes	3B		4	3	0	0	0
33	Pre Test	65	0	0	0	0	5	0	0	0	0	0	0	5	3	yes	3B		5	0	0	0	0
34	Pre Test	66	2	1	0	0	1	0	2	0	0	0	0	6	2	yes	3B		3	0	0	0	0
37	Pre Test	70	1	3	0	0	4	0	1	0	0	0	0	9	3	yes	3B		5	0	0	0	0
39	Pre Test	72	0	0	1	1	2	0	0	0	0	0	0	4	3	yes	3B		3	1	0	0	0
40	intervention I	11	3	2	7	0	0	0	0	0	0	0	0	12	2	yes	4A	Int I: five cases of th were judged 3 times, unsure between th and s	7	0	0	0	0
41	intervention I	12	3	5	1	0	0	0	0	0	0	0	0	9	2	yes	4A		1	0	0	0	0
43	intervention I	14	7	9	0	0	0	0	0	0	0	0	0	16	2	yes	4A		0	0	0	0	0
44	intervention I	15	1	6	2	3	0	0	0	1	0	0	0	13	2	yes	4A		2	4	0	0	0
45	intervention I	16	2	2	0	0	0	0	0	0	0	0	0	4	2	yes	4A		0	0	0	0	0
46	intervention I	17	6	6	1	3	0	0	0	0	0	0	0	16	2	yes	4A		1	3	0	0	0
47	intervention I	18	6	3	0	0	0	0	0	0	0	0	2	11	2	yes	4A	Other = ch	0	0	0	0	2
48	intervention I	19	1	8	0	0	0	0	0	0	0	1	0	10	2	yes	4A	uns maybe sh	0	0	1	0	0
49	intervention I	35	3	4	0	3	0	0	3	0	0	0	0	13	2	yes	4B		3	3	0	0	0
50	intervention I	37	3	8	6	5	0	0	0	0	0	0	0	22	2	yes	4B		6	5	0	0	0
51	intervention I	38	1	1	9	13	0	0	0	0	0	0	0	24	2	yes	4B		9	13	0	0	0
52	intervention I	39	7	2	3	0	0	0	0	0	0	0	0	12	2	yes	4B		3	0	0	0	0
53	intervention I	40	9	11	1	0	1	0	1	2	0	0	1	26	2	yes	4B	other = h	3	2	0	0	1
54	intervention I	41	6	6	0	5	0	0	0	0	0	0	0	17	2	yes	4B		0	5	0	0	0
55	intervention I	42	6	4	0	0	0	0	0	0	0	0	0	10	2	yes	4B		0	0	0	0	0
56	intervention I	43	4	6	2	1	3	0	0	0	0	0	0	16	2	yes	4B		5	1	0	0	0
57	intervention I	44	3	8	0	1	0	0	0	4	0	1	3	20	2	yes	4B	uns s d th; other l	0	5	1	3	0
59	intervention I	56	6	4	0	1	0	0	0	0	0	0	0	11	2	yes	3B		0	1	0	0	0
60	intervention I	57	13	5	2	1	3	0	0	0	0	2	0	26	2	yes	3B	uns h th uns and th n s	5	1	2	0	0
61	intervention I	66	6	4	0	0	0	0	0	0	0	0	0	10	2	yes	3B		0	0	0	0	0
64	intervention II	11	1	4	3	0	0	0	0	0	0	1	0	9	2	yes	4A	unsure between th and s	3	0	1	0	0
65	intervention II	12	3	4	1	0	0	0	0	0	0	0	0	8	2	yes	4A		1	0	0	0	0
67	intervention II	14	6	7	0	0	0	0	0	0	0	0	0	13	2	yes	4A		0	0	0	0	0
68	intervention II	15	3	9	2	0	0	0	0	1	0	0	0	15	2	yes	4A		2	1	0	0	0
69	intervention II	16	2	1	1	1	0	0	0	0	0	0	0	5	2	yes	4A		1	1	0	0	0
70	intervention II	17	1	4	0	1	0	0	0	0	0	0	0	6	2	yes	4A		0	1	0	0	0
71	intervention II	18	13	7	0	0	0	0	0	0	0	0	0	20	2	yes	4A		0	0	0	0	0
72	intervention II	19	2	4	1	0	0	0	0	0	0	0	0	7	2	yes	4A		1	0	0	0	0
73	intervention II	35	3	11	0	1	2	0	2	0	0	0	0	19	2	yes	4B		4	1	0	0	0
75	intervention II	37	2	7	3	2	1	0	0	0	0	0	0	15	2	yes	4B		4	2	0	0	0
76	intervention II	38	2	10	2	4	1	0	0	0	0	1	0	20	2	yes	4B	uns th t s	3	4	1	0	0
77	intervention II	39	3	10	3	0	0	2	0	0	0	0	0	18	2	yes	4B		3	2	0	0	0
78	intervention II	40	4	17	5	0	0	0	2	0	0	0	0	28	2	yes	4B		7	0	0	0	0
79	intervention II	41	3	7	0	0	0	0	0	0	0	0	0	10	2	yes	4B		0	0	0	0	0
80	intervention II	42	2	6	4	0	0	0	0	0	0	0	1	13	2	yes	4B	other ts	4	0	0	0	1
81	intervention II	43	2	7	0	1	2	0	0	0	0	0	0	12	2	yes	4B		2	1	0	0	0
82	intervention II	44	2	12	0	1	2	0	3	0	0	0	1	21	2	yes	4B	other ts	5	1	0	0	1

Tagging and abbreviations in auditive analysis of dental fricatives

Auditive analysis of consonants – Instructions for external judges

I am analysing how explicit pronunciation exercises affect the pronunciation of certain phonemes. In these recordings, I am focussing on the pronunciation of the voiced and voiceless dental fricative. In order to check my auditive analyses, I need some other speakers of English to make a note of the pronunciation of the dental fricatives they hear in the recordings.
The speakers are all children who speak German and are learning English at school. They were shown a number of picture cards and asked to say the English words for the depicted objects. Some of them were also asked to describe the difference between the voiced and voiceless dental fricative. They did exercises which focussed on the pronunciation of the two dental fricatives.
Please listen to the recordings and, using the excel spreadsheets and the abbreviations offered below, make a note of what you hear. Make yourself familiar with the layout of the spreadsheet before you begin listening to the recordings. Please use headphones while analysing the recordings and listen to them in a quiet space (so ideally not on the bus or in a crowded room). If you carry out the analysis in the office, I can provide you with headphones (they have to remain in the office, however, since they belong to Christian Langstrof).

The main aim is to analyse the pronunciation of <th> in the words. Sometimes, the speakers do not know the word for the object on the picture card and will say something else (e.g. Tuesday twice rather than Tuesday and Thursday). If it is audibly a different word, and one that does not include a dental fricative, disregard it. Not all speakers say all the words in each recording, so you may have many blank spaces in the spreadsheet. If the speaker says a word and self-corrects, make a note of both pronunciations of the dental fricative and mark it accordingly (see below).

Layout of the spreadsheet: There are five spreadsheets in the document, labelled *Ist-Zustand I, Intervention I, Intervention II, Ist-Zustand II,* and *Ist-Zustand III*. They refer to the recordings, there were five in total. In the first column of each spreadsheet, you have the number of the speaker and the words that were elicited. The last word of each speaker is *other*. This is not actually the word *other*, but space for a word that the speaker says but was not listed yet. Each row starts with 1st, 2nd etc. This refers to the amount of times the speakers said the word. E.g. if the speaker says *mouth* once, put what you hear in 1st. If they say *mouth* again, put this second instant in 2nd etc. Please also note whether the speaker pronounces the dental fricatives as such from the start of the recording with the categories <yes>, <mostly yes> (=there were only one or max. two instances of something other than a dental fricative and a total of more than one or two occurrences of the dental fricative in the recording), <mostly no> (=there were only one or max. two instances of a dental fricative and a total of more than one or two occurrences of something other than the dental fricative in the recording) and <no>. Please also note whether the speaker has a lisp in the column *lisp?* You can use the speakers English or German speech to identify a lisp. If there is anything you would like to comment on for the recording, please do so in the last column *comments*.

While filling in the spreadsheet, please use the abbreviations below. If you feel the need to add any more abbreviations, please write a comment in the spreadsheet explaining it. Wherever possible, use orthographic transcription of phonemes to make note-taking easier and faster while listening to the recording (e.g. th for /θ/ or /ð/ or n for /n/).

If you have any questions at all, please do not hesitate to contact me (charlotte.anna.hahn@upb.de) at any time.

IMPORTANT: Before you start, please print out the privacy policy, sign it and put it on my desk/in my letterbox/give it to me.

SUMMARY OF WHAT YOU NEED TO DO:
- Listen to the recordings (~2hrs worth; roughly 40 recordings)
- While listening, take notes in the spreadsheet of what you hear when the speaker says a word that includes <th>
- note whether or not the speaker has a lisp
- note whether the speaker is physically capable of pronouncing d, t, v, f

abbreviation / tag	meaning	Comments
th	dental or voiced fricative as expected (e.g. *th* in *brother* is voiced)	If the voicing is not as expected, put in brackets whether it sounds voiced or unvoiced (e.g. th(voiced) for mouth)
uns	Unsure about which phoneme is being pronounced.	
uns (th)	Unsure about which phoneme is being said, but you think it sounds most like the one in brackets.	
unc	Unclear pronunciation due to the quality of the recording	
th !g	The phoneme was pronounced while otherwise speaking German (e.g. 'Also bei *three* hört es sich so an und bei *the* so.')	
th !c	The previous pronunciation of a word was self-corrected without feedback or instruction by the interviewer (e.g. moth- mother)	In case of self-correction, list each pronunciation of the phoneme in a separate column. E.g. for moth- mother write th in column 1st and th !c in column 2nd if both versions were pronounced with a unvoiced dental fricative.
/	Whenever you leave a blank space (i.e. when the word was not spoken, you have no comments etc.), fill in the blank space with /.	
(n)	After the intervention (only for recordings Intervention I and possibly Intervention II)	Intervention = I tell the speakers to put their finger to their teeth and tongue to pronounce /θ/

Checked, ok	If d, t, f, v are all pronounced and sound ok	
Checked, except v	All phonemes are pronounced and sound ok, except (in this example) v, which was not pronounced	
Checked, ok , except v (…)	All phonemes are pronounced and sound ok, except (in this example) v, which is pronounced differently to what was expected (add in brackets how it is pronounced differently to what is expected)	
No/yes/slight lisp	Possible answers to column: lisp?	

Analysis of dental fricatives

Auditive analysis 3rd judge

Consonants to be reanalysed (pp = perceived phoneme)

Pre-test (= Ist-Zustand I)

Speaker	Word 1	pp	Word 2	pp	Word 3	pp	Instance 4	pp	Instance 5	pp	Instance 6	pp
13	Mouth	th	brother	z								
14	Mouth (1st time)	th	Mouth (2nd time)	th								
15	mouth	s	mother	d (klingt fast wie ein l)	Three (1st time)	s	Three (2nd time)	s				
16	three	s										
17	Bathroom	Uns. Sounds like /k/ (barkroom)										
18	Thirteen	s										
19	three	s										
21	Mouth	s	three	s								

35	brother	d										
37	Bathroom (1st time)	f	Bathroom (2nd time)	f	Bathroom (3rd time)	f	Bathroom (4th time)	f	Brother	z	three	s
38	Brother	Unc. d	three	s								
41	Thursday	th	Brother	z	thirteen	s						
43	Mouth	f	Brother	z	thirteen	s						
44	Brother	d	Three	th								
45	Mouth	f	mother	th								
47	brother	d										
52	Thursday	f	Thirteen	th								
53	Mouth	f	mother	d								
57	Bathroom	t	Thursday	f	Brother	d	three	f				
60	Mother	d	father	d								
64	Mouth	th	Thursday	f	Th voiced	th						
66	thursday	f										
67	Thursday	f	Mother	th	Father	th	Brother	th	thirteen	f		
69	Mouth	f	Thursday	f	Brother (2nd time)	Uns. th	Three (1st time)	s	Three (2nd time)	t		
71	Mouth	f	Mother	v								
72	mouth	f										

Annotations for column pp (=perceived phoneme):

Phonemes: th, f, v, s, z, t, d

Uns = unsure

Unc = unclear (e.g. due to bad quality of recording

If a phoneme cannot be described by orthographic transcription, use the distinctive features
If necessary, please also add any other comments in the pp column

Consonants to be reanalysed (pp = perceived phoneme)

Intervention I

Speaker	Word 1	pp	Word 2	pp	Word 3	pp	Instance 4	pp	Instance 5	pp	Instance 6	pp
11	Mouth (1st time)	s	Three (1st time)	s	Thirteen (2nd time)	s	Thirteen (3rd time)	s	Thirteen (4th time)	s		
15	Mother (1st time)	d	Mother (3rd time)	z								
35	Brother (2nd time)	z										
37	Three (5th time)	s										
38	Brother (7th time)	z	Three (1st time)	th	Three (3rd time)	s	Three (4th time)	s				
39	Brother (4th time)	th										
40	Brother (3rd time)	th	Brother (4th time)	d	Three (2nd time)	f	Three (3rd time)	th				
43	Brother (1st time)	z	Three (1st time)	s	Three (3rd time)	f	Three (4th time)	f	Three (6th time)	f	Thirteen (1st time)	s
44	Brother (3rd time)	d	Brother (5th time)	Uns. th								
45	Brother (1st time)	th	Brother (5th time)	th	Three (1st time)	f	Three (2nd time)	th				
57	Brother (2nd time)	d+z	Brother (4th time)	th	Three (1st time)	Unc. (overlap)	Three (5th time)	s				
66	Brother (2nd time)	th										

69	Three (2nd time)	Uns. s										

Annotations for column pp (=perceived phoneme):

Phonemes: th, f, v, s, z, t, d

Uns = unsure

Unc = unclear (e.g. due to bad quality of recording

If a phoneme cannot be described by orthographic transcription, use the distinctive features
If necessary, please also add any other comments in the pp column

Consonants to be reanalysed (pp = perceived phoneme)

Intervention II

Speaker	Word 1	pp	Word 2	pp	Word 3	pp	Instance 4	pp	Instance 5	pp	Instance 6	pp
11	Mouth (2nd time)	Uns. th/s	Three (1st time)	s								
12	Brother (1st time)	th	Month	th	Teeth (1st time)	s	Teeth (2nd time)	th	Teeth (3rd time)	(finde ichnicht)		
15	Brother	d										
16	Mouth	th	Mother	th	Brother	z						
17	Brother (1st time)	z										
19	Mother	th	Father	th								
35	Thursday (1st time)	f										
36	Three (1st time)	Uns. t										
37	Bathroom (2nd time)	f	Brother (1st time)	z	Brother (2nd time)	z	Three (1st time)	s	Thirteen (1st time)	s	Thirteen (2nd time)	s
38	Bathroom (1st time)	f	Bathroom (2nd time)	th	Thursday (2nd time)	th	Three (1st time)	s	Thirteen (2nd time)	th		
39	Bathroom (1st time)	t	Bathroom (2nd time)	t	Bathroom (3rd time)	thr	Bathroom (4th time)	th				
40	Thirteen (1st time)	s	Thirteen (2nd time)	s	Thirteen (3rd time)	s						
41	bathroom (1st time)	th										

42	Mouth (1st time)	s	Bathroom (1st time)	ts	Thursday (1st time)	s	Thursday (2nd time)	s	Three (2nd time)	th		
43	Mouth (1st time	f	Brother (2nd time)	z								
44	Mouth (2nd time)	f	Brother (1st time)	z								
57	Thursday	f	Mother	d	Father	d	Brother (1st time)	d	Three (4th time)	s	Three (6th time)	th
64	Father	d	three	s								
66	Mother	d	Father	d	Brother (2nd time)	th						

Annotations for column pp (=perceived phoneme):

Phonemes: th, f, v, s, z, t, d

Uns = unsure

Unc = unclear (e.g. due to bad quality of recording

If a phoneme cannot be described by orthographic transcription, use the distinctive features
If necessary, please also add any other comments in the pp column

Consonants to be reanalysed (pp = perceived phoneme)

Post-Test I (= Ist-Zustand II)

Speaker	Word 1	pp	Word 2	pp	Word 3	pp	Instance 4	pp	Instance 5	pp	Instance 6	pp
11	Thursday	s	Brother	z	Thirteen (1st time) (hier setzt sie nur an)	s	Thirteen (2nd time) (hier setzt sie nur an)	s	Thirteen (3rd time)	s		
12	Brother	th										
13	Bathroom	t										
15	Father	z	Brother	d	Three	s						
16	The	z										
17	Bathroom	t										
18	Three	th										
35	Mouth	f	Thursday	s								
36	Mouth	f										
37	Bathroom	t	Three (1st time)	th								
38	Brother (1st time)	z	Three (1st time)	th								
39	Bathroom	t	Thirteen	s								
40	Three	s(+v)										
42	Brother	th	Three (1st time)	s								
43	Brother (2nd time)	z										
44	Thursday (1st time)	Uns. t/th	Brother	d								
45	Bathroom	d	Thursday	f	Mother	Uns. th	Father	d				
47	Brother	d										

57	Thursday	f	Brother	d								
59	Mouth	f	Thursday (1st time)	f	Brother	d	Three	f				
60	Mouth	f	Thursday	f	Mother	d	Father	d	Brother	d	Thirteen	f
64	Thursday	f	Mother	d								
65	Thursday	f										
66	Thursday	f	Brother	d								
69	Mouth	f	Thursday	Unc. (rauschen) tendiere zu f								
70	Thursday	f	Thirteen (2nd time)	f	Thirteen (3rd time)	f	Thirteen (4th time)	th				
72	Thursday	f										

Annotations for column pp (=perceived phoneme):

Phonemes: th, f, v, s, z, t, d

Uns = unsure

Unc = unclear (e.g. due to bad quality of recording

If a phoneme cannot be described by orthographic transcription, use the distinctive features
If necessary, please also add any other comments in the pp column

Consonants to be reanalysed (pp = perceived phoneme)

Pre-test (= Ist-Zustand I) – Das ist der Post-Test II (= Ist-Zustand III)

Speaker	Word 1	pp	Word 2	pp	Word 3	pp	Instance 4	pp	Instance 5	pp	Instance 6	pp
11	Thirteen	s										
12	Mouth	nt /maʊnt/	Brother	th								
15	Mother	z	Brother	z								
16	The	th										
21	Mouth	s										
23	Mouth	s	Brother	v	Three	s						
35	Thursday	th										
36	Mouth	f										
37	Bathroom	f	Three	s								
39	Three	s										
42	Bathroom	s										
43	Thirteen	th										
44	Brother	d	Three	th								
45	Mouth	th	Three	f								
52	Three	th										
53	Mouth	f	Thursday	f	Three	f						
57	Mouth	s	Thursday	f	Brother	d	Three	s	Thirteen (1st time)	f		
59	Thursday	f	Three	f								
60	Thursday	f	Three	s	Thirteen (1st time)	f	Thirteen (2nd time)	f				
64	Thursday	f	Mother	d	Brother	d						
65	Thursday	f	Three	f								
66	Thursday	f	Brother	d								
67	thursday	Unc.										

		ten die re zu f										
69	Three	s	Thursday	f								
70	Thursday	f	Father	Uns. t/d	Three	f	Thirteen	f				
71	mouth	f	Thursday (1st time)	f	Thursday (2nd time)	f	Three	f	grandmother	v	Thirteen	f
72	Thursday	f	Brother	z	three	s(+ w)						

Annotations for column pp (=perceived phoneme):

Phonemes: th, f, v, s, z, t, d

Uns = unsure

Unc = unclear (e.g. due to bad quality of recording

If a phoneme cannot be described by orthographic transcription, use the distinctive features
If necessary, please also add any other comments in the pp column

Analysis of TRAP

Praat script

Praat script

l.1 What this script does:
l.2 automatically runs through four tiers
l.3 notes the word as annotated for each interval in tier 1
l.4 notes the lexical set as annotated for each interval in tier 2 and measures F1 and F2, and creates the mean of F1 and F2 for each annotated interval
l.5 notes the word as annotated for each interval in tier 3
l.6 notes the word as annotated for each interval in tier 4
l.7 This script was created 22nd July 2019 by Charlotte Anna Hahn; adapted 23rd July 2019 with the help of Lisa Scheiwe!

l.9 before running:
l.10 check the save path is correct
l.11 check the maxformant value is correct

l.13 extracts the names of the praat objects, tells it to use the soundfile and the textgrid that belongs with it
thisSound$ = selected$ ("Sound")
thisTextGrid$ = selected$ ("TextGrid")

l.17 this tells praat from which tier to get the number of vowels (in this case from tier 2 which ist number of intervals)
select TextGrid 'thisTextGrid$'

# l.20 creates the formant object with default settings
timeStepDefault = 0
numFormantsDefault = 5
maxFormantDefault = 5500
windowLengthDefault = 0.025
preEmphasisDefault = 50

l.27 Set up formant variables; change values if necessary
1.28 each something = something is a definition: you are defining the first thing with the second for the script
	timeStep = timeStepDefault
	numFormants = numFormantsDefault
	maxFormant = 7500
	windowLength = windowLengthDefault
	preEmphasis = 50

l.35 create a formant object
	select Sound 'thisSound$'
	formantObj = To Formant (burg): timeStep, numFormants, maxFormant, windowLength, preEmphasis
	thisFormant$ = selected$ ("Formant")
	select TextGrid 'thisTextGrid$'

```
numberOfTiers = Get number of tiers

# l.43 this is where the loop starts, the so-called for loop. Must start with for and end with endfor
for tiernumber from 1 to numberOfTiers
	numberOfIntervals = Get number of intervals: tiernumber
	for thisInterval from 1 to numberOfIntervals

	select TextGrid 'thisTextGrid$'

# l.50 one file is saved for each tier
# l.51 starts with if for tier one, continues with elsif for tiers two and three and ends with else for tier four
# l.52 each if must be closed with endif. elsifs and elses do not need to be closed, because they are seen as belonging to the first if.
# l.53 so you have if the tiernumber is 1, do this, but if (=elsif) the tiernumber is 2, do this, but if (=elsif) the tiernumber is 3, do this, but if (=else) the tiernumber is four, do this.
if tiernumber = 1
 word$ = Get label of interval: tiernumber, thisInterval
	if word$ = ""
	ignore = 1
	else
	start_time_word = Get start point: tiernumber, thisInterval
	end_time_word = Get end point: tiernumber, thisInterval
fileappend "D:\Analyses and Recordings Speakers\1_054\wordIst-ZustandIII.txt" 'thisTextGrid$' 'tab$' 'word$' 'tab$' 'start_time_word:3' 'tab$' 'end_time_word:3' 'newline$'
	endif

elsif tiernumber = 2
		thisPhoneme$ = Get label of interval: 2, thisInterval
		thisPhonemeStartTime = Get start point: 2, thisInterval
		thisPhonemeEndTime = Get end point: 2, thisInterval
		duration = thisPhonemeEndTime - thisPhonemeStartTime
		vowel$ = Get label of interval: tiernumber, thisInterval
	if vowel$ = ""
	ignore = 1
	else
	select Formant 'thisFormant$'
	mean1 = Get mean: 1, thisPhonemeStartTime, thisPhonemeEndTime, "Hertz"
     mean2 = Get mean: 2, thisPhonemeStartTime, thisPhonemeEndTime, "Hertz"
fileappend "D:\Analyses and Recordings Speakers\1_054\formantsIst-ZustandIII.txt" 'thisPhonemeStartTime:3' 'tab$' 'thisPhonemeEndTime:3' 'tab$'
```

```
'thisTextGrid$' 'tab$' 'thisPhoneme$' 'tab$' 'mean1:0' 'tab$' 'mean2:0' 'tab$'
'newline$'
        endif

else tiernumber = 3
 word$ = Get label of interval: tiernumber, thisInterval
        if word$ = ""
        ignore = 1
        else
        start_time_word = Get start point: tiernumber, thisInterval
        end_time_word = Get end point: tiernumber, thisInterval
fileappend "D:\Analyses and Recordings Speakers\1_054\wordthIst-
ZustandIII.txt" 'thisTextGrid$' 'tab$' 'word$' 'tab$' 'start_time_word:3' 'tab$'
'end_time_word:3' 'newline$'
        endif

endif
        endfor
endfor

#l.103 this creates a small window in which praat will talk to you. So in this case
it will tell you when it has finished the analysis :)
appendInfoLine: newline$, newline$, "Finished :)"
```

Analysis of TRAP

Example spreadsheet trap Speaker 68

pre-test		
BATH	711	2353
DRESS 5	746	2454
	631	2116
	687	2367
	746	2434
	581	2515
	774	2306
Mean	694,1667	2365,333
Stdev	**75,6238**	**141,892**
START 2	1038	1728
	1151	1739
Mean	1094,5	1763,5
Stdev	**79,9031**	**50,2046**
TRAP 14	807	2337
	556	2478
	687	2179
	755	2207
	767	2526
	814	2264
	711	2396
	843	2493
	721	2464
	641	2477
	743	2465
	820	2069
	808	2559
	675	2391
Mean	739,1429	2378,929
Stdev	**80,5957**	**147,319**

Intervention I		
DRESS	704	2321
TRAP 5	729	2240
	1240	1985
	1275	1984
	667	2257
	676	2207
Mean	917,4	2134,6
Stdev	**311,616**	**138,197**

Intervention II		
TRAP	866	2295
TRAP	879	2344
TRAP	645	2239
TRAP	909	2379
TRAP	751	2492
TRAP	867	2196
TRAP	886	1960
TRAP	899	2245
Mean 8	837,75	2268,75
Stdev	**91,9546**	**156,029**

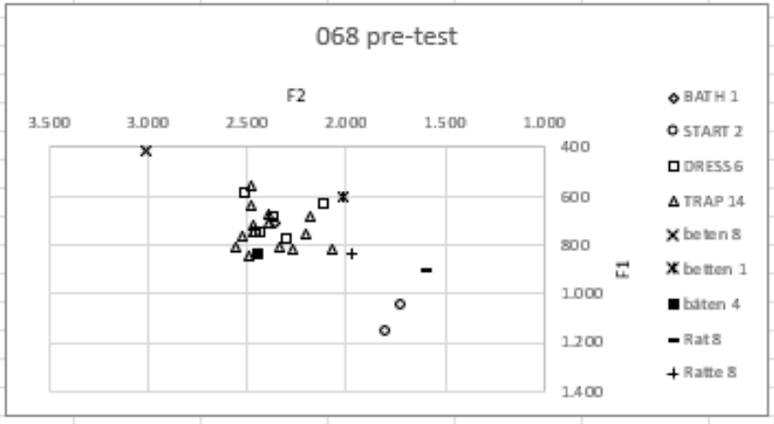
post-test I		
PALM	1032	1852
DRESS 5	699	2297
	586	2141
	625	2210
	777	2322
	782	2428
Mean	693,8	2279,6
Stdev	**88,1516**	**109,747**
START 2	837	1683
	743	1510
Mean	790	1596,5
Stdev	**66,468**	**122,329**
TRAP 11	853	2252
	788	1996
	689	1827
	690	2127
	815	2383
	721	2455
	783	2272
	677	2276
	641	2210
	695	2367
	748	2570
Mean	736,3636	2248,636
Stdev	**66,123**	**209,074**

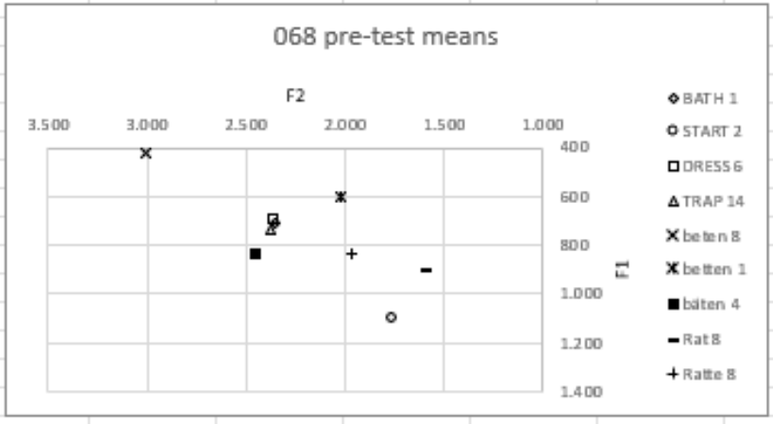
post-test II		
PALM	1078	1814
DRESS 9	675	2109
	668	2011
	717	2254
	879	2130
	742	1661
	864	2267
	878	2010
	895	2403
	743	2020
	784,5556	2096,111
Stdev	**93,4413**	**211,955**
START 2	1050	1828
	976	1444
Mean	1013	1636
Stdev	**52,3259**	**271,529**
TRAP 10	883	2211
	898	2019
	883	2036
	679	2225
	918	2318
	1010	2064
	656	1706
	851	2286
	892	2442
	805	2501
Mean	847,5	2180,8
Stdev	**108,172**	**233,27**

German		
beten 8	479	3106
	442	3135
	354	2858
	450	2976
	406	2898
	405	3088
	439	3000
	378	3001
Mean	419,125	3007,75
Stdev	**40,9893**	**98,4665**
betten	605	2019
Rat 8	893	1460
	873	1428
	976	1406
	835	1544
	821	1558
	817	1841
	1077	1782
	897	1740
Mean	898,625	1594,875
Stdev	**88,8272**	**170,006**
Ratte 8	899	1986
	969	1813
	510	2113
	748	2252
	927	1696
	888	1972
	787	1850
	970	2047
Mean	837,25	1966,125
Stdev	**154,461**	**177,348**
bäten 4	826	2344
	832	2479
	825	2600
	870	2371
Mean	838,25	2448,5
Stdev	**21,3912**	**116,632**

file name	word	start word	end word	start vowe	end vowe	file name	lexical se	F1	F2
068_lst-Zus	apple	3.355	4.221	3.652	3.715	068_lst-Zu:	TRAP	807	2337
068_lst-Zus	bedroom	17.383	18.970	17.595	17.699	068_lst-Zu:	DRESS	746	2454
068_lst-Zus	bathroom	23.010	24.482	23.321	23.410	068_lst-Zu:	BATH	711	2353
068_lst-Zus	attic	27.570	28.897	27.942	28.013	068_lst-Zu:	TRAP	556	2478
068_lst-Zus	January	30.860	32.043	31.287	31.388	068_lst-Zu:	TRAP	687	2179
068_lst-Zus	February	32.101	32.966	32.211	32.262	068_lst-Zu:	DRESS	631	2116
068_lst-Zus	March	32.995	33.832	33.095	33.245	068_lst-Zu:	START	1038	1728
068_lst-Zus	Wednesday	37.333	37.972	37.442	37.498	068_lst-Zu:	DRESS	687	2367
068_lst-Zus	Saturday	38.965	39.668	39.065	39.112	068_lst-Zu:	TRAP	755	2207
068_lst-Zus	red	42.959	43.796	43.224	43.307	068_lst-Zu:	DRESS	746	2434
068_lst-Zus	black	44.056	44.835	44.367	44.485	068_lst-Zu:	TRAP	767	2526
068_lst-Zus	yellow	45.123	45.845	45.316	45.398	068_lst-Zu:	DRESS	581	2515
068_lst-Zus	family	49.337	50.405	49.791	49.857	068_lst-Zu:	TRAP	814	2264
068_lst-Zus	dad	52.656	53.810	53.050	53.208	068_lst-Zu:	TRAP	711	2396
068_lst-Zus	hands	67.391	68.863	67.932	68.054	068_lst-Zu:	TRAP	843	2493
068_lst-Zus	hands	79.887	81.272	80.127	80.267	068_lst-Zu:	TRAP	721	2464
068_lst-Zus	jacket	82.340	83.898	82.895	82.945	068_lst-Zu:	TRAP	641	2477
068_lst-Zus	cap	83.898	84.707	84.262	84.373	068_lst-Zu:	TRAP	743	2465
068_lst-Zus	carrot	85.313	86.756	85.693	85.738	068_lst-Zu:	TRAP	820	2069
068_lst-Zus	cat	89.355	90.452	89.770	89.893	068_lst-Zu:	TRAP	808	2559
068_lst-Zus	January	118.572	120.130	118.890	118.950	068_lst-Zu:	TRAP	675	2391
068_lst-Zus	February !g	123.045	124.834	123.345	123.403	068_lst-Zu:	DRESS	774	2306
068_lst-Zus	March	128.701	129.509	128.971	129.177	068_lst-Zu:	START	1151	1799

BATH	711	2353		beten 8	419	3008
				betten 1	605	2019
DRESS 5	746	2454		Rat 8	899	1595
	631	2116		Ratte 8	837	1966
	687	2367		bäten 4	838	2449
	746	2434				
	581	2515				
!g	774	2306				
Mean	694,1667	2365,333				
START 2	1038	1728				
	1151	1799				
Mean	1094,5	1763,5				
TRAP 14	807	2337				
	556	2478				
	687	2179				
	755	2207				
	767	2526				
	814	2264				
	711	2396				
	843	2493				
	721	2464				
	641	2477				
	743	2465				
	820	2069				
	808	2559				
	675	2391				
Mean	739,1429	2378,929				
euclidean d	46,98604					

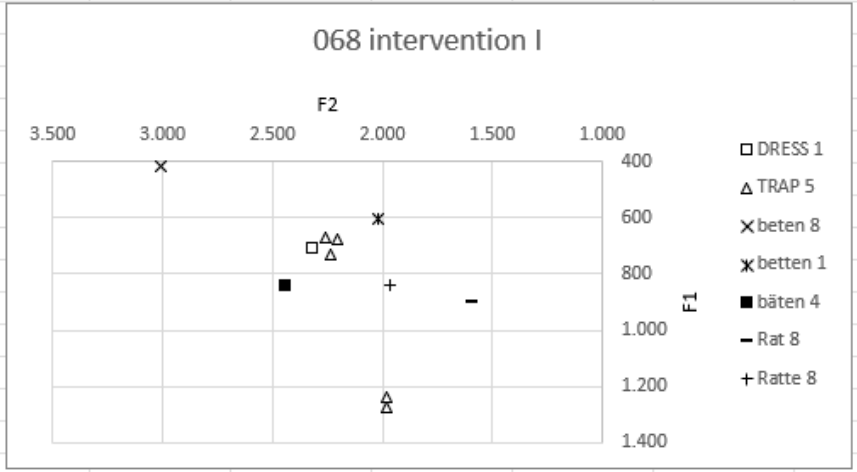


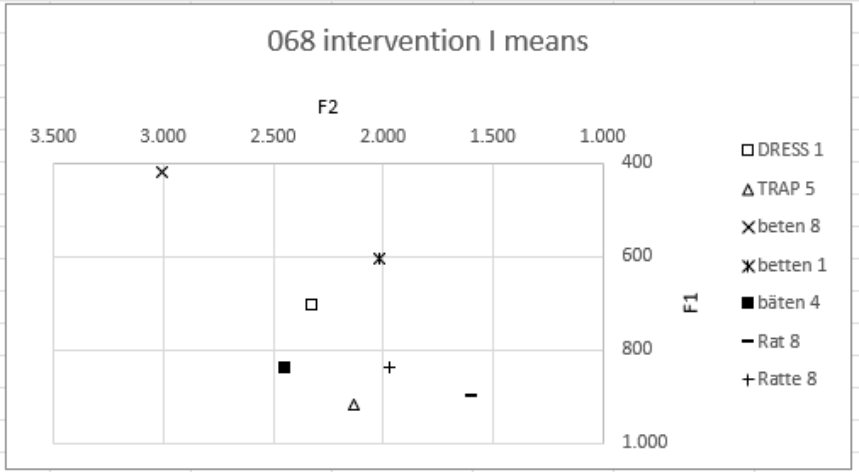


file name	word	start word	end word	start vowe	end vowel	file name2	lexical set	F1	F2
068_Interven	January	13.802	14.928	13.986	14.054	068_Interver	TRAP	729	2240
068_Interven	February	16.882	18.100	17.098	17.211	068_Interver	DRESS	704	2321
068_Interven	January	137.349	139.715	137.869	137.966	068_Interver	TRAP af	1240	1985
068_Interven	January	140.090	142.082	140.537	140.622	068_Interver	TRAP	1275	1984
068_Interven	January	143.554	145.372	144.278	144.343	068_Interver	TRAP	667	2257
068_Interven	January	146.122	147.652	146.396	146.478	068_Interver	TRAP	676	2207

			beten 8	419	3008
DRESS	704	2321	betten 1	605	2019
			Rat 8	899	1595
TRAP 5	729	2240	Ratte 8	837	1966
	1240	1985	bäten 4	838	2449
	1275	1984			
	667	2257			
	676	2207			
Mean	917,4	2134,6			

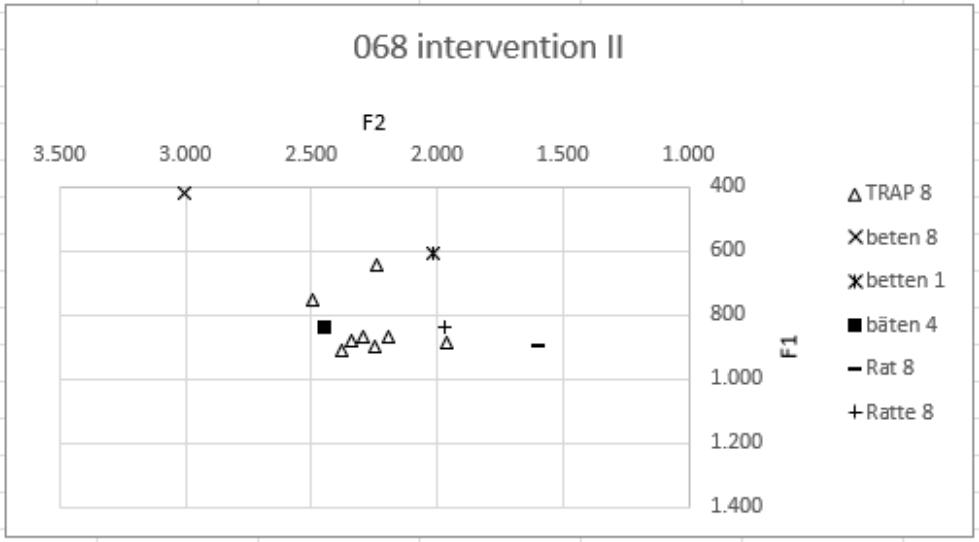
euclidean dis	283,3452311

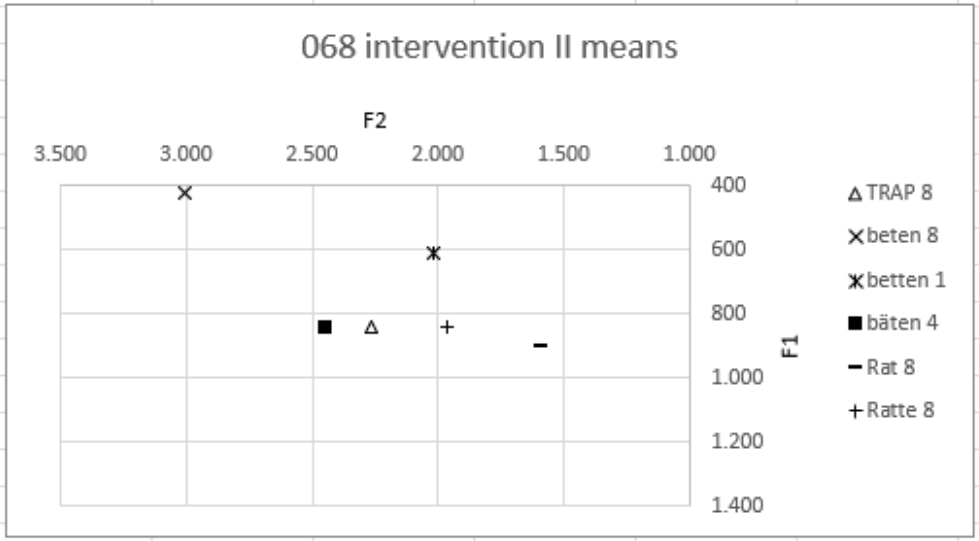




file name	word	start word	end word	start vowel	end vowel	file name2	lexical set	F1	F2
068_Interven	March !g	33.533	34.366	33.688	33.868	068_Interver	TRAP	1116	1739
068_Interven	January !g	35.581	36.592	35.707	35.730	068_Interver	TRAP	633	2336
068_Interven	apple	71.142	72.057	71.225	71.317	068_Interver	TRAP	866	2295
068_Interven	carrot	72.918	73.969	73.285	73.339	068_Interver	TRAP	879	2344
068_Interven	cap	74.502	75.185	74.782	74.850	068_Interver	TRAP	645	2239
068_Interven	hands	75.991	76.838	76.178	76.313	068_Interver	TRAP	909	2379
068_Interven	cat	77.671	78.367	77.948	78.072	068_Interver	TRAP	751	2492
068_Interven	January	83.577	84.888	83.762	83.841	068_Interver	TRAP	867	2196
068_Interven	Saturday	87.101	88.330	87.486	87.531	068_Interver	TRAP	886	1960
068_Interven	black	90.433	91.034	90.684	90.767	068_Interver	TRAP	899	2245
							Mean 8	837,75	2268,75

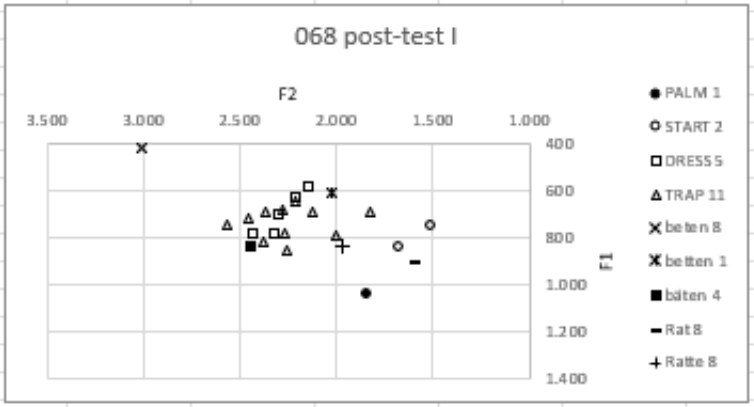
beten 8	419	3008
betten 1	605	2019
Rat 8	899	1595
Ratte 8	837	1966
bäten 4	838	2449

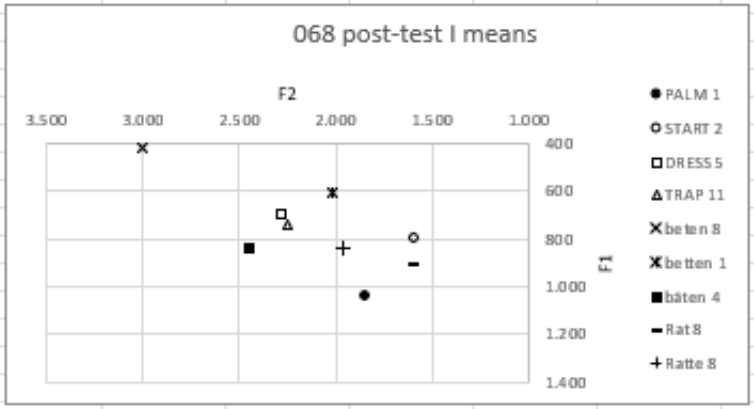




file name	word	start word	end word	start vow	end vowe	file name	lexical se	F1	F2
068_lst-Zus	apple	10.282	11.378	10.780	10.837	068_lst-Zu:	TRAP	853	2252
068_lst-Zus	family	14.524	15.447	14.833	14.878	068_lst-Zu:	TRAP	788	1996
068_lst-Zus	father	16.082	16.861	16.375	16.447	068_lst-Zu:	PALM	1032	1852
068_lst-Zus	January	21.814	22.997	22.288	22.337	068_lst-Zu:	TRAP	689	1827
068_lst-Zus	February	23.026	23.805	23.122	23.173	068_lst-Zu:	DRESS	699	2297
068_lst-Zus	March	23.815	24.498	23.851	23.994	068_lst-Zu:	START	837	1683
068_lst-Zus	Wednesday	28.604	29.013	28.669	28.707	068_lst-Zu:	DRESS	586	2141
068_lst-Zus	Saturday	29.878	30.511	29.972	30.006	068_lst-Zu:	TRAP	690	2127
068_lst-Zus	red	39.647	40.686	40.090	40.220	068_lst-Zu:	TRAP	815	2383
068_lst-Zus	black	40.714	41.696	41.058	41.202	068_lst-Zu:	TRAP	721	2455
068_lst-Zus	yellow	41.753	42.590	42.064	42.131	068_lst-Zu:	DRESS	625	2210
068_lst-Zus	cap	48.195	49.321	48.748	48.803	068_lst-Zu:	TRAP	783	2272
068_lst-Zus	dress	50.273	51.514	50.854	50.948	068_lst-Zu:	DRESS	777	2322
068_lst-Zus	legs	53.246	54.660	53.711	53.896	068_lst-Zu:	DRESS	782	2428
068_lst-Zus	carrot	55.064	56.420	55.666	55.787	068_lst-Zu:	TRAP	677	2276
068_lst-Zus	arms	57.199	58.267	57.567	57.794	068_lst-Zu:	START	743	1510
068_lst-Zus	jacket	59.710	60.807	60.058	60.101	068_lst-Zu:	TRAP	641	2210
068_lst-Zus	hands	61.932	63.116	62.348	62.474	068_lst-Zu:	TRAP	695	2367
068_lst-Zus	cat	65.338	66.665	65.780	65.891	068_lst-Zu:	TRAP	748	2570

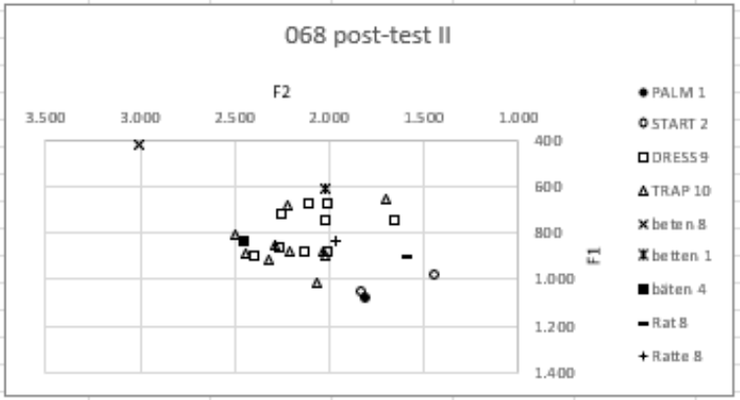
PALM	1032	1852	beten 8	419	3008
			betten 1	605	2019
DRESS 5	699	2297	Rat 8	899	1595
	586	2141	Ratte 8	837	1966
	625	2210	bäten 4	838	2449
	777	2322			
	782	2428			
Mean	693,8	2279,6			
START 2	837	1683			
	743	1510			
Mean	790	1596,5			
TRAP 11	853	2252			
	788	1996			
	689	1827			
	690	2127			
	815	2383			
	721	2455			
	783	2272			
	677	2276			
	641	2210			
	695	2367			
	748	2570			
Mean	736,3636	2248,636			
euclidean d	52,63468				

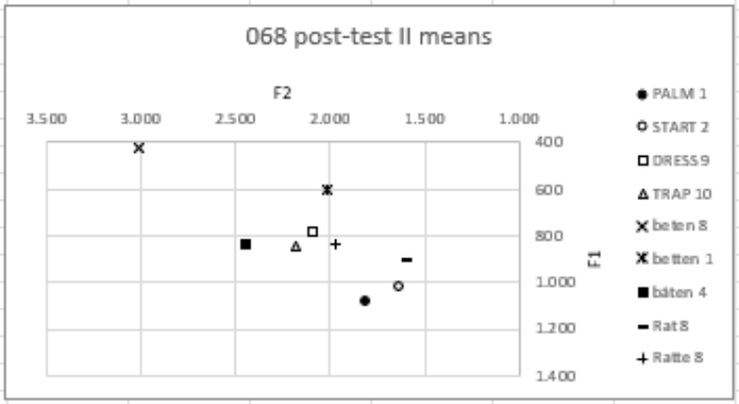




file name	word	start word	end word	start vowe	end vowe	file name	lexical se	F1	F2
068_lst-Zus	apple	1.941	3.211	2.254	2.300	068_lst-Zu:	TRAP	883	2211
068_lst-Zus	family	4.885	6.414	5.324	5.386	068_lst-Zu:	TRAP	898	2019
068_lst-Zus	father	6.847	7.886	7.263	7.389	068_lst-Zu:	PALM	1078	1814
068_lst-Zus	Wednesday	15.464	16.017	15.610	15.652	068_lst-Zu:	DRESS	675	2109
068_lst-Zus	Saturday	16.966	17.624	17.087	17.134	068_lst-Zu:	TRAP	883	2036
068_lst-Zus	January	18.705	20.062	19.318	19.358	068_lst-Zu:	TRAP	679	2225
068_lst-Zus	February	20.293	21.360	20.691	20.749	068_lst-Zu:	DRESS	668	2011
068_lst-Zus	March	21.389	21.880	21.458	21.588	068_lst-Zu:	START	1050	1828
068_lst-Zus	seven	27.709	28.315	27.828	27.884	068_lst-Zu:	DRESS	717	2254
068_lst-Zus	eleven	31.028	31.835	31.312	31.425	068_lst-Zu:	DRESS	879	2130
068_lst-Zus	twelve	31.835	32.643	32.183	32.269	068_lst-Zu:	DRESS	742	1661
068_lst-Zus	red	36.885	37.808	37.116	37.261	068_lst-Zu:	DRESS	864	2267
068_lst-Zus	black	37.808	38.674	38.118	38.236	068_lst-Zu:	TRAP	918	2318
068_lst-Zus	yellow	38.876	39.800	39.233	39.282	068_lst-Zu:	DRESS	878	2010
068_lst-Zus	hands	46.178	47.188	46.485	46.631	068_lst-Zu:	TRAP	1010	2064
068_lst-Zus	jacket	47.678	48.804	48.051	48.115	068_lst-Zu:	TRAP	656	1706
068_lst-Zus	arms	49.352	50.391	49.605	49.824	068_lst-Zu:	START	976	1444
068_lst-Zus	carrot	50.622	51.921	51.144	51.177	068_lst-Zu:	TRAP	851	2286
068_lst-Zus	legs	52.440	53.450	52.707	52.829	068_lst-Zu:	DRESS	895	2403
068_lst-Zus	dress	55.413	56.538	55.785	55.872	068_lst-Zu:	DRESS	743	2020
068_lst-Zus	cap	57.018	57.826	57.400	57.487	068_lst-Zu:	TRAP	892	2442
068_lst-Zus	cat	58.288	59.413	58.715	58.856	068_lst-Zu:	TRAP	805	2501

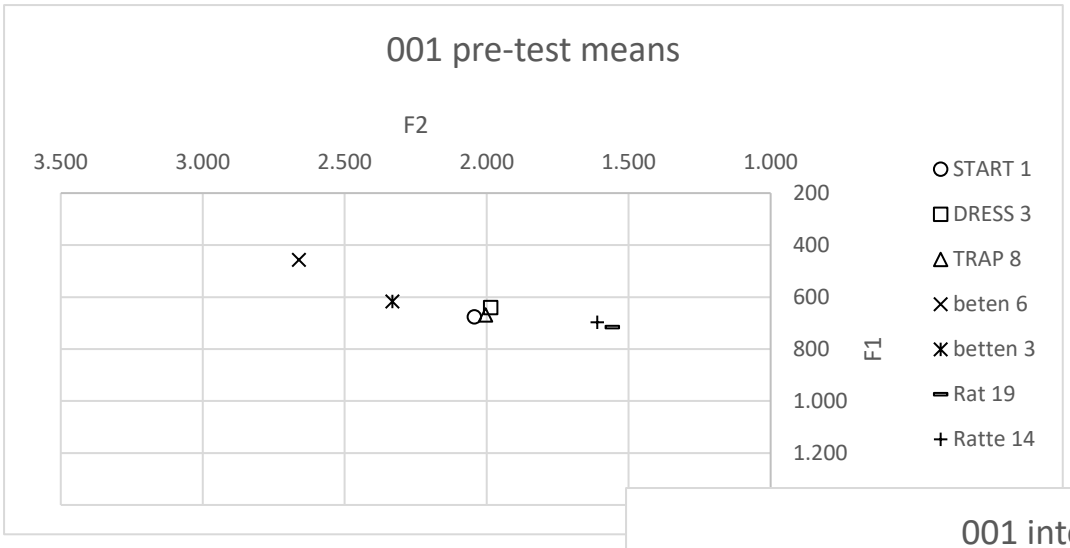
PALM	1078	1814	beten 8	419	3008
			betten 1	605	2019
DRESS 9	675	2109	Rat 8	899	1595
	668	2011	Ratte 8	837	1966
	717	2254	bäten 4	838	2449
	879	2130			
	742	1661			
	864	2267			
	878	2010			
	895	2403			
	743	2020			
	784,5556	2096,111			
START 2	1050	1828			
	976	1444			
Mean	1013	1636			
TRAP 10	883	2211			
	898	2019			
	883	2036			
	679	2225			
	918	2318			
	1010	2064			
	656	1706			
	851	2286			
	892	2442			
	805	2501			
Mean	847,5	2180,8			
euclidean d	105,5188				





Analysis of TRAP

Vowel plots for participants of the intervention group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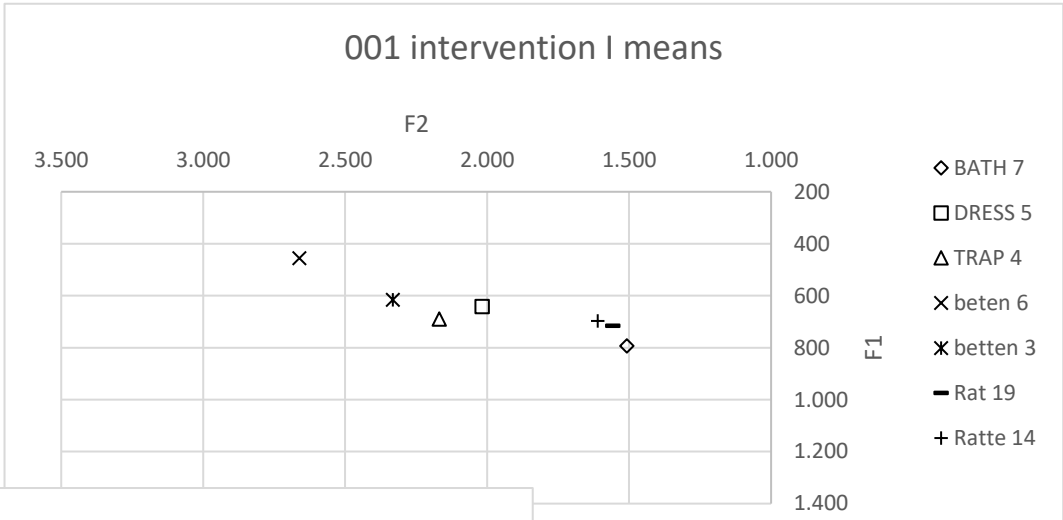
F2
3.500
3.000
2.500
2.000
1.500
1.000
200
400
600
800
1.000
1.200
F1
START 1
DRESS 3
TRAP 8
beten 6
betten 3
Rat 19
Ratte 14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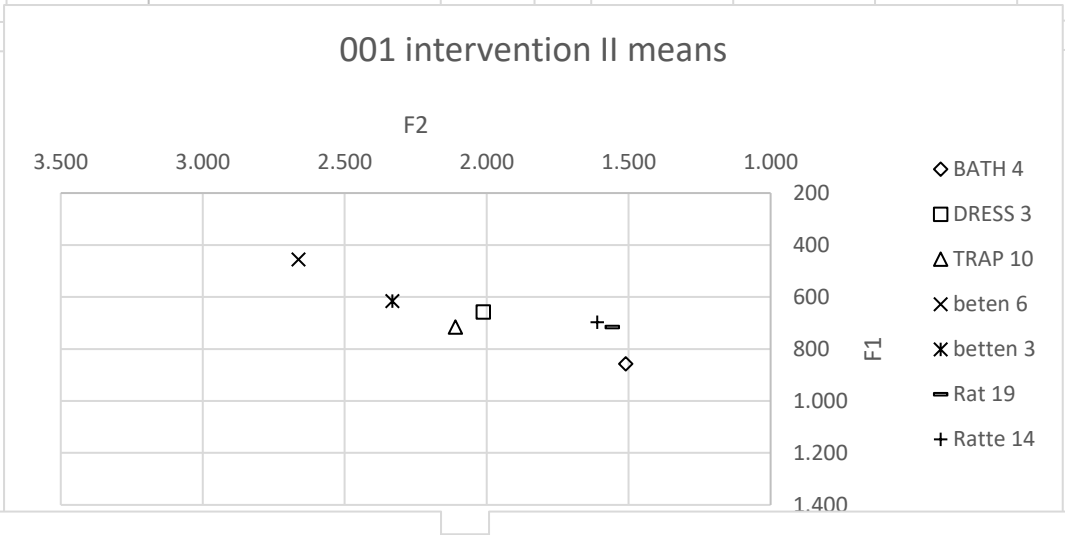
3.000
2.500
2.000
1.500
1.000
200
400
600
800
1.000
1.200
1.400
F1
BATH 7
DRESS 5
TRAP 4
beten 6
betten 3
Rat 19
Ratte 14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3.000
2.500
2.000
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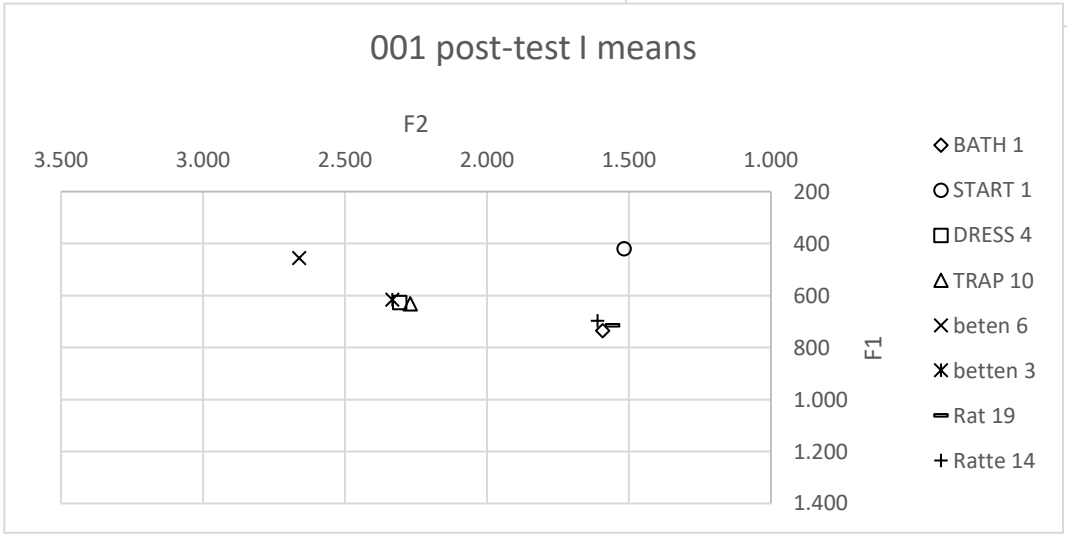
1.000
200
400
600
800
1.000
1.200
1.400
F1
BATH 4
DRESS 3
TRAP 10
beten 6
betten 3
Rat 19
Ratte 14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3.000
2.500
2.000
1.500
1.000
200
400
600
800
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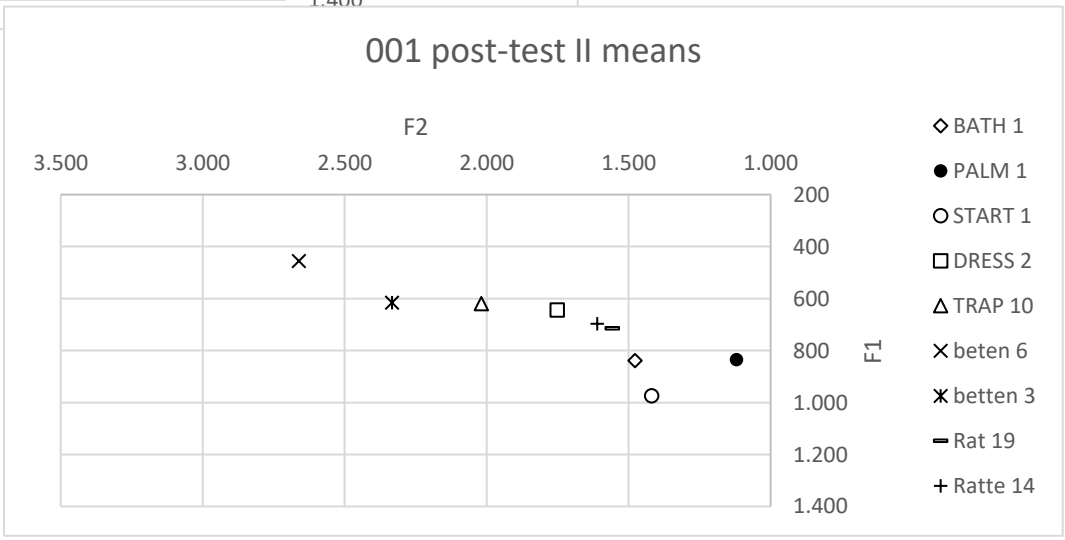
1.200
1.400
F1
BATH 1
START 1
DRESS 4
TRAP 10
beten 6
betten 3
Rat 19
Ratte 14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1.000
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400
600
800
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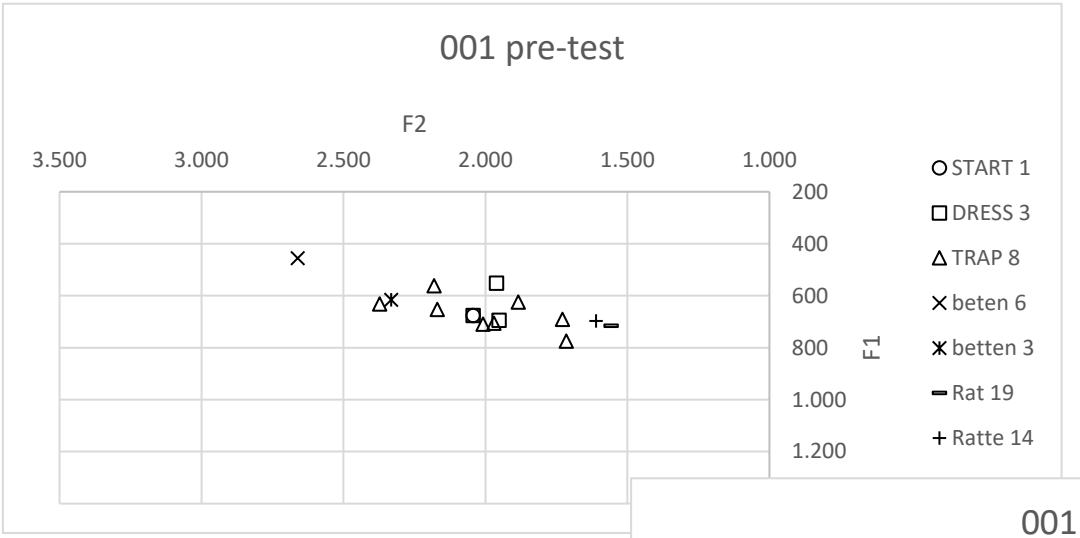
1.400
F1
BATH 1
PALM 1
START 1
DRESS 2
TRAP 10
beten 6
betten 3
Rat 19
Ratte 14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1.500
1.000
200
400
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800
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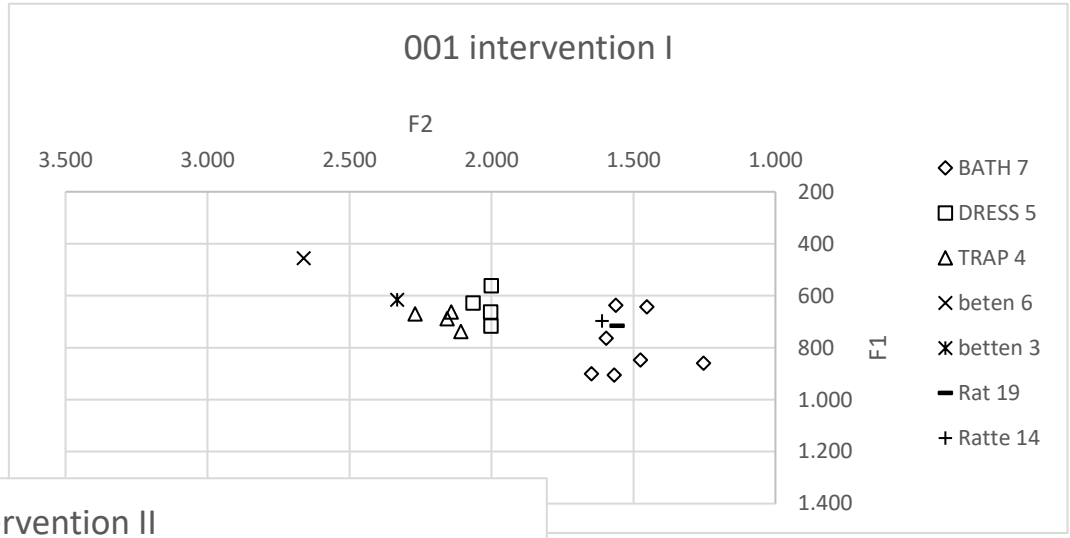
1.200
F1
START 1
DRESS 3
TRAP 8
beten 6
betten 3
Rat 19
Ratte 14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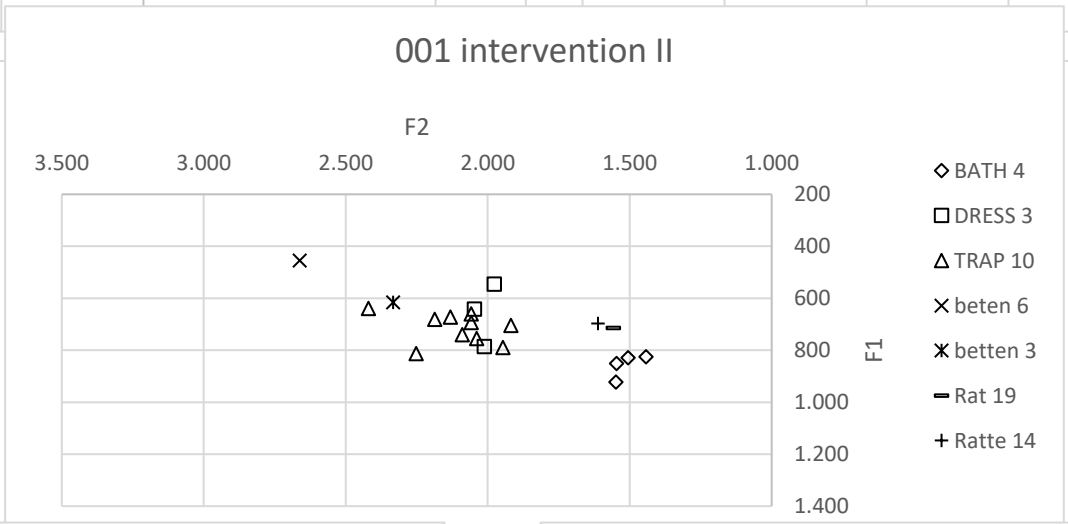
1.200
1.400
F1
BATH 7
DRESS 5
TRAP 4
beten 6
betten 3
Rat 19
Ratte 14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2.500
2.000
1.500
1.000
200
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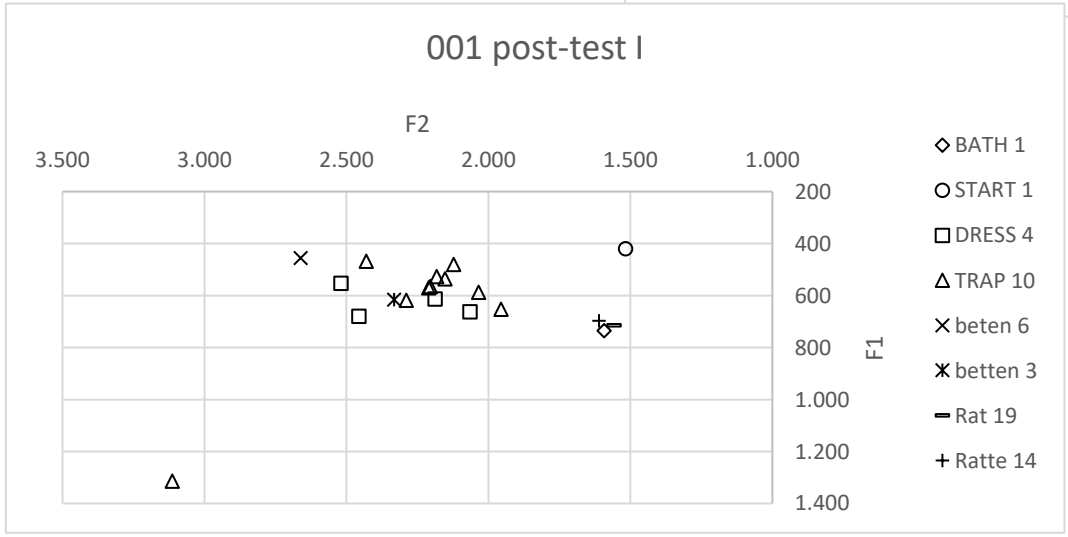
1.400
F1
BATH 4
DRESS 3
TRAP 10
beten 6
betten 3
Rat 19
Ratte 14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400
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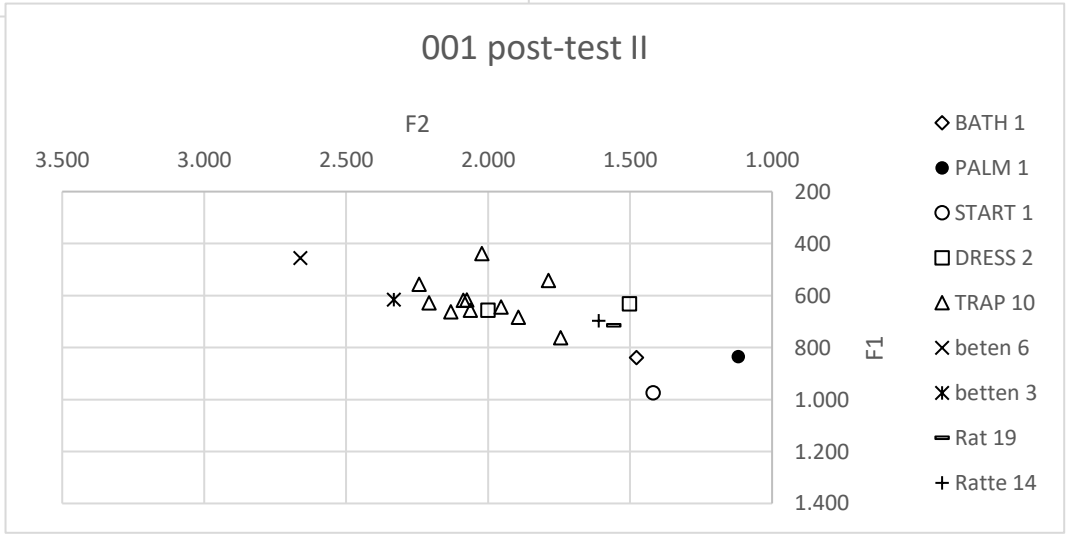
1.400
F1
BATH 1
START 1
DRESS 4
TRAP 10
beten 6
betten 3
Rat 19
Ratte 14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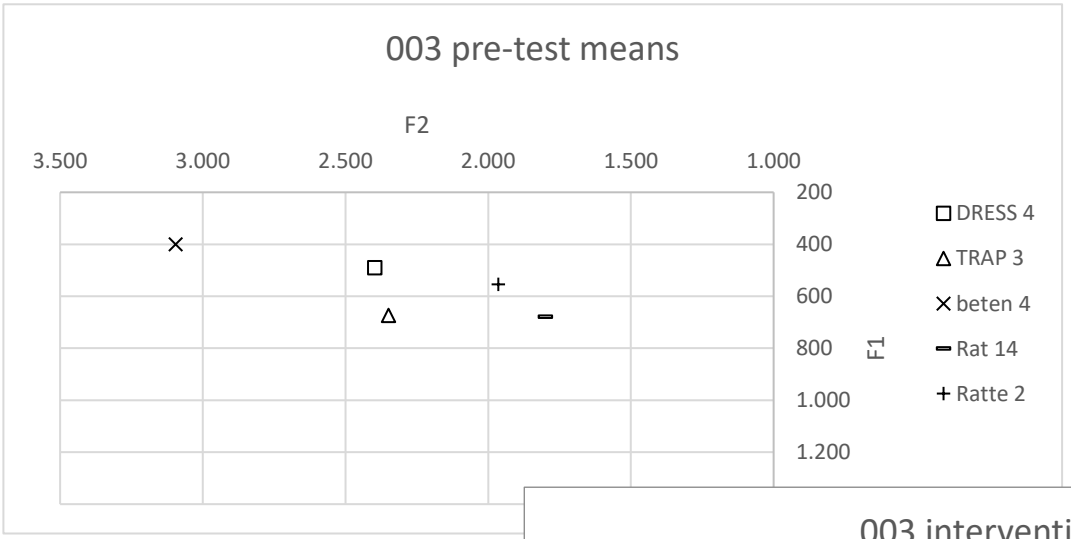
2.000
1.500
1.000
200
400
600
800
1.000
1.200
1.400
F1
BATH 1
PALM 1
START 1
DRESS 2
TRAP 10
beten 6
betten 3
Rat 19
Ratte 14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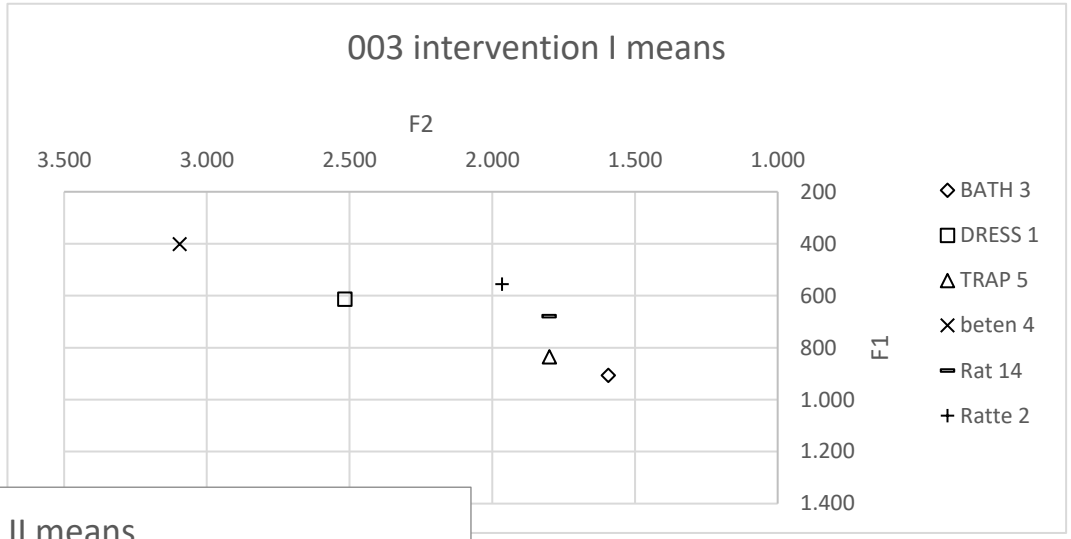
DRESS 4
TRAP 3
beten 4
Rat 14
Ratte 2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DRESS 1
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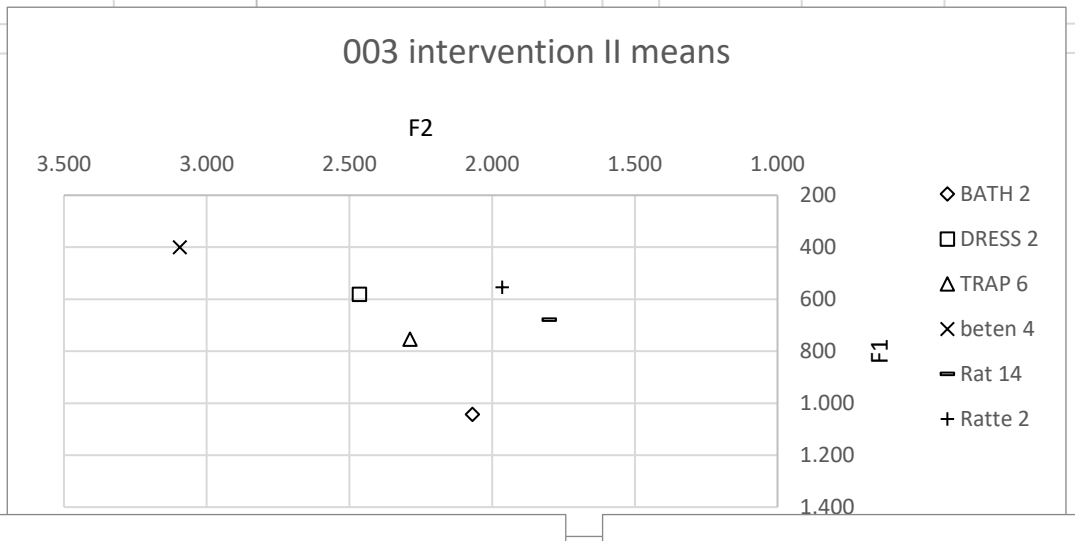
beten 4
Rat 14
Ratte 2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DRESS 2
TRAP 6
beten 4
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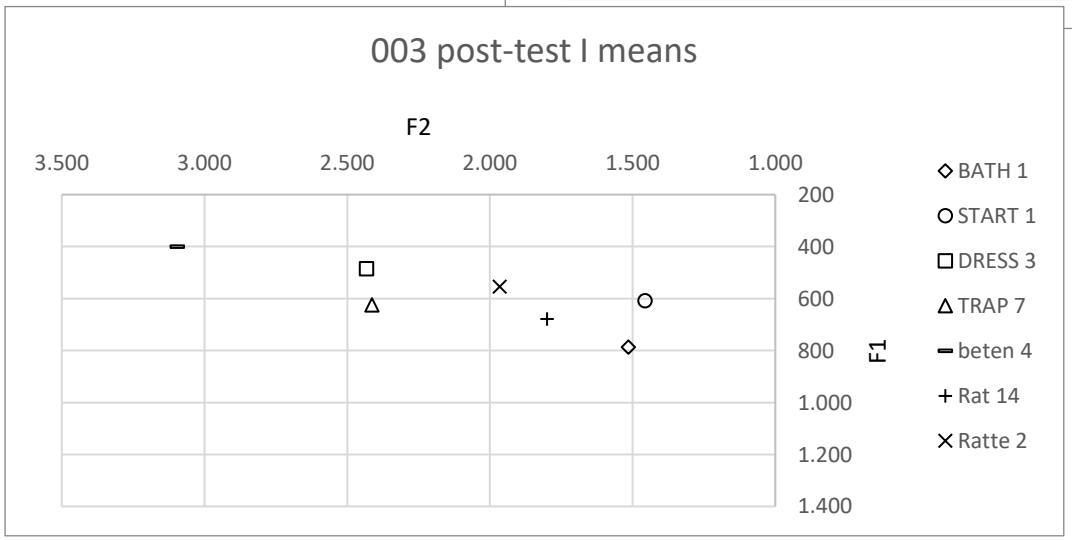
Ratte 2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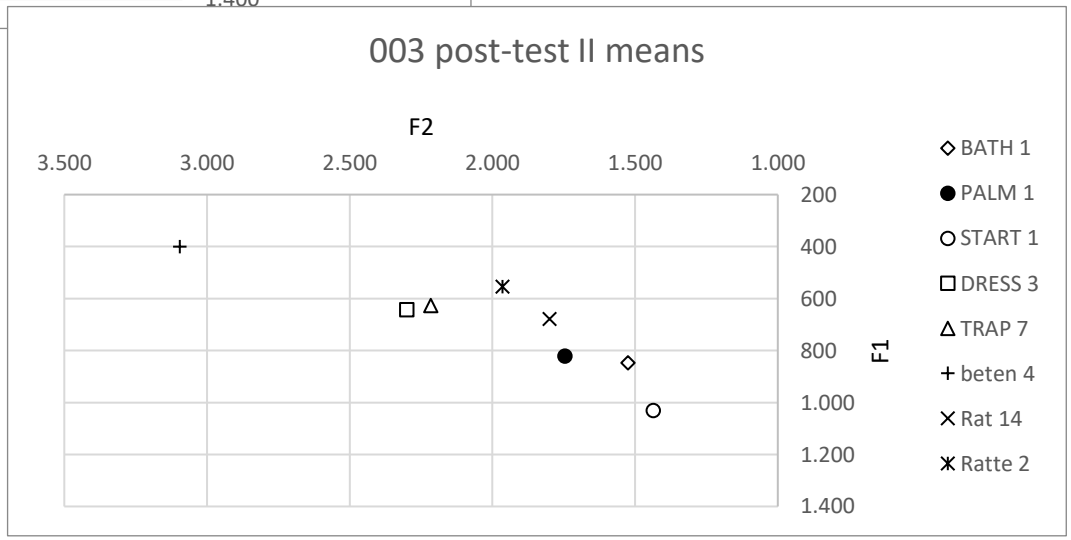
START 1
DRESS 3
TRAP 7
beten 4
Rat 14
Ratte 2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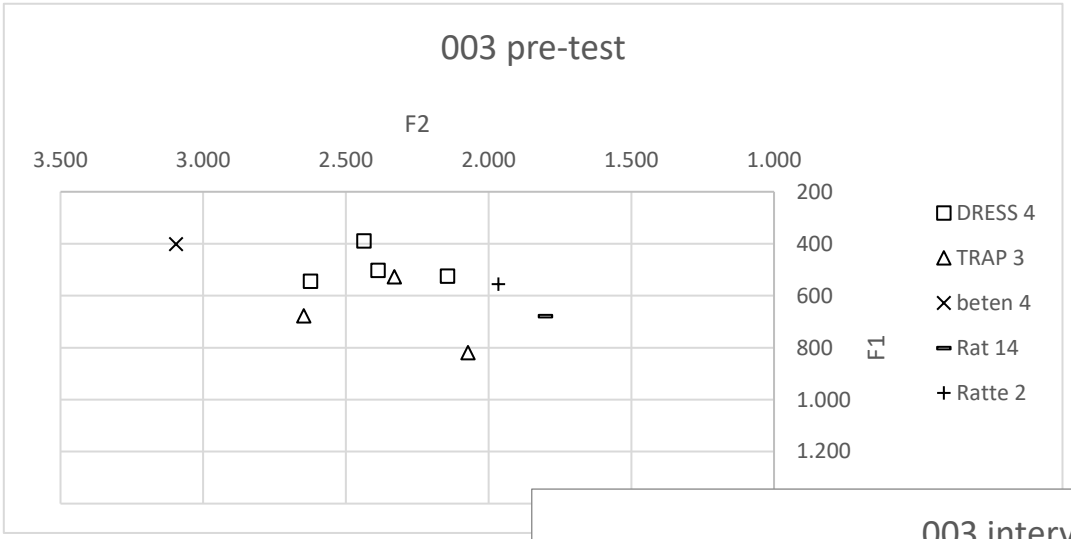
PALM 1
START 1
DRESS 3
TRAP 7
beten 4
Rat 14
Ratte 2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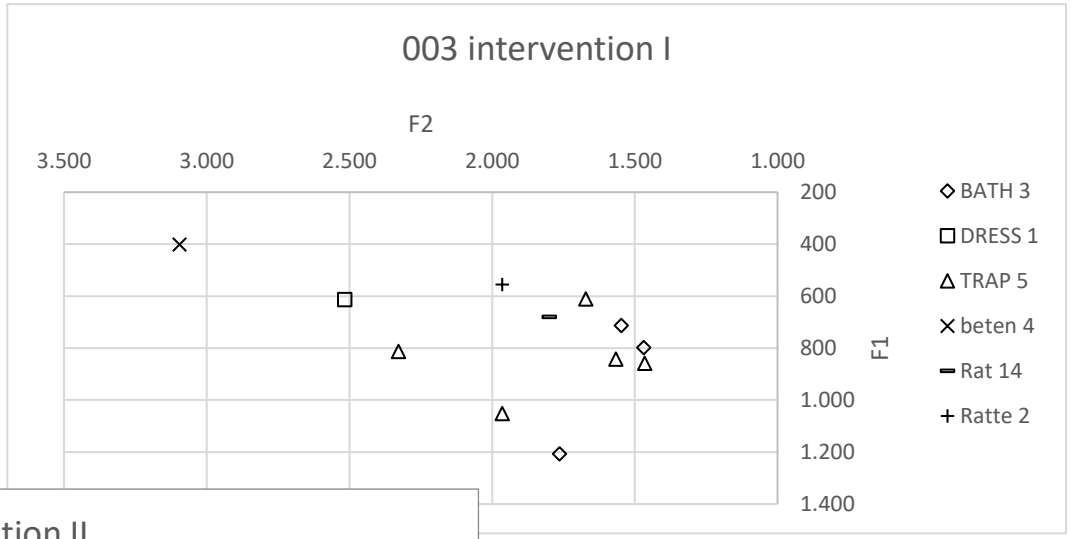
TRAP 3
beten 4
Rat 14
Ratte 2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DRESS 1
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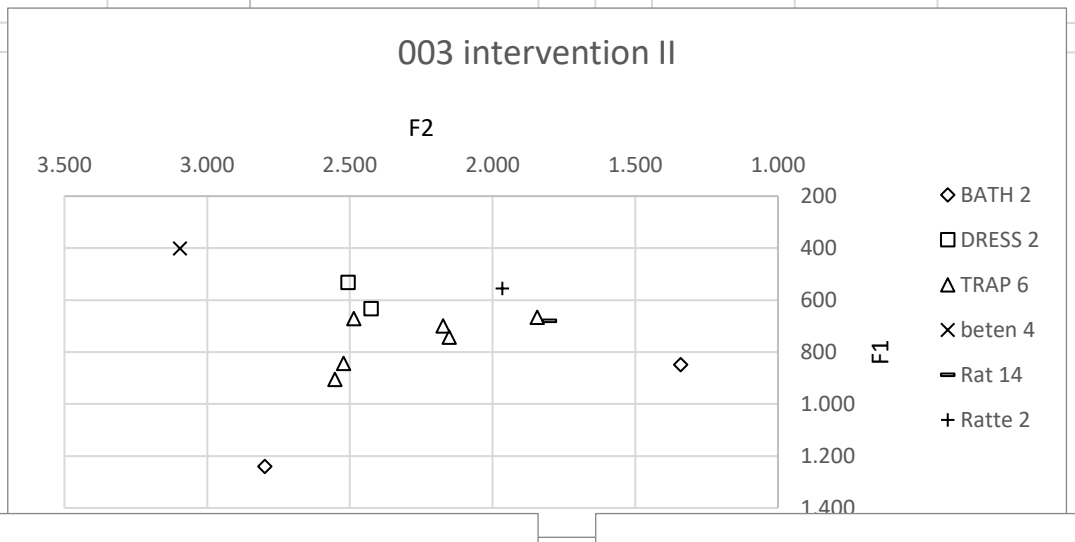
Ratte 2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DRESS 2
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Rat 14
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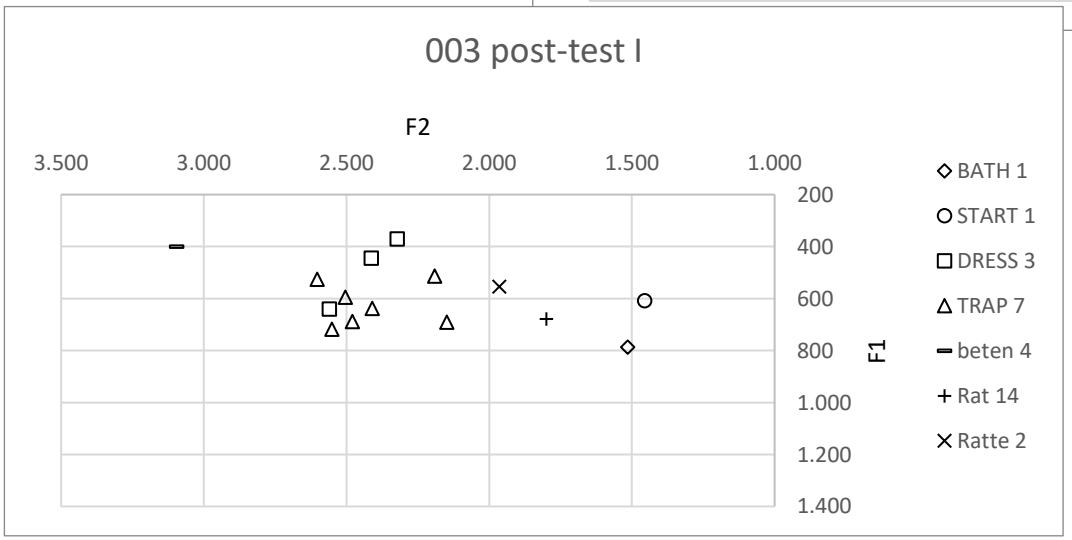
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DRESS 3
TRAP 7
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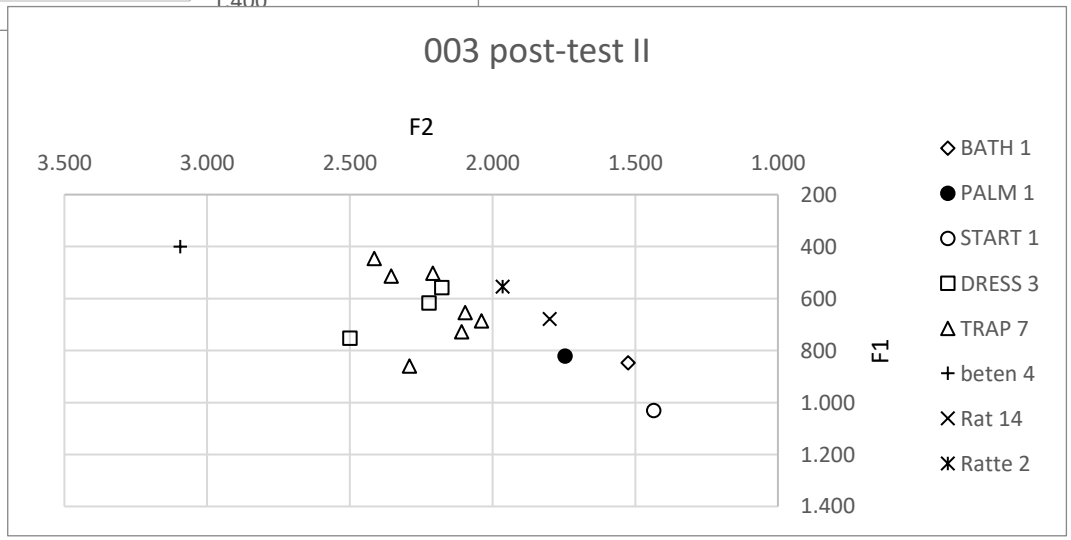
Rat 14
Ratte 2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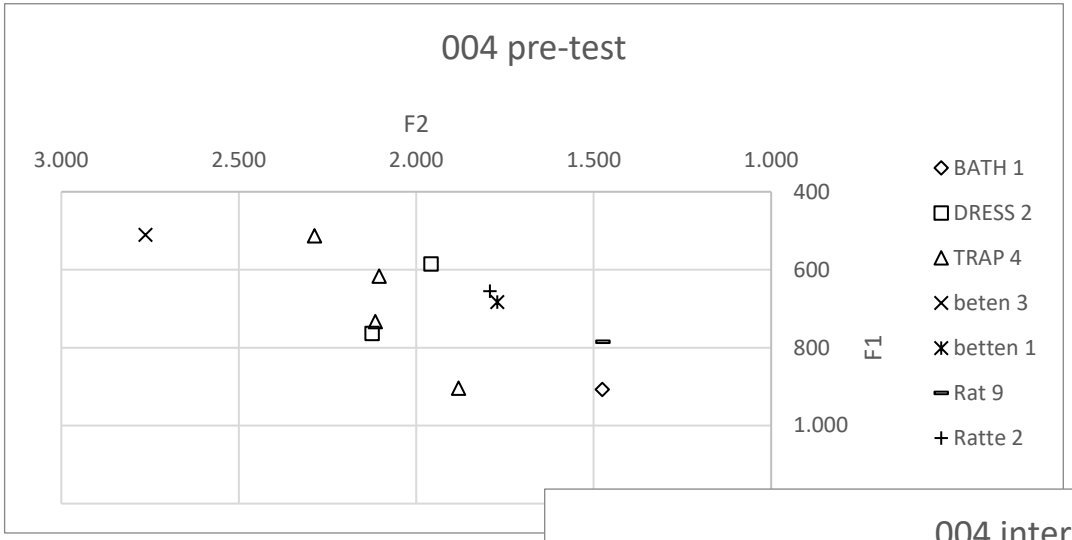
PALM 1
START 1
DRESS 3
TRAP 7
beten 4
Rat 14
Ratte 2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TRAP 4
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betten 1
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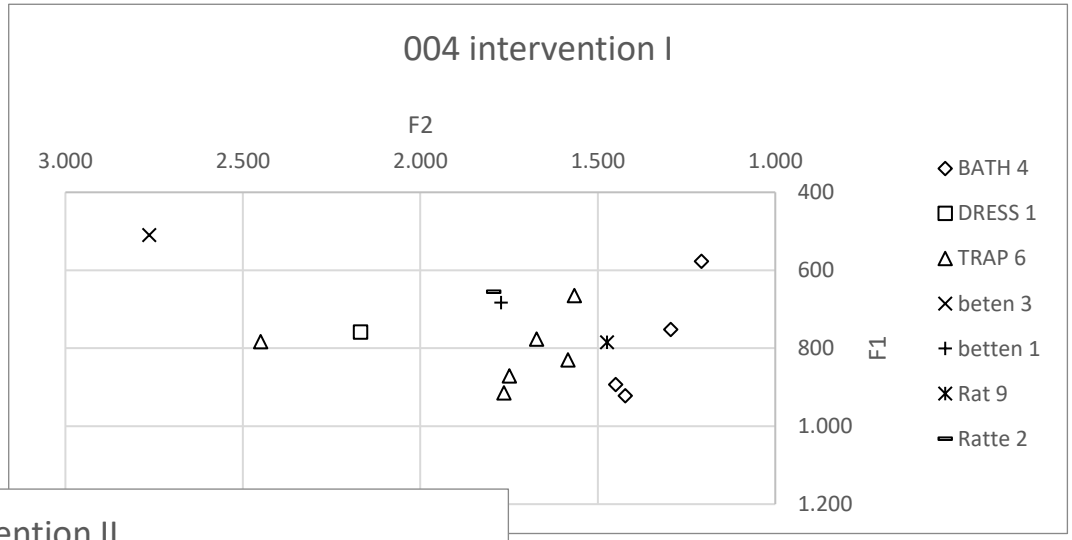
Ratte 2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TRAP 6
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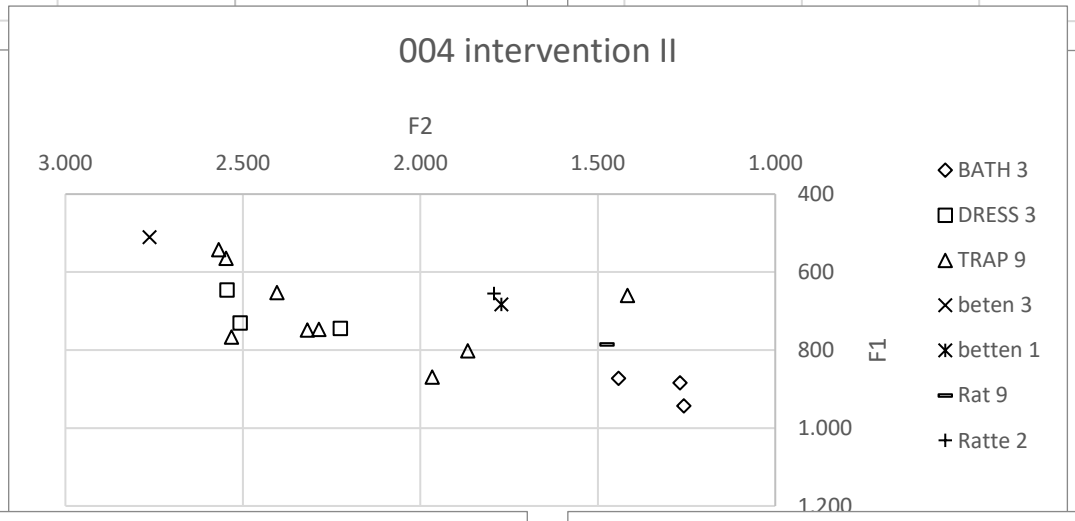
betten 1
Rat 9
Ratte 2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TRAP 9
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betten 1
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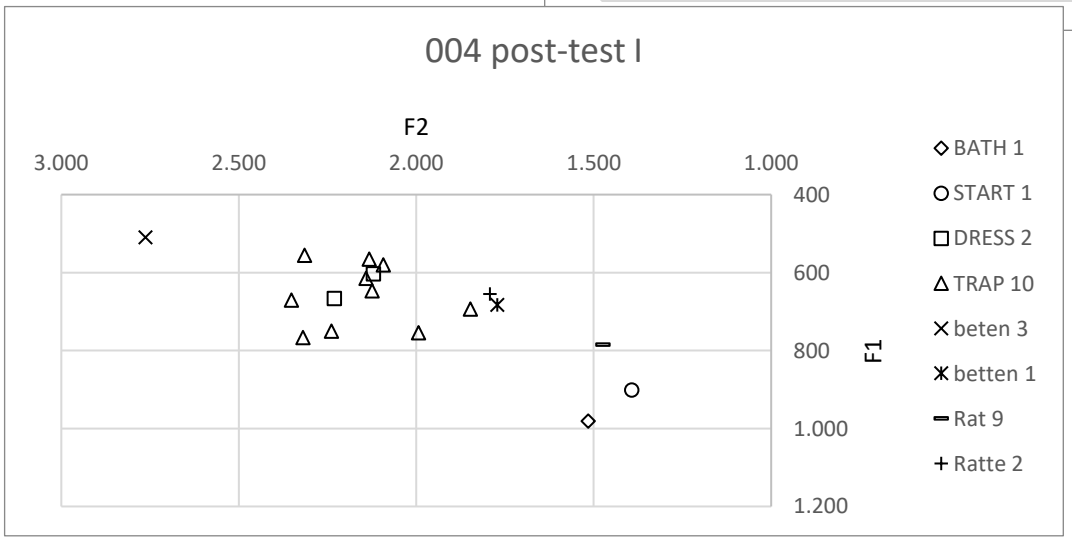
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START 1
DRESS 2
TRAP 10
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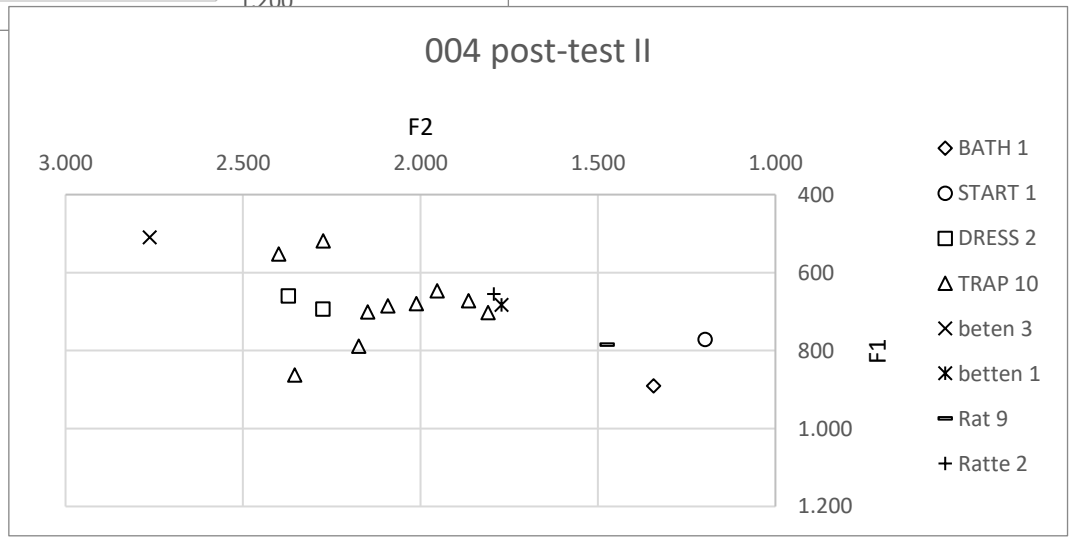
betten 1
Rat 9
Ratte 2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START 1
DRESS 2
TRAP 10
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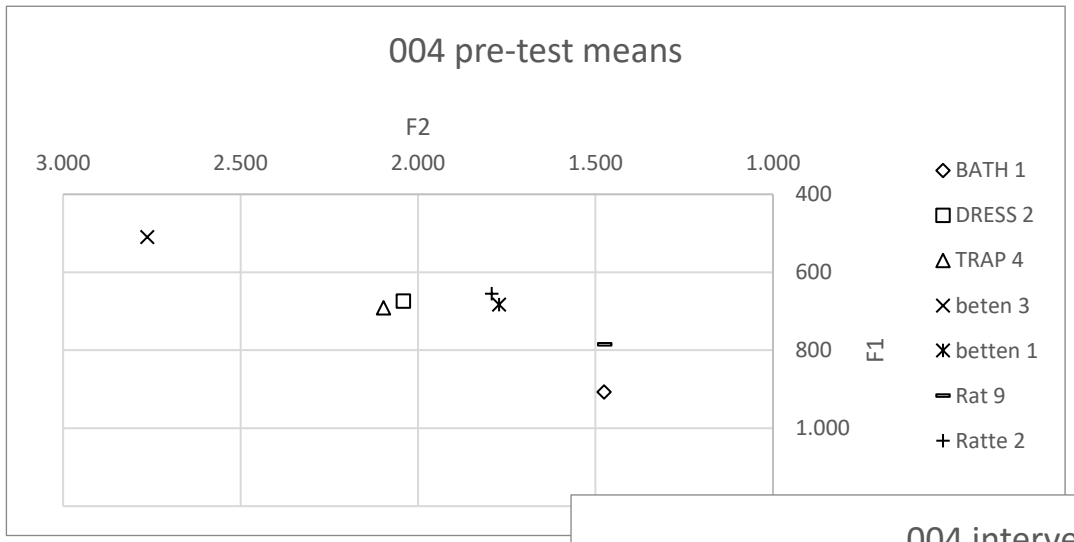
betten 1
Rat 9
Ratte 2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TRAP 4
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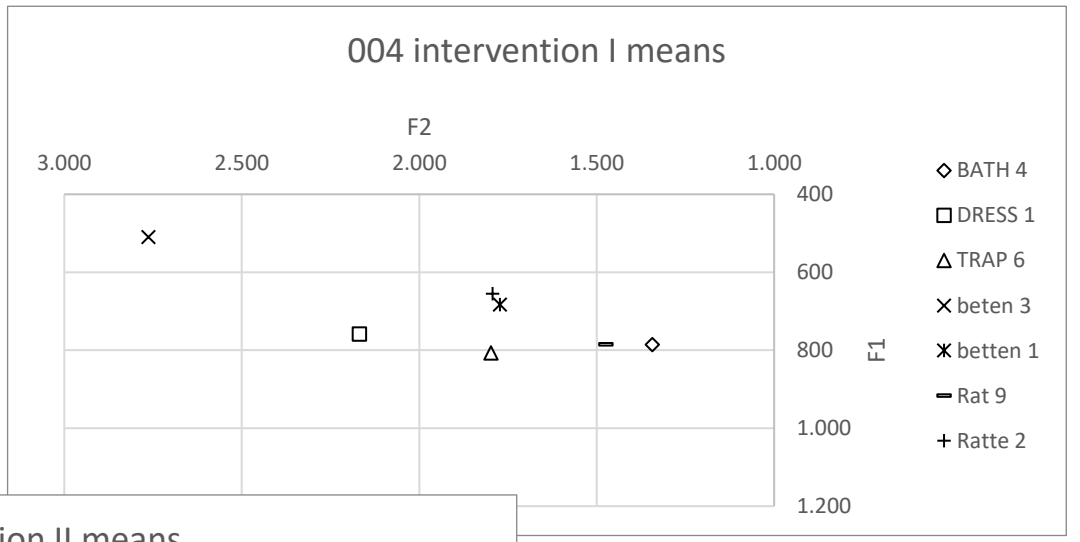
betten 1
Rat 9
Ratte 2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TRAP 6
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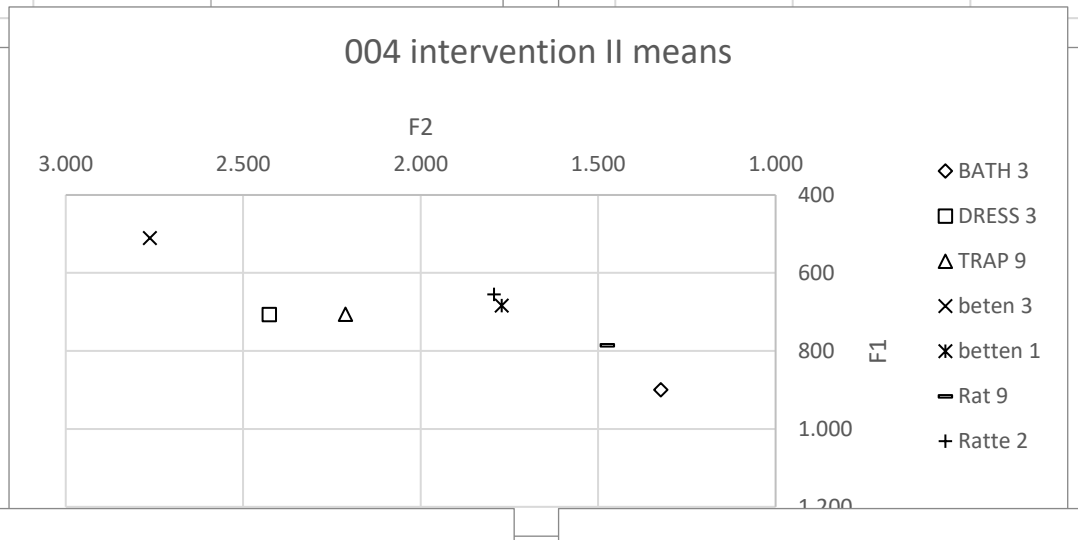
betten 1
Rat 9
Ratte 2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TRAP 9
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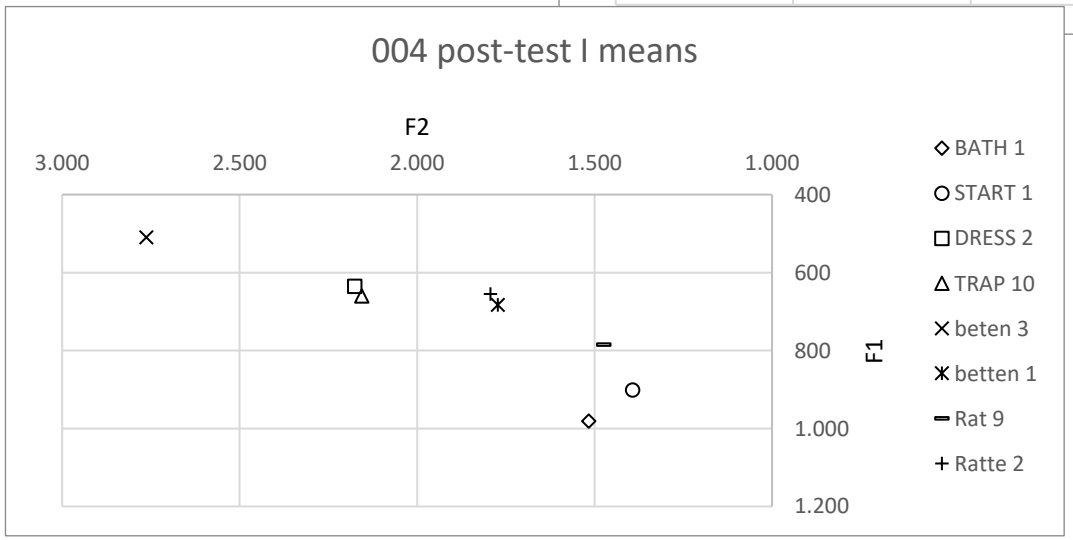
Rat 9
Ratte 2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DRESS 2
TRAP 10
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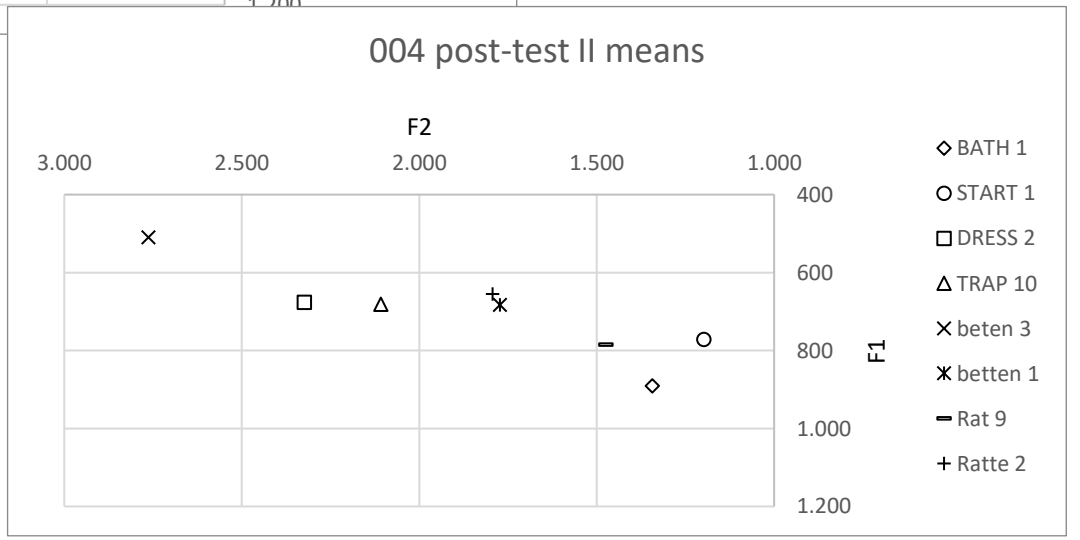
betten 1
Rat 9
Ratte 2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DRESS 2
TRAP 10
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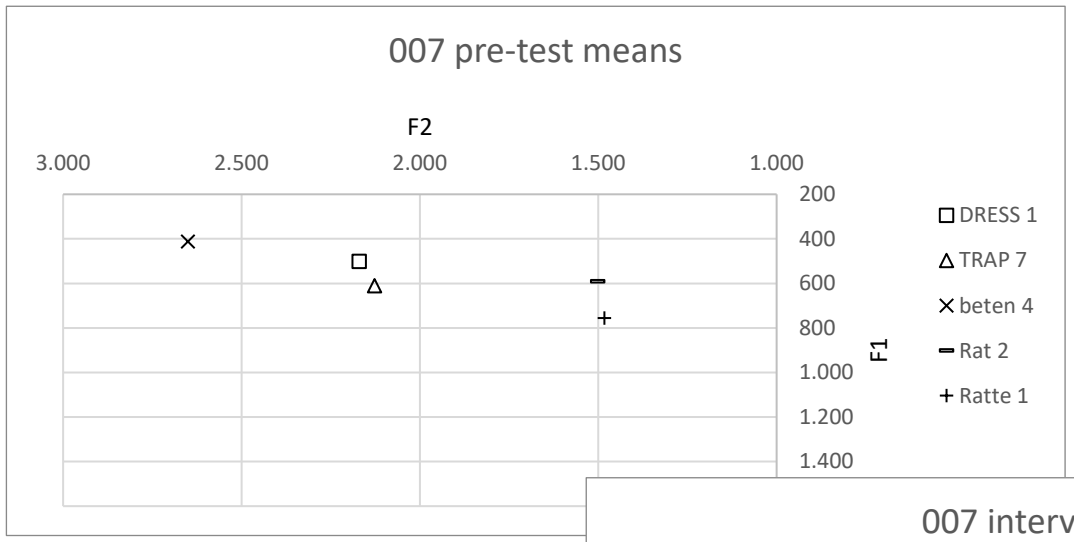
betten 1
Rat 9
Ratte 2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TRAP 7
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Rat 2
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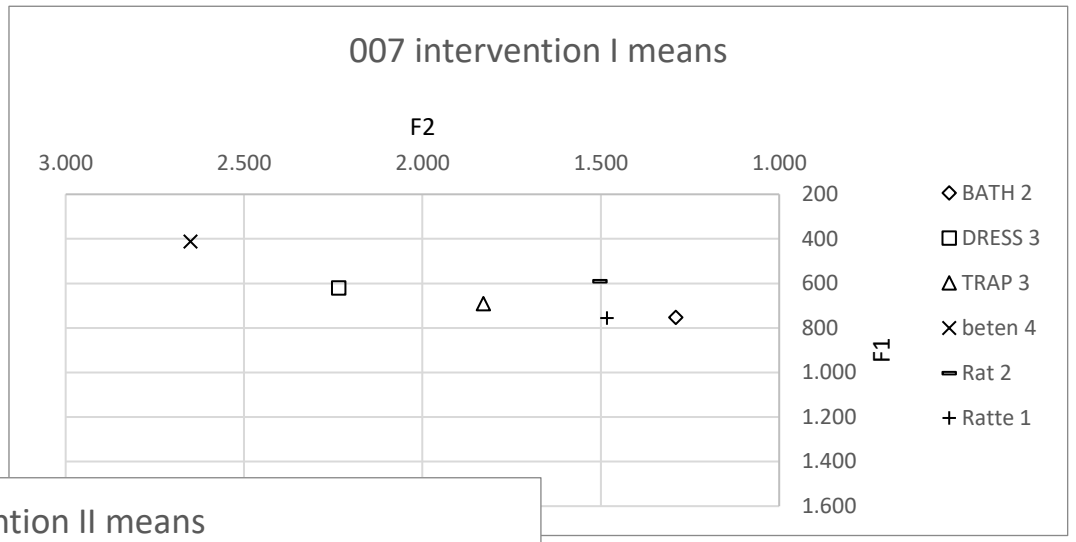
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DRESS 3
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Rat 2
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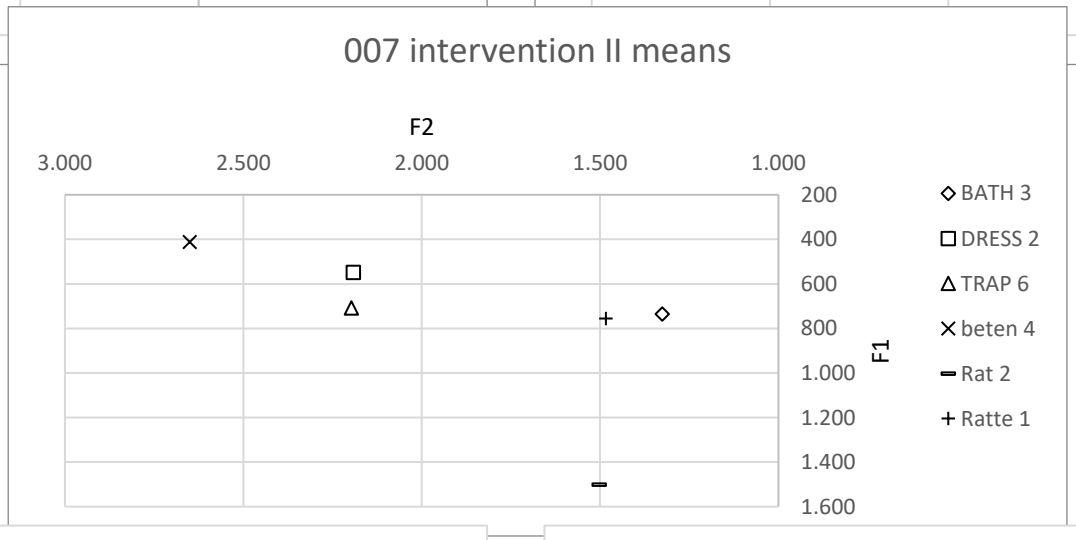
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DRESS 2
TRAP 6
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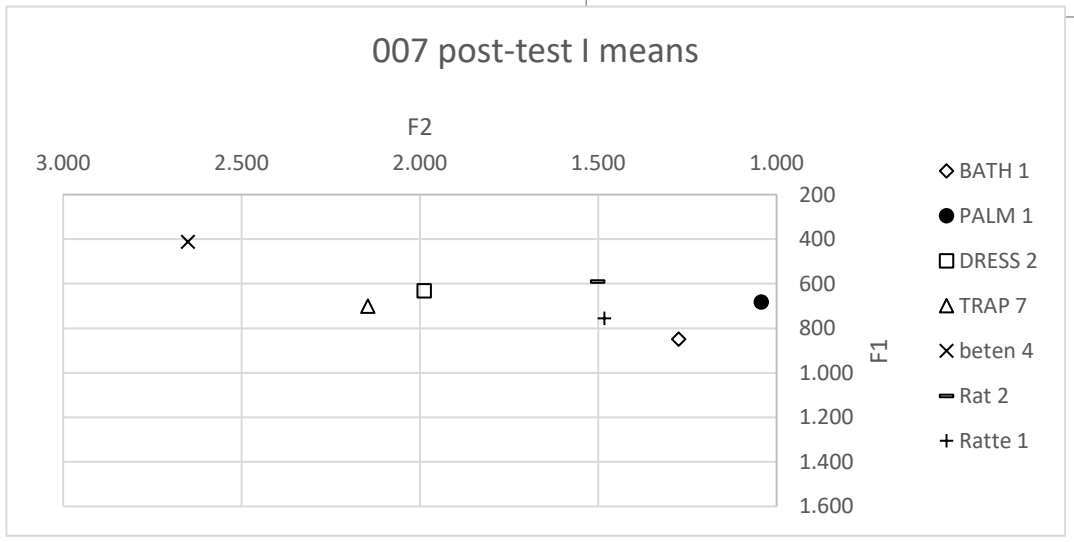
Rat 2
Ratte 1


007 post-test I means
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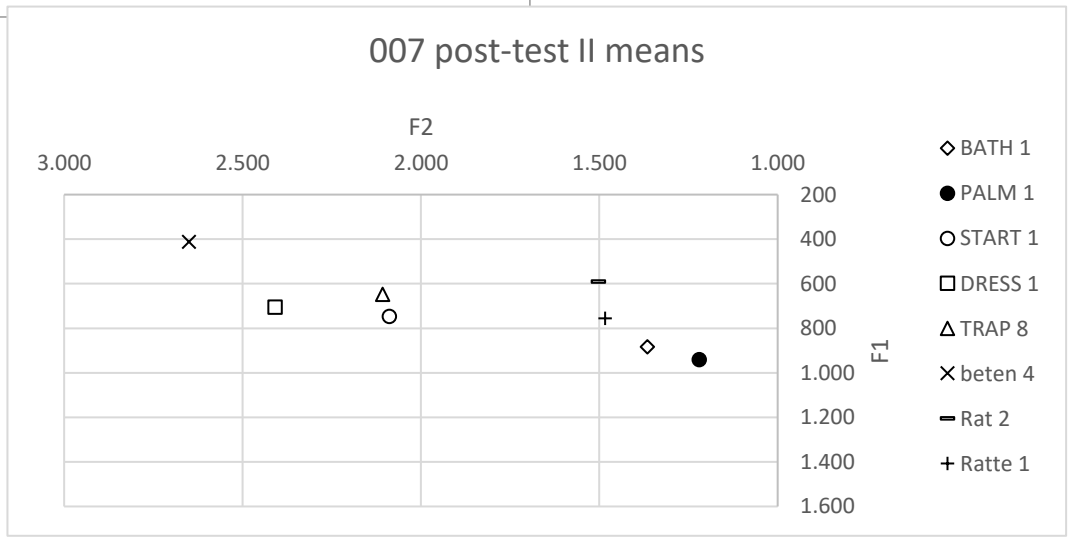
PALM 1
DRESS 2
TRAP 7
beten 4
Rat 2
Ratte 1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800
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PALM 1
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DRESS 1
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Rat 2
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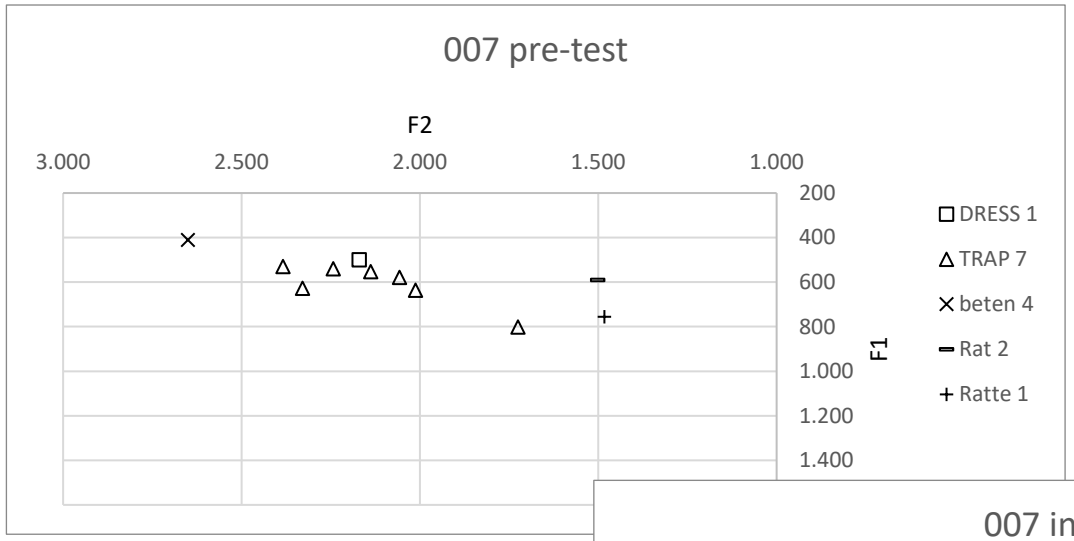
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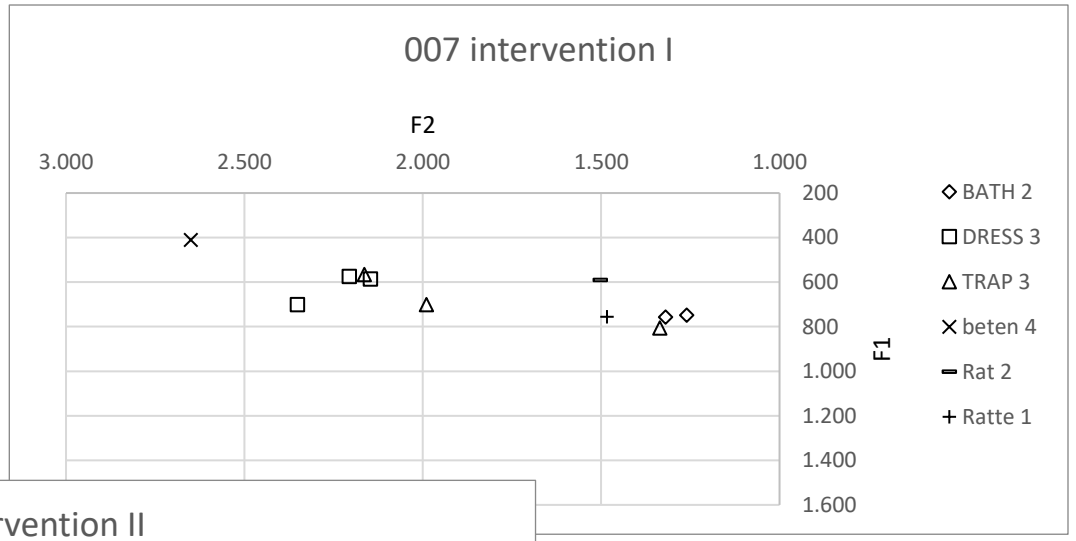
DRESS 1
TRAP 7
beten 4
Rat 2
Ratte 1


007 intervention I
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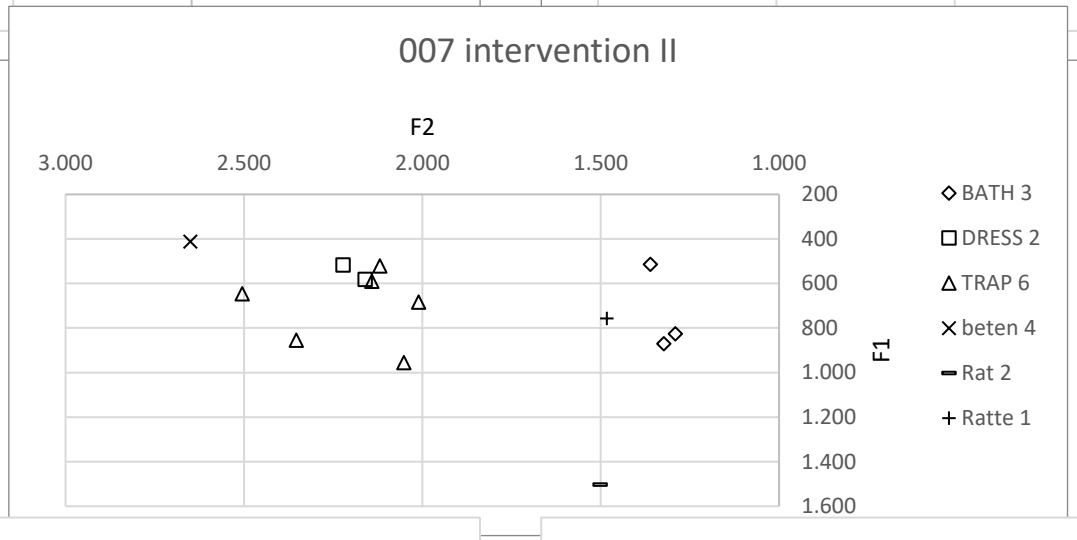
DRESS 3
TRAP 3
beten 4
Rat 2
Ratte 1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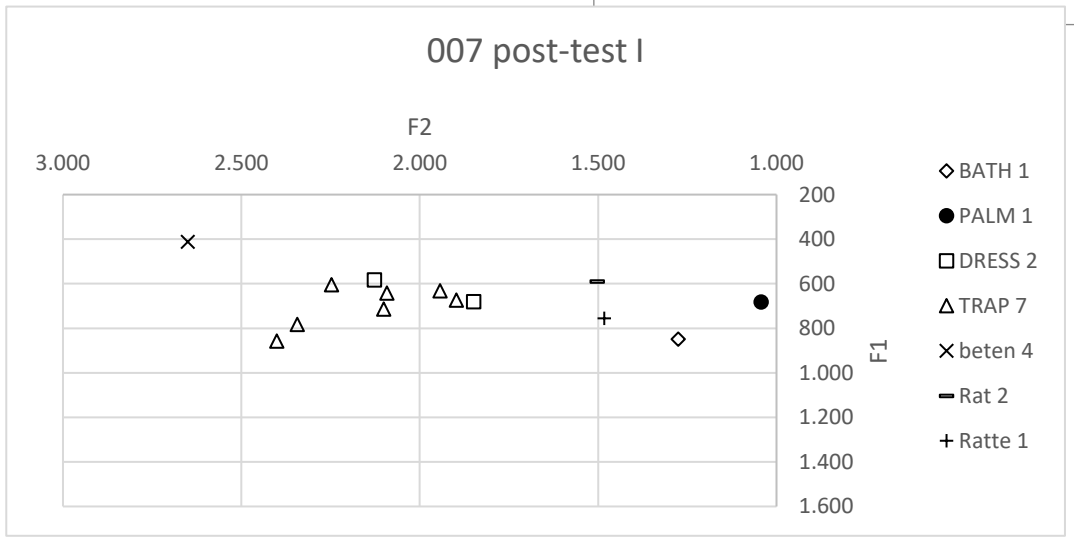
DRESS 2
TRAP 6
beten 4
Rat 2
Ratte 1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PALM 1
DRESS 2
TRAP 7
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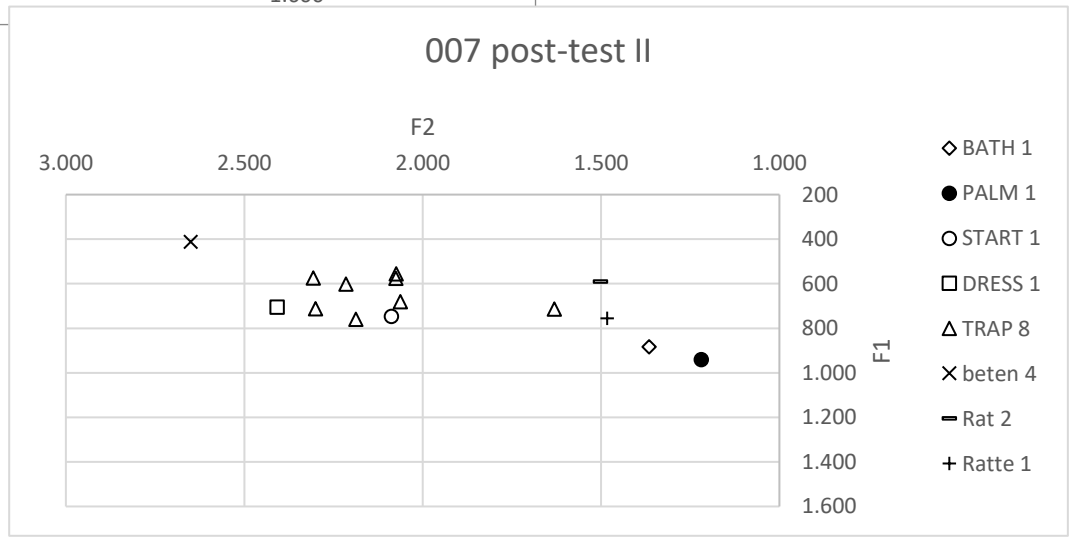
Rat 2
Ratte 1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PALM 1
START 1
DRESS 1
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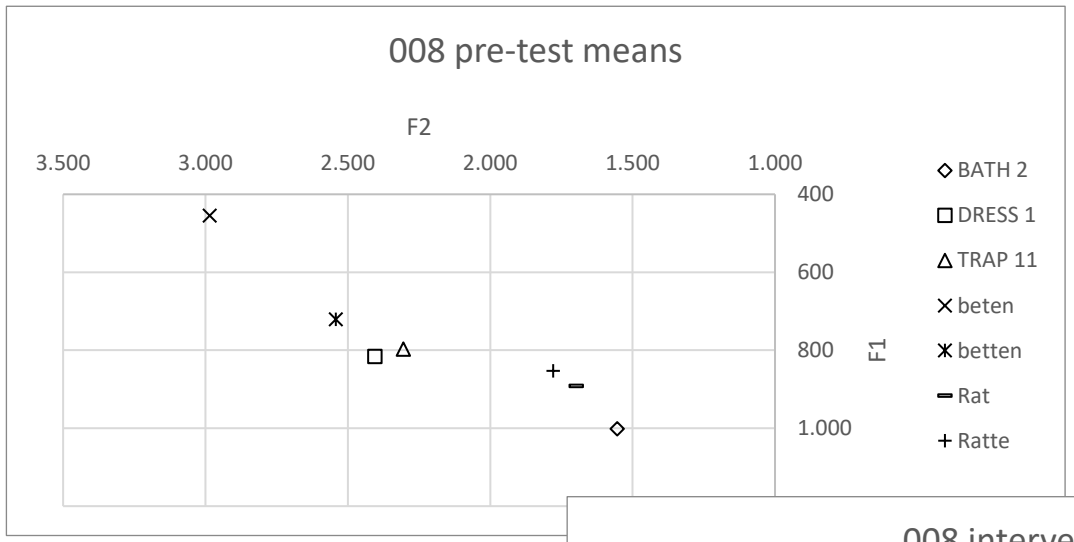
beten 4
Rat 2
Ratte 1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DRESS 1
TRAP 11
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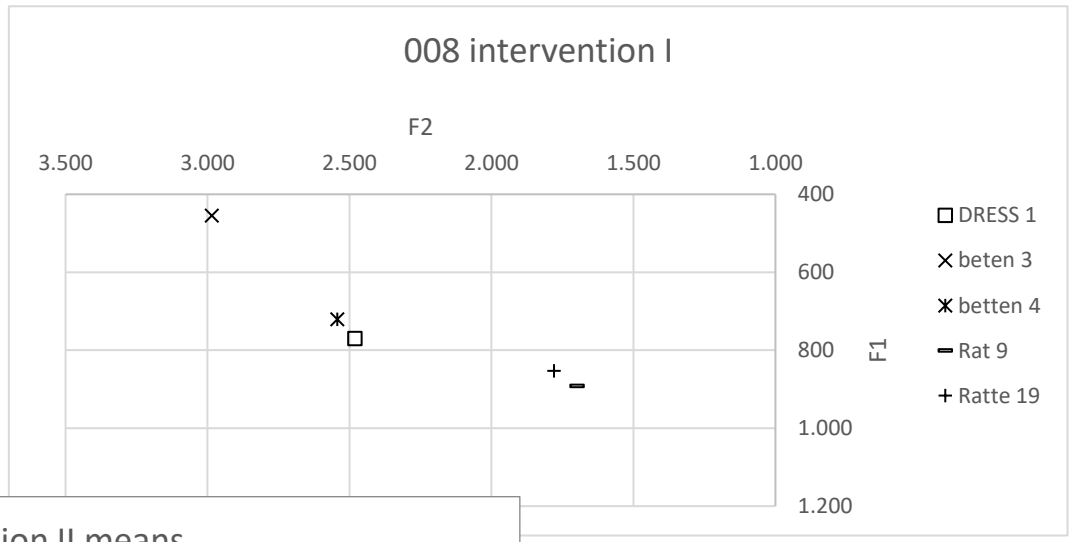
betten
Rat
Ratte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DRESS 1
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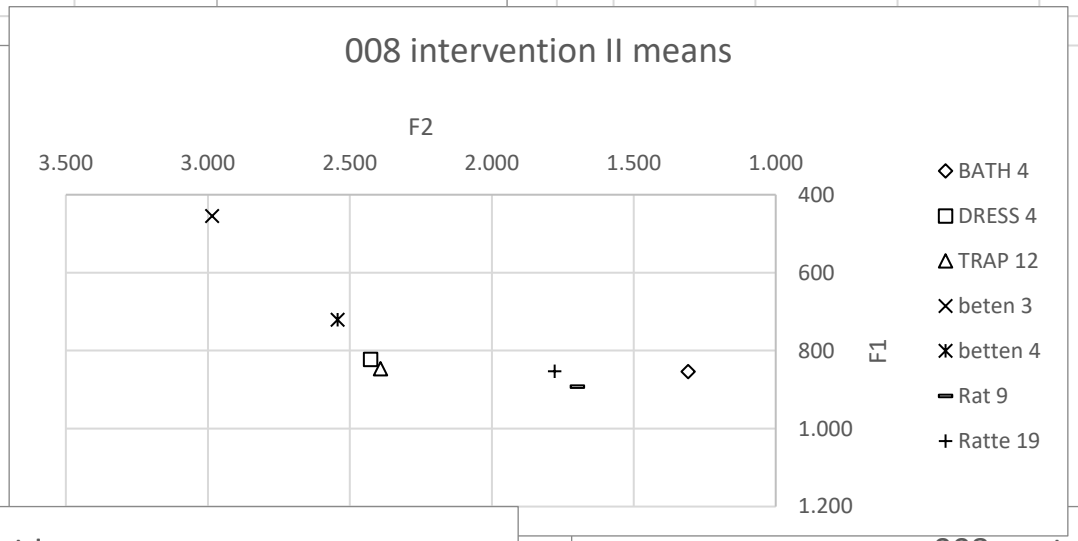
betten 4
Rat 9
Ratte 19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DRESS 4
TRAP 12
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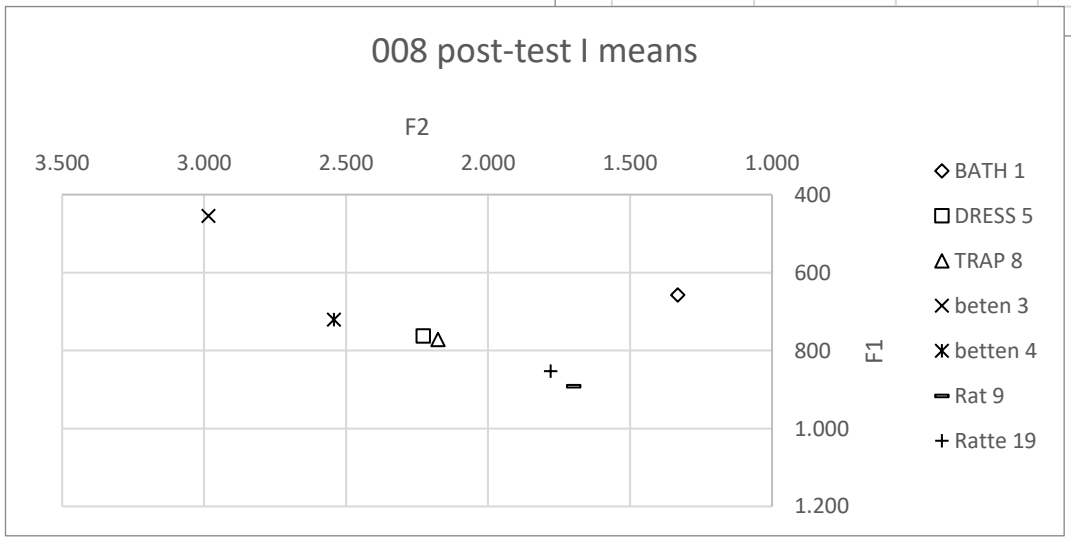
betten 4
Rat 9
Ratte 19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1.200
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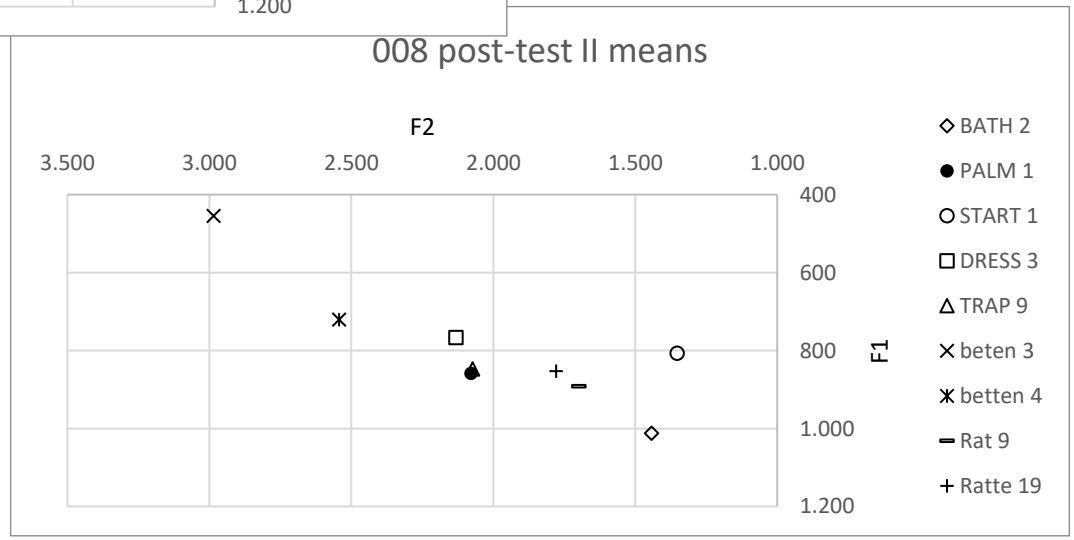
DRESS 5
TRAP 8
beten 3
betten 4
Rat 9
Ratte 19


008 post-test II means
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1.000
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600
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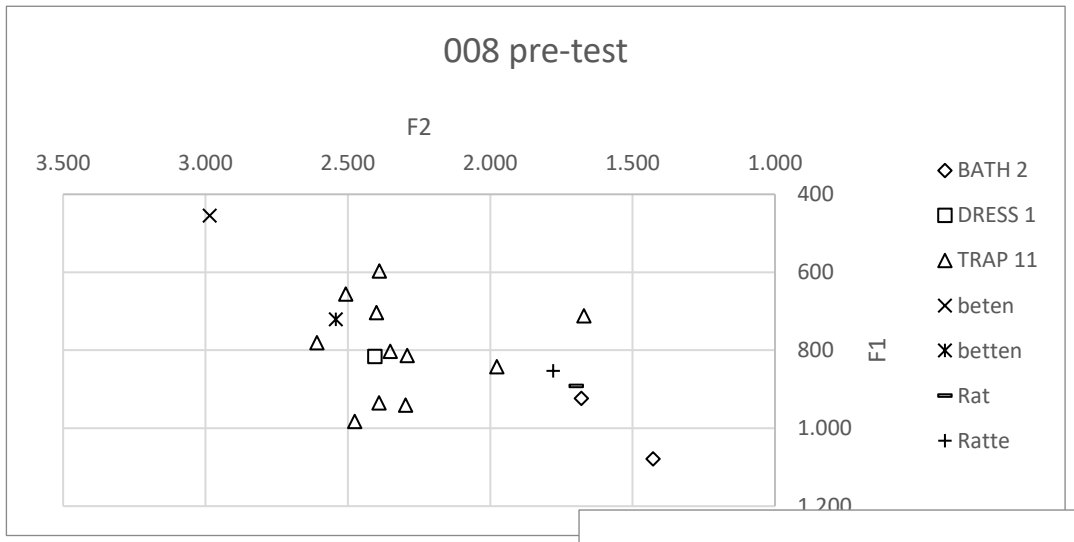
PALM 1
START 1
DRESS 3
TRAP 9
beten 3
betten 4
Rat 9
Ratte 19


008 pre-test
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2.000
1.500
1.000
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600
800
1.000
1.200
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BATH 2
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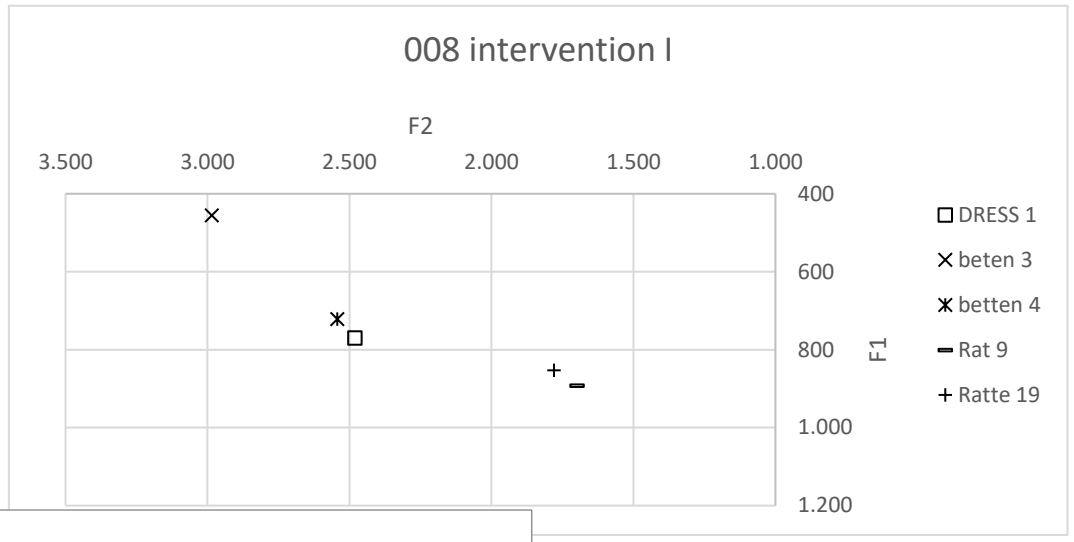
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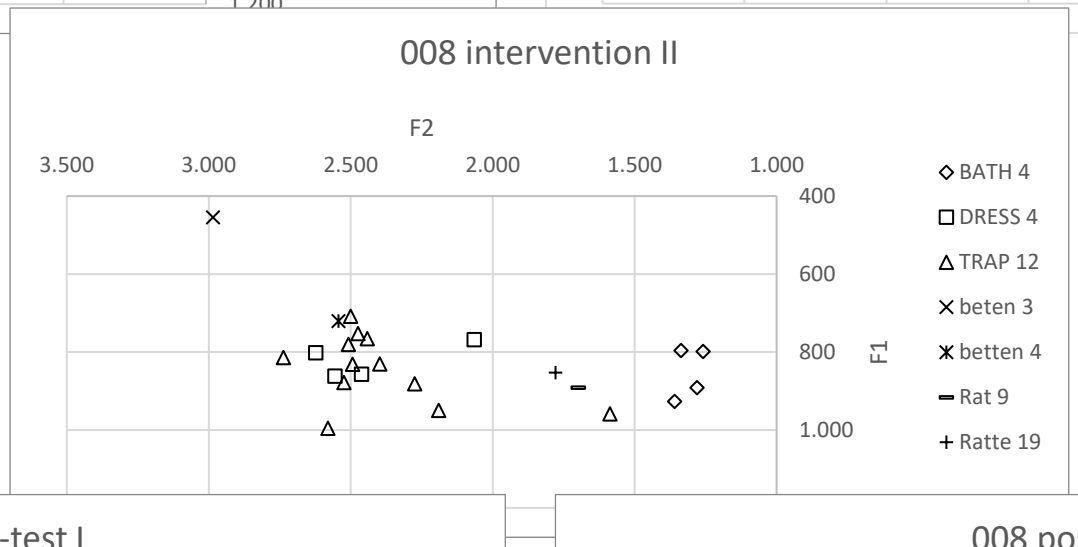
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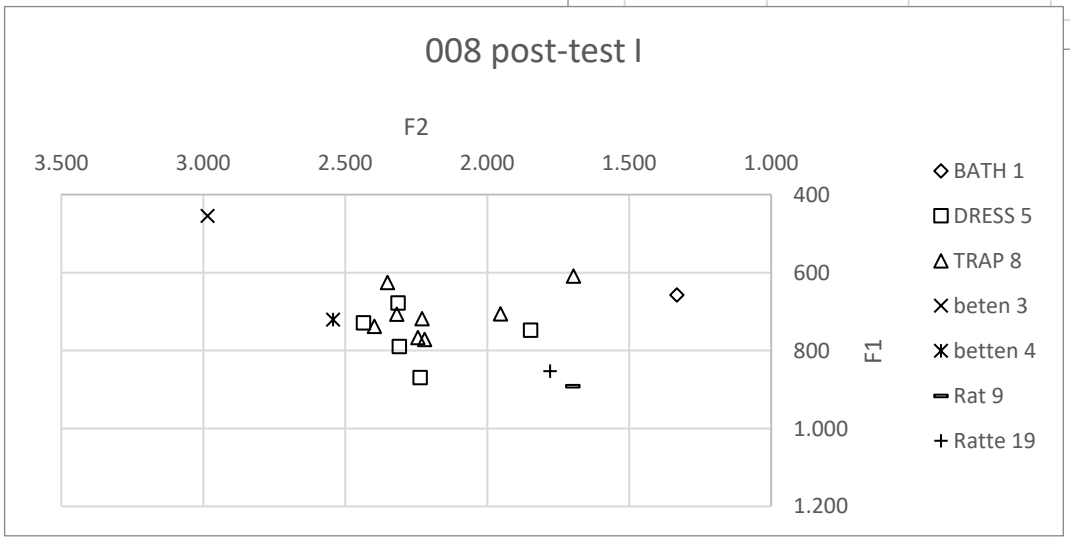
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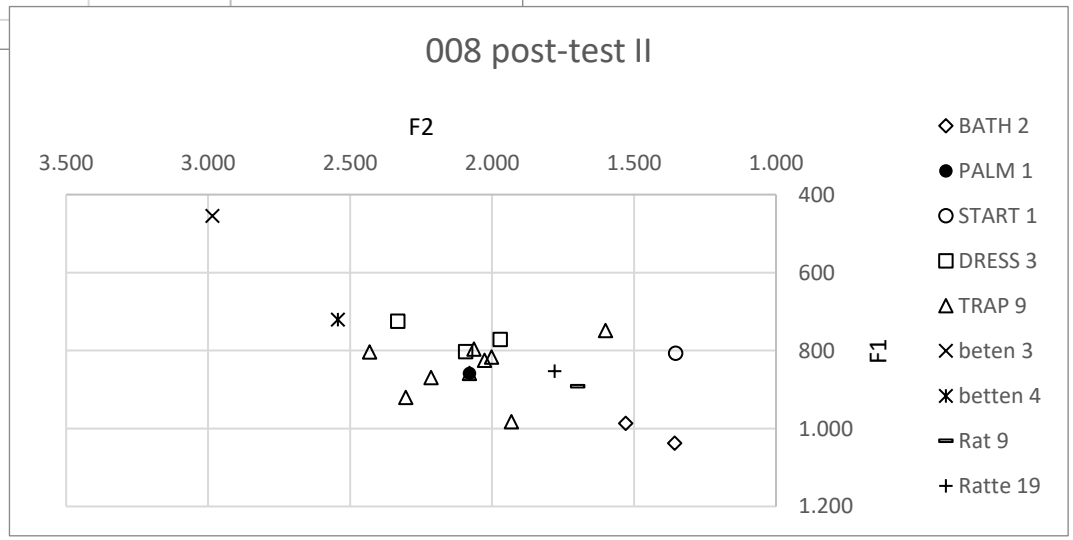
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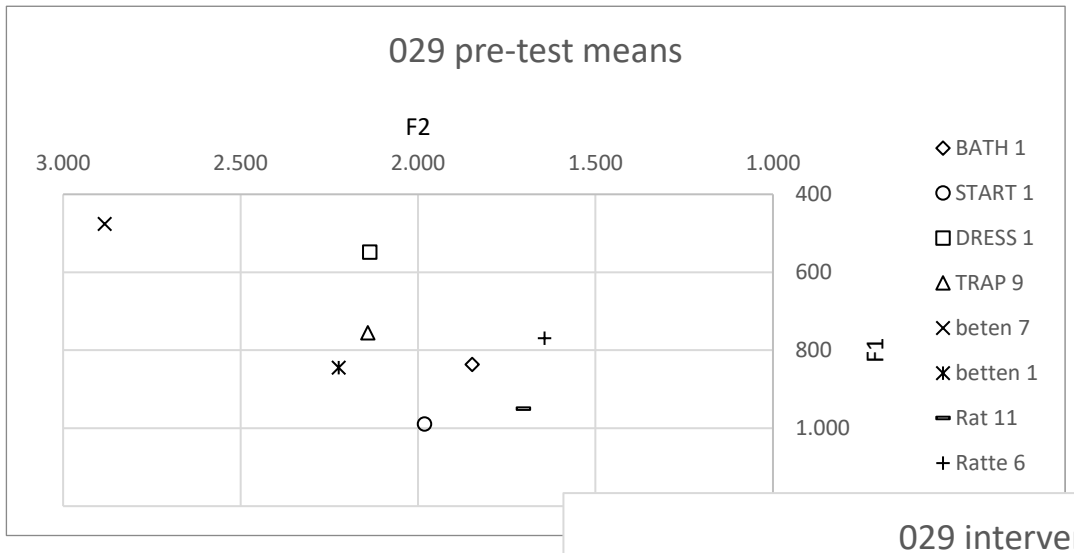
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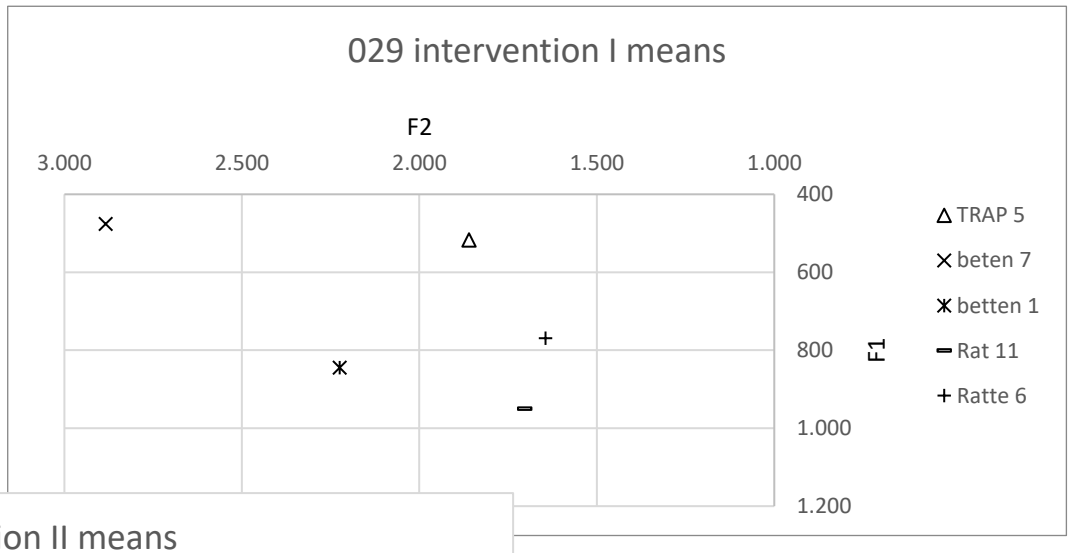
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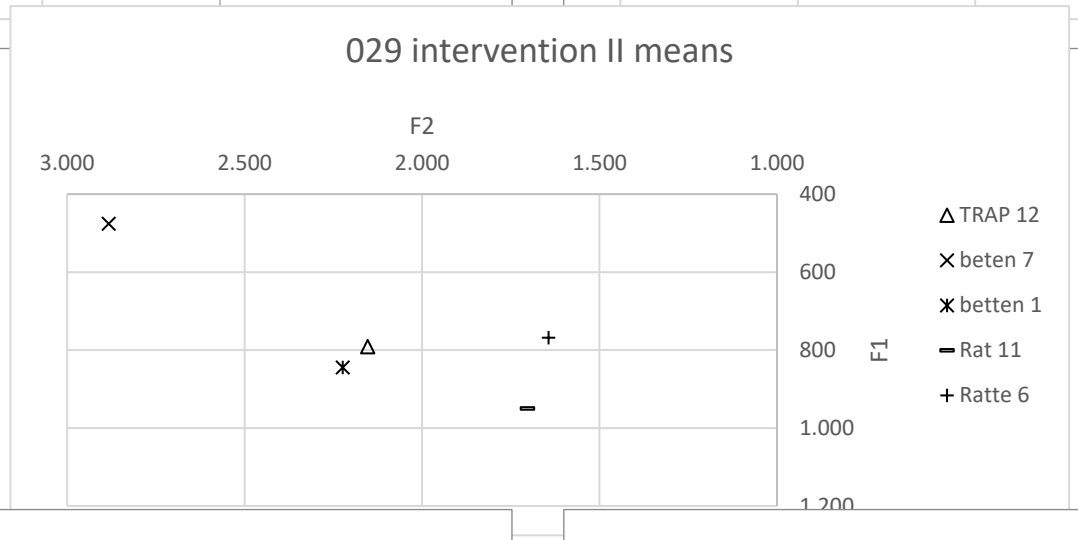
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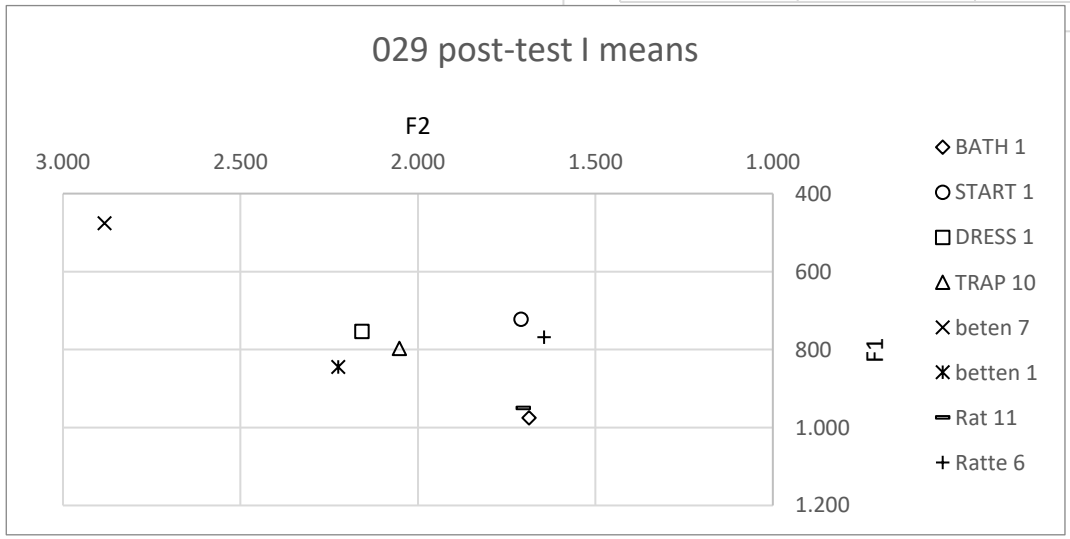
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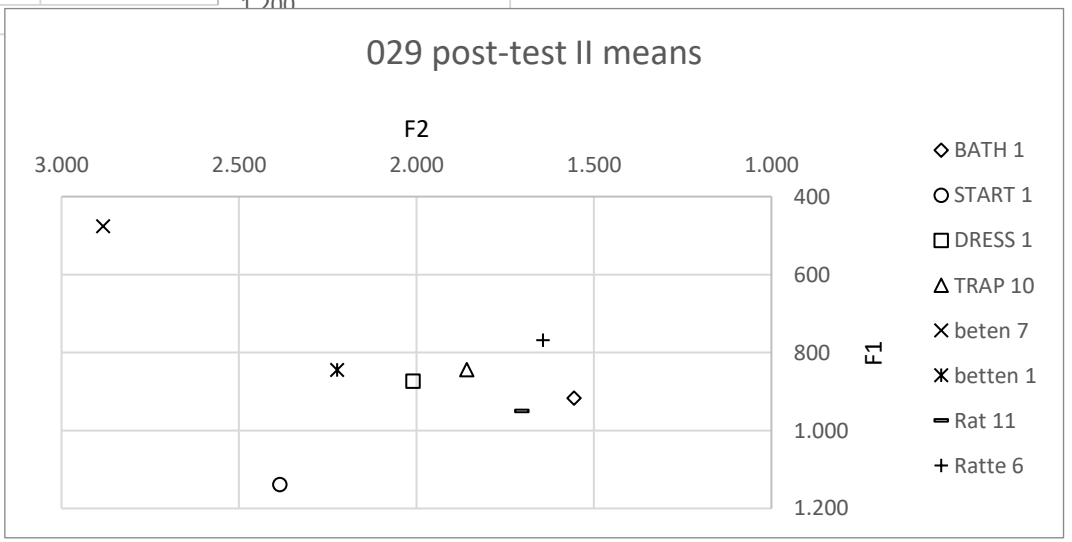
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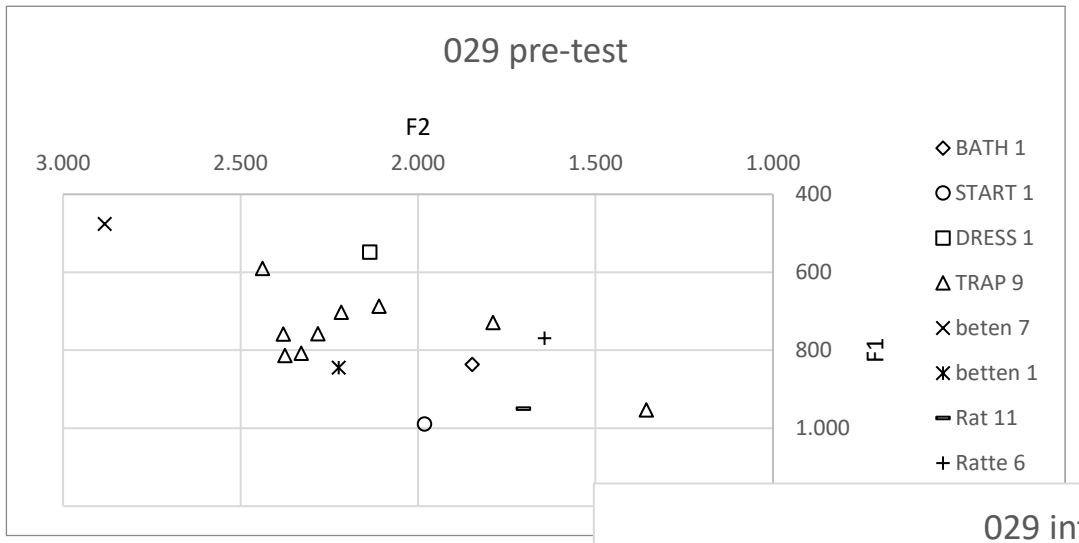
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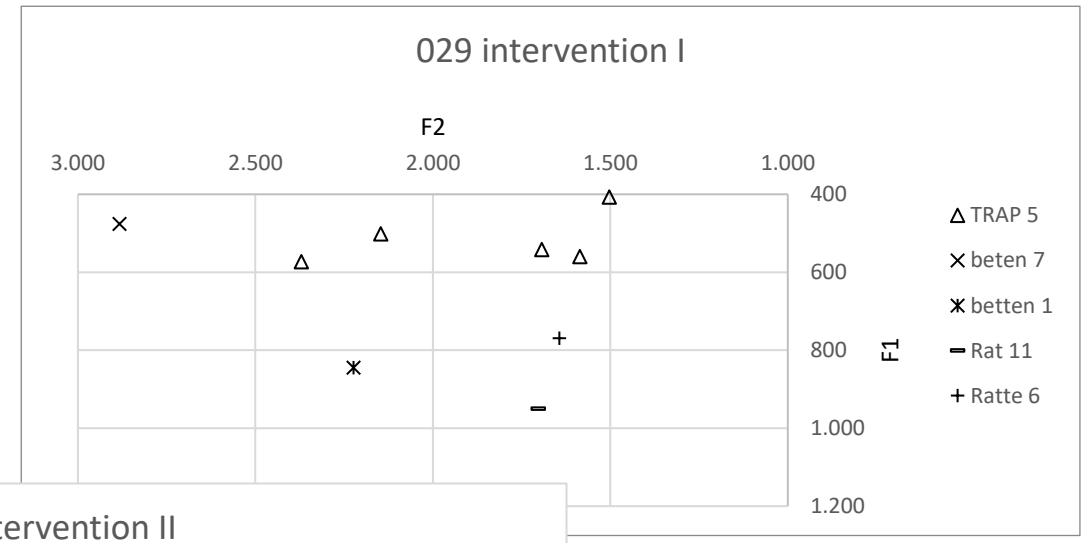
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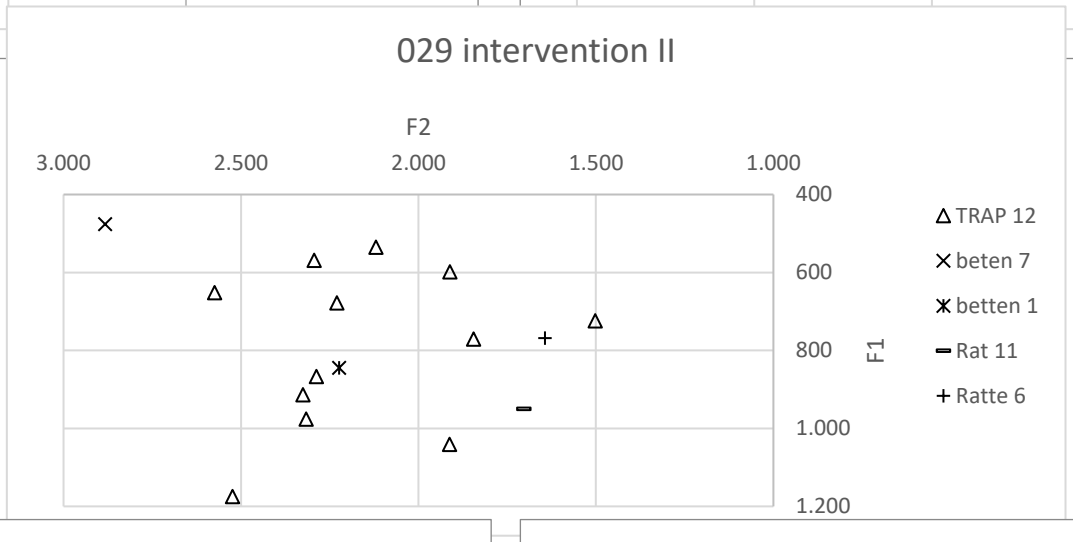
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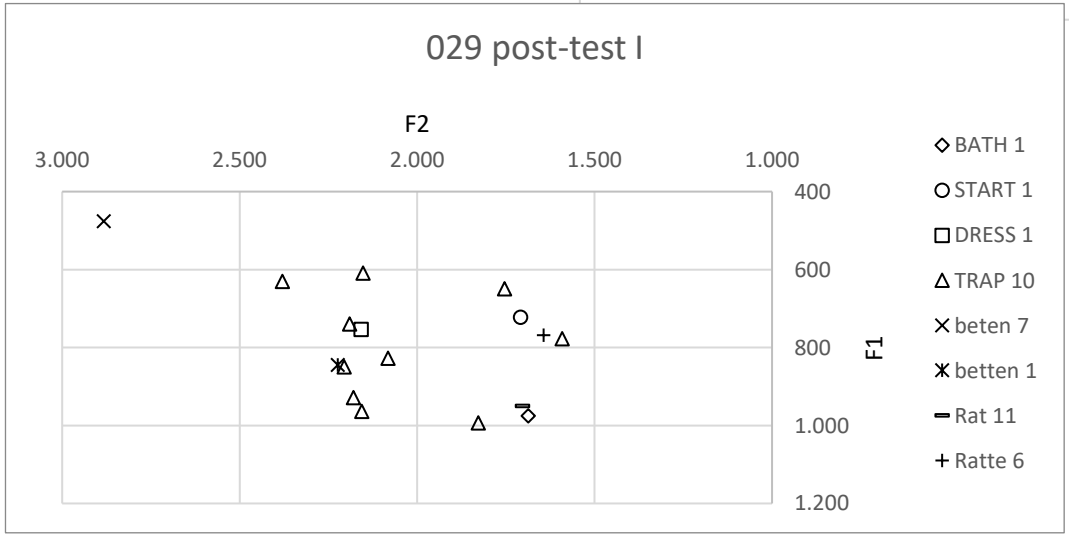
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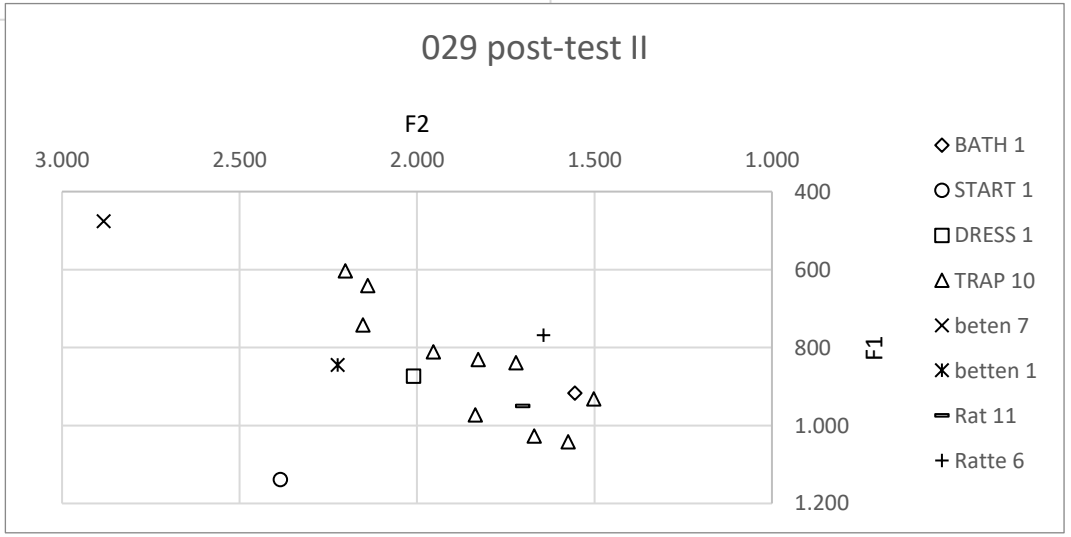
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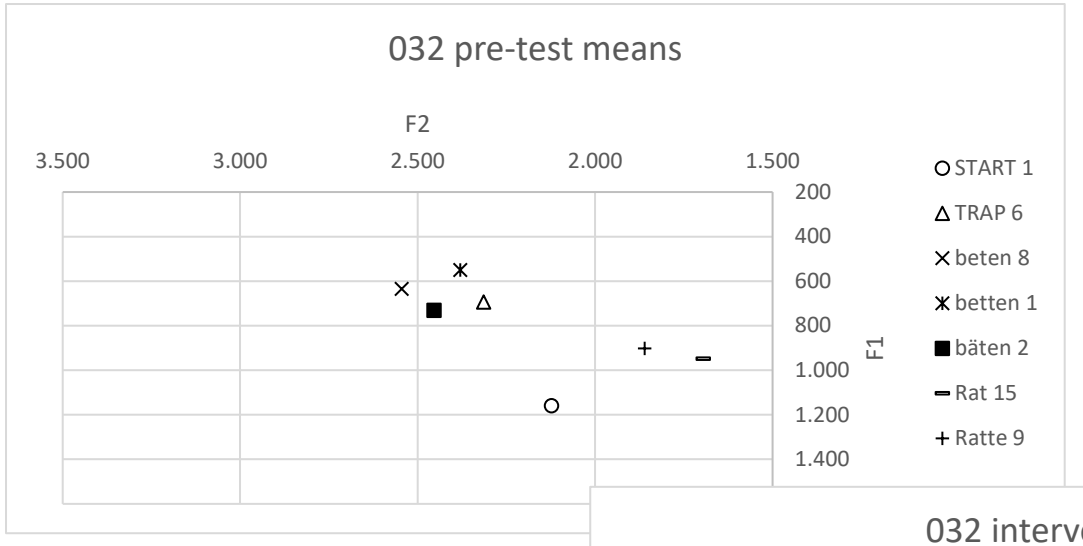
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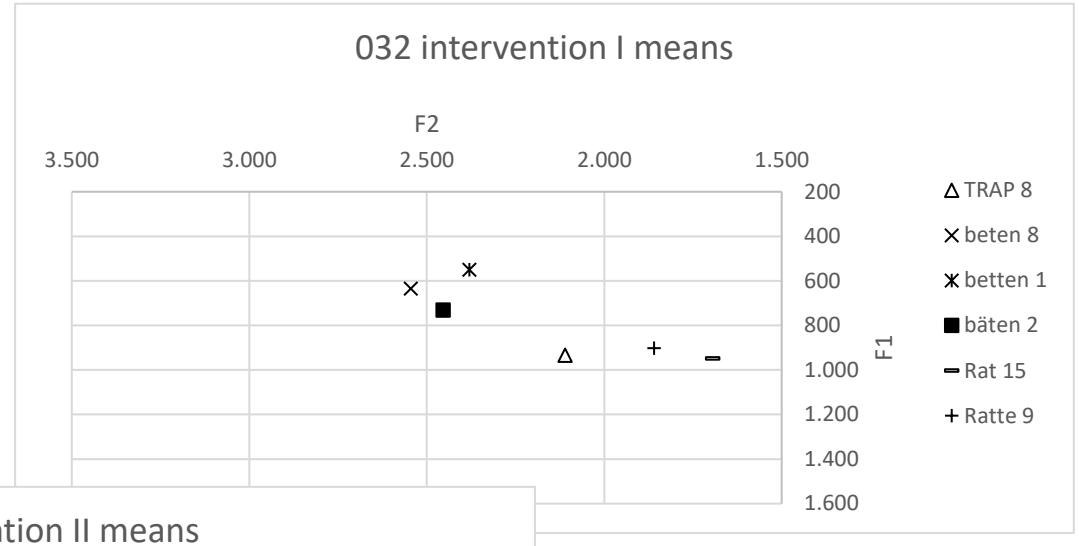
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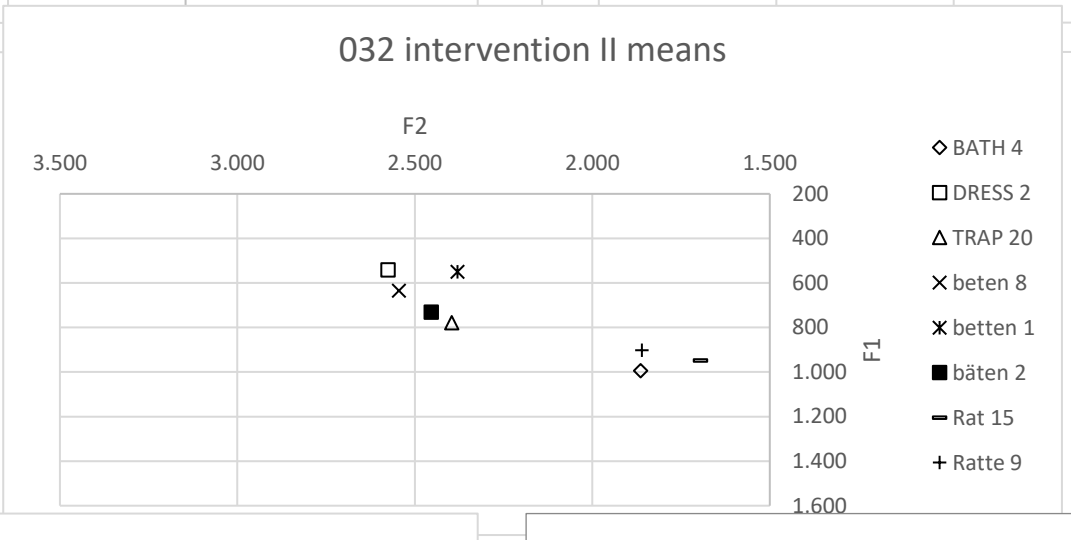
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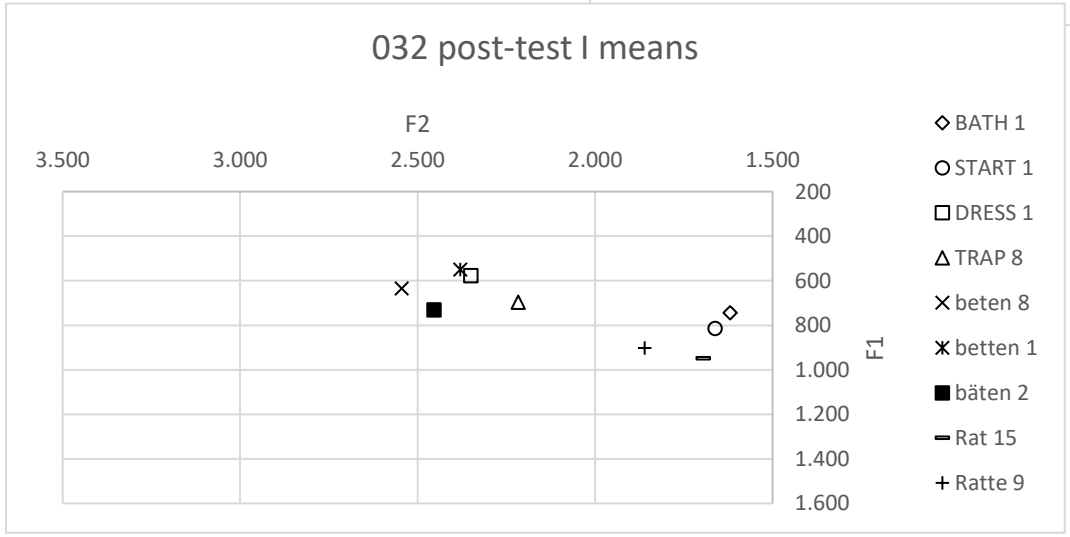
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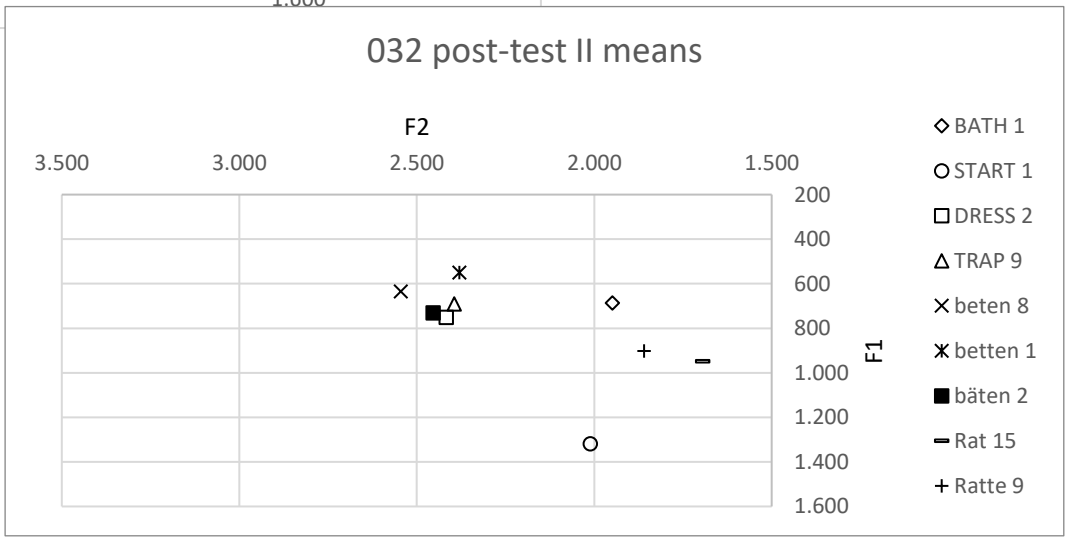
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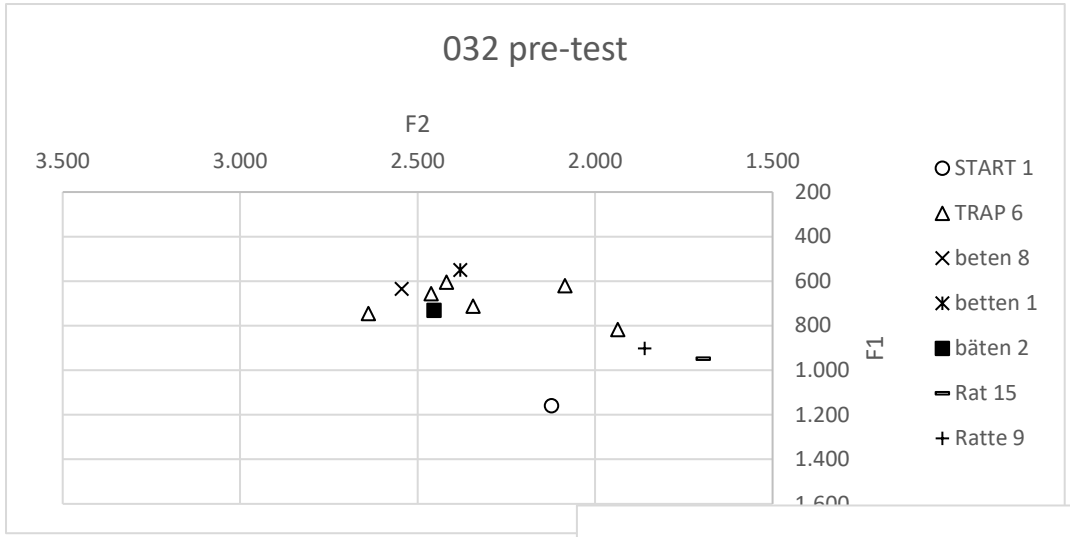
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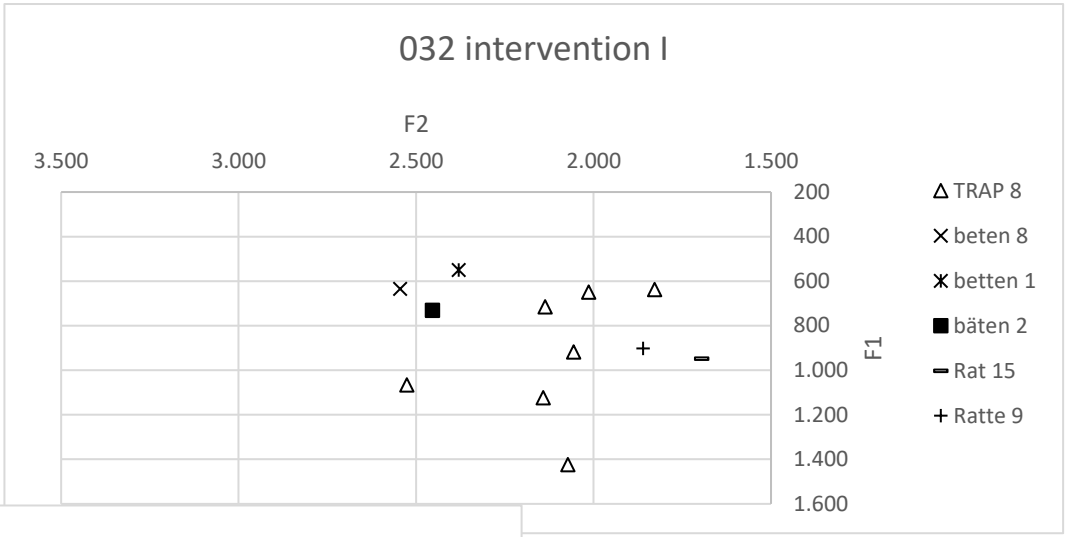
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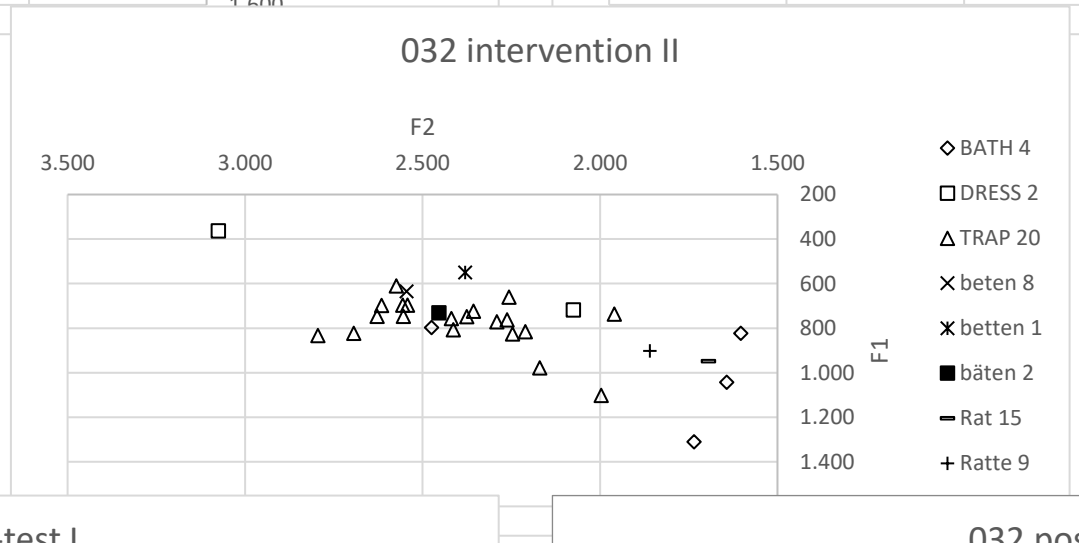
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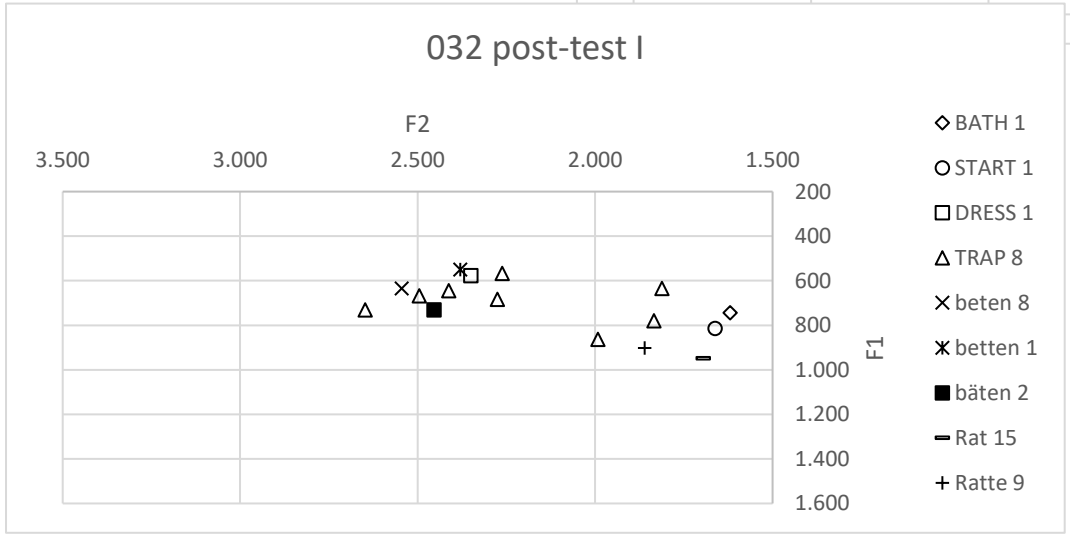
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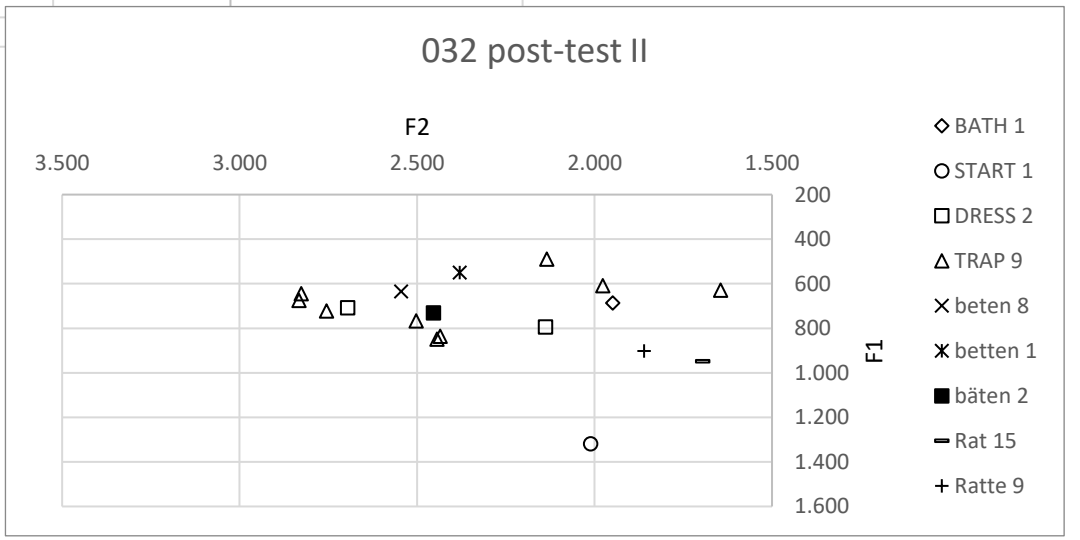
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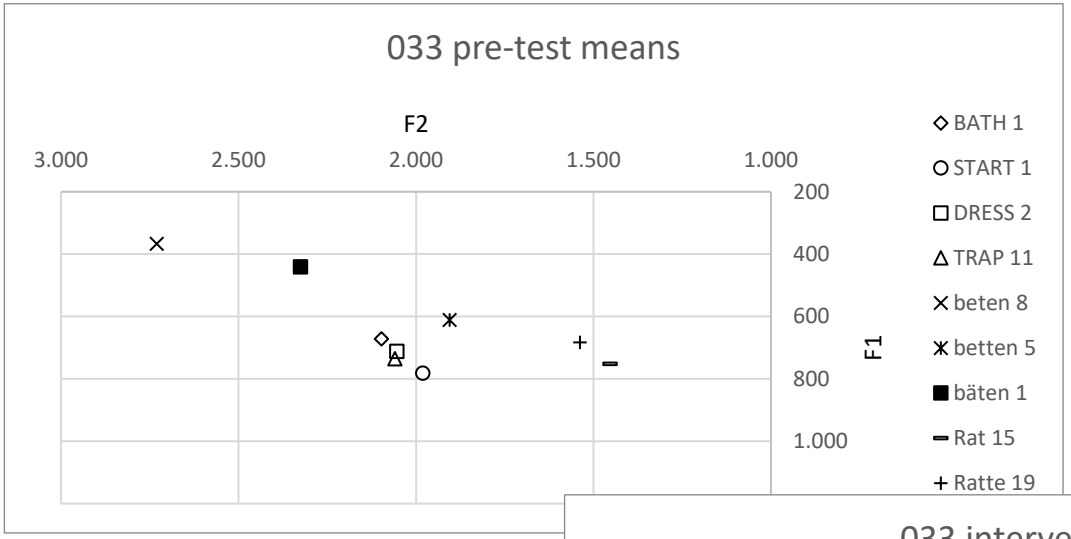
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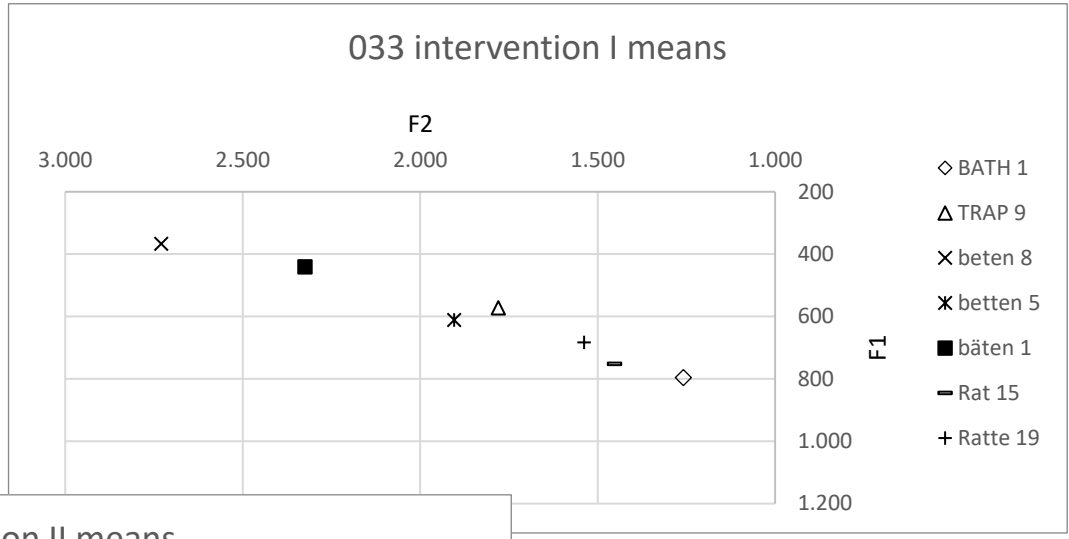
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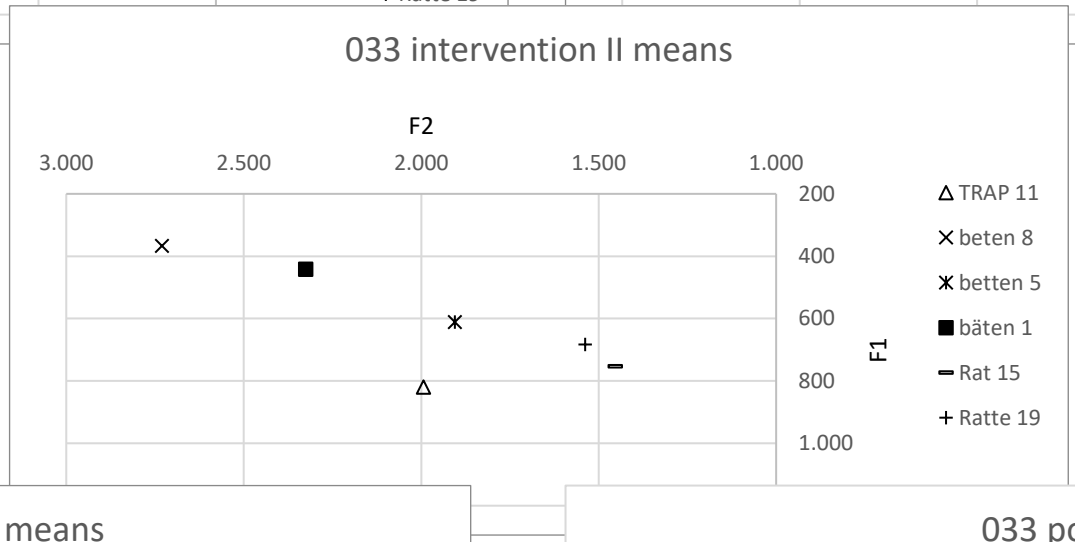
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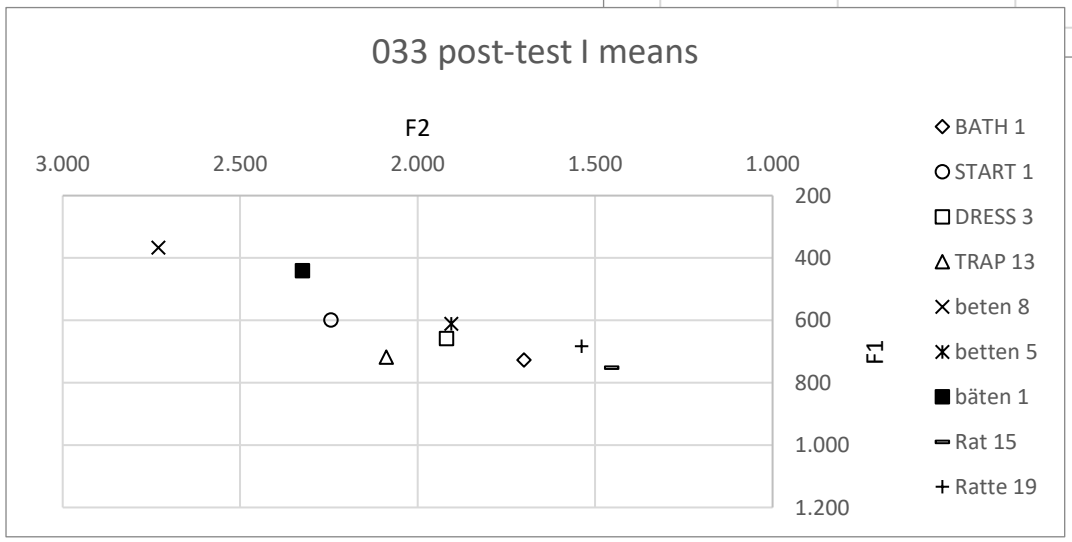
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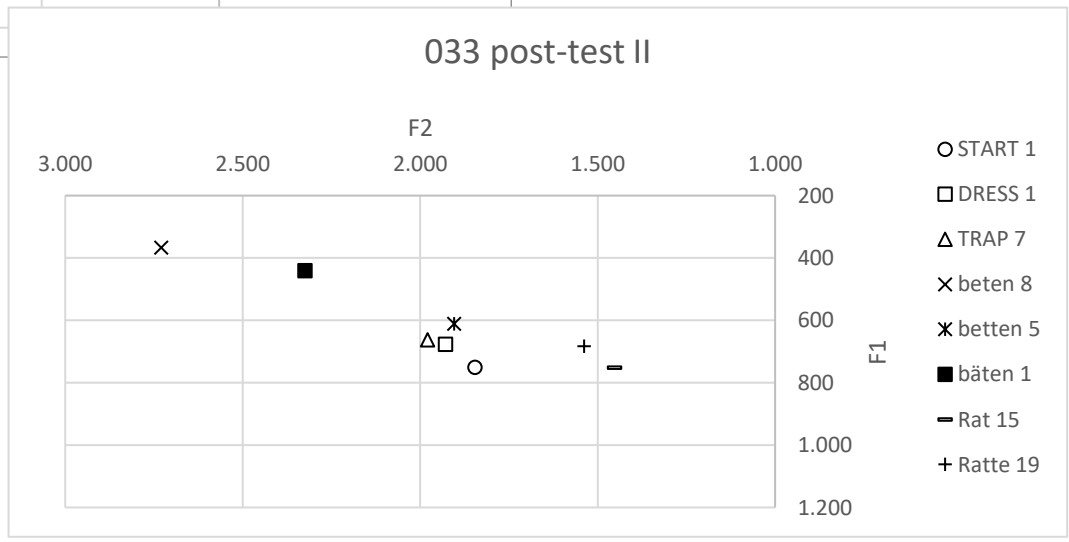
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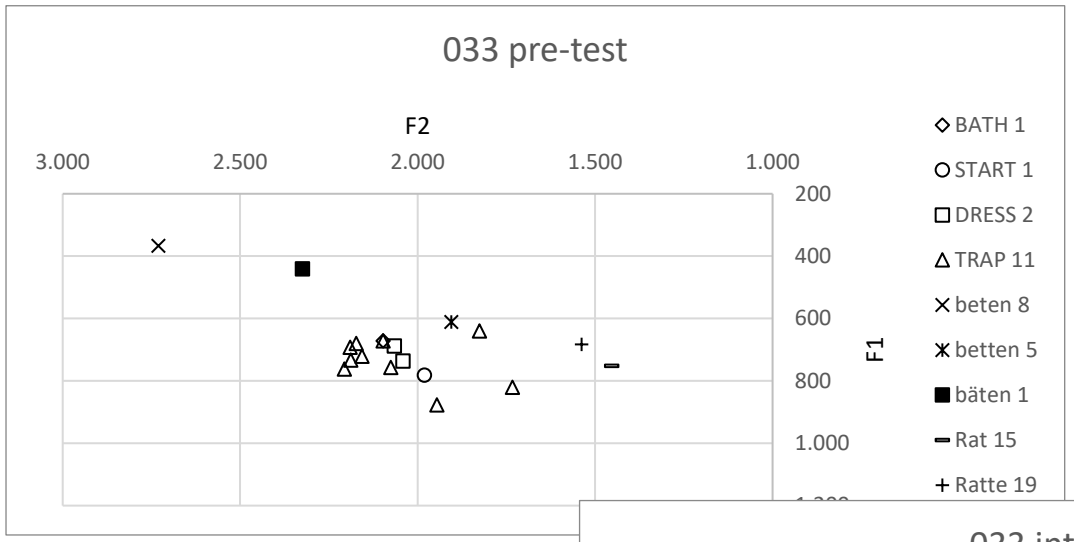
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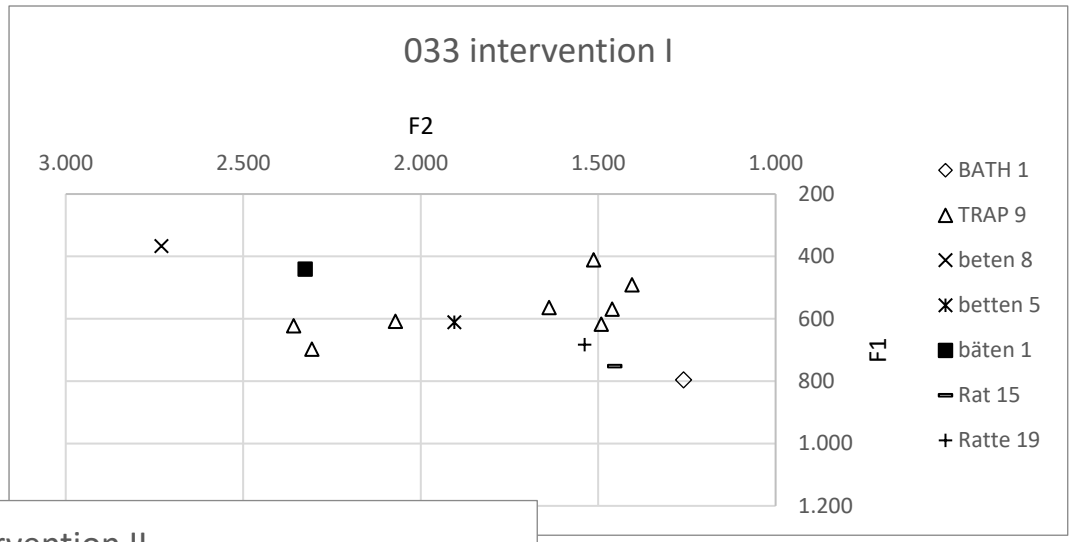
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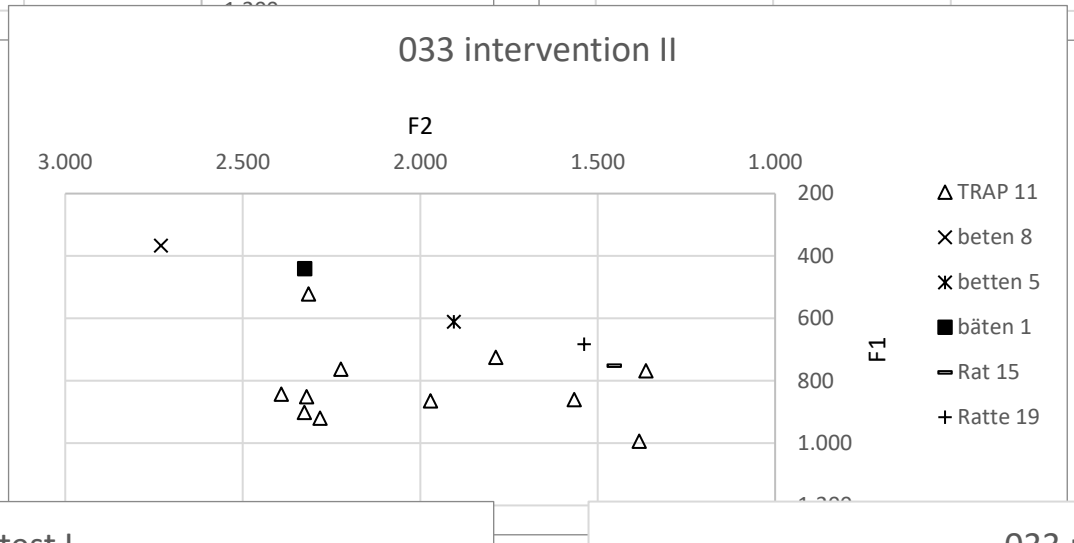
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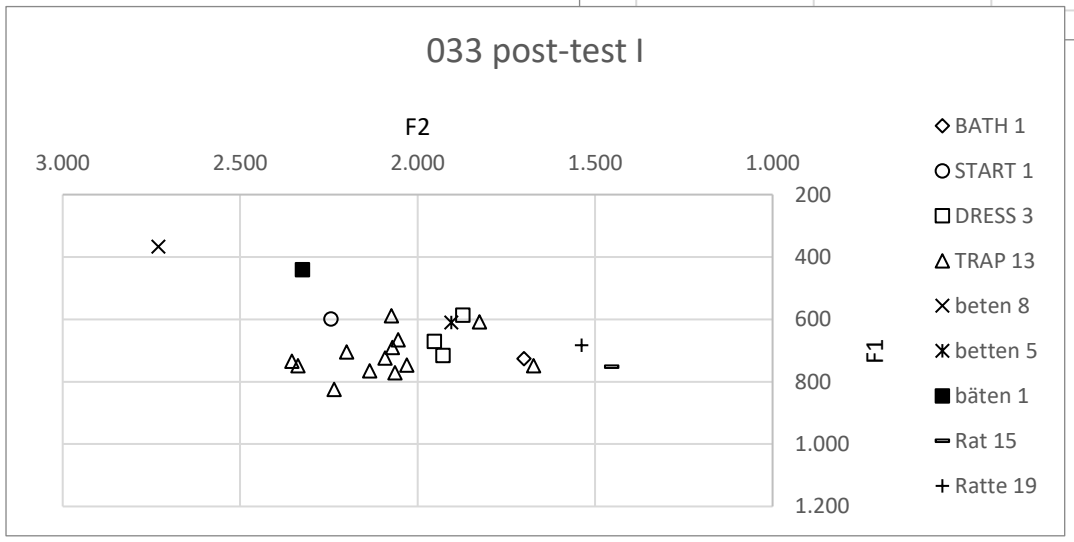
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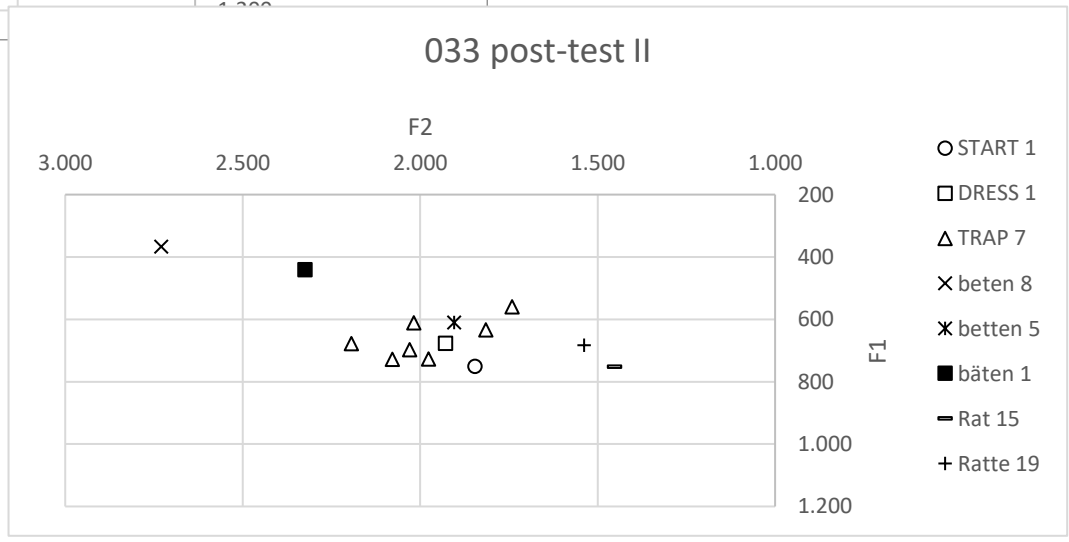
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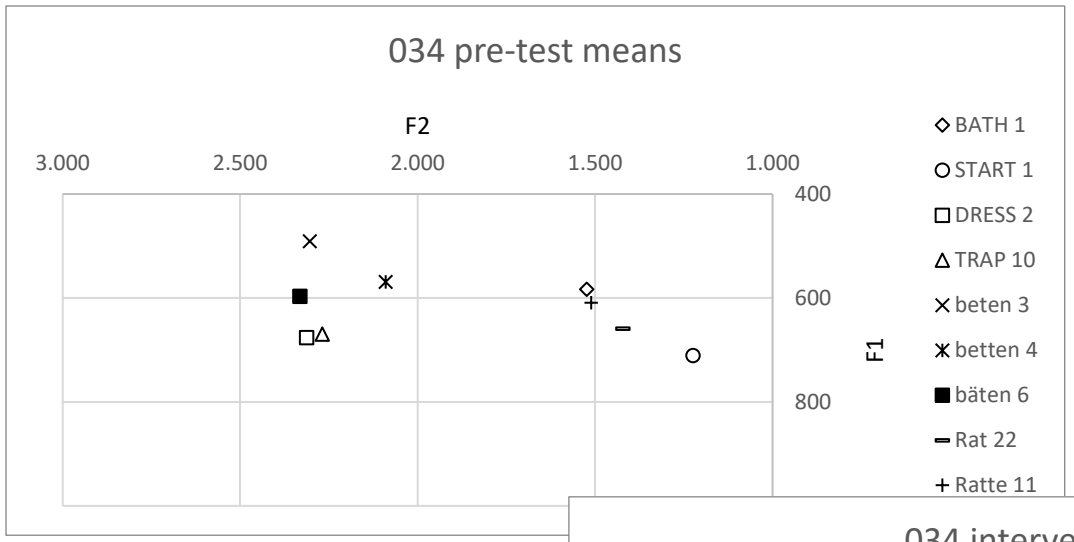
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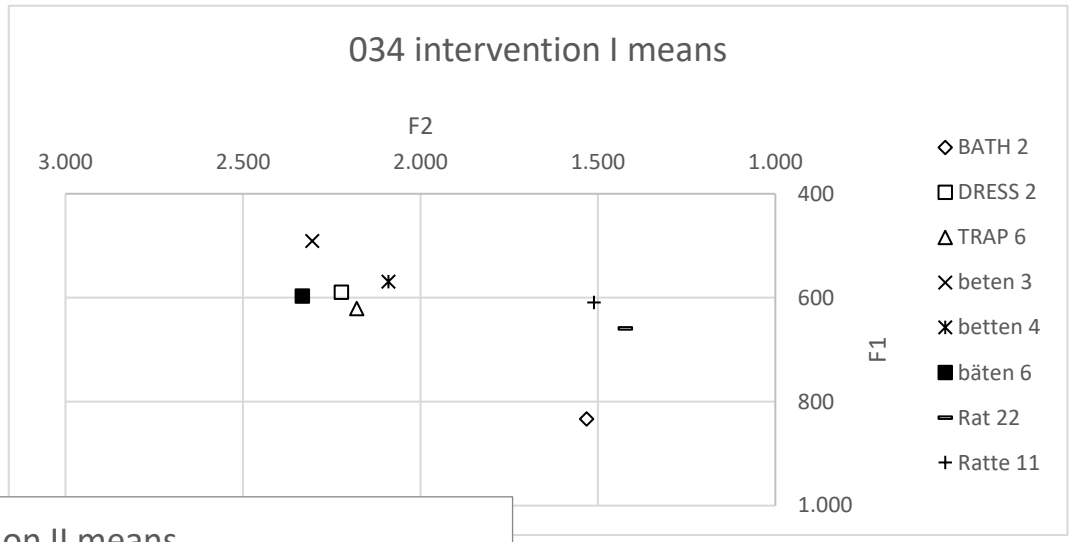
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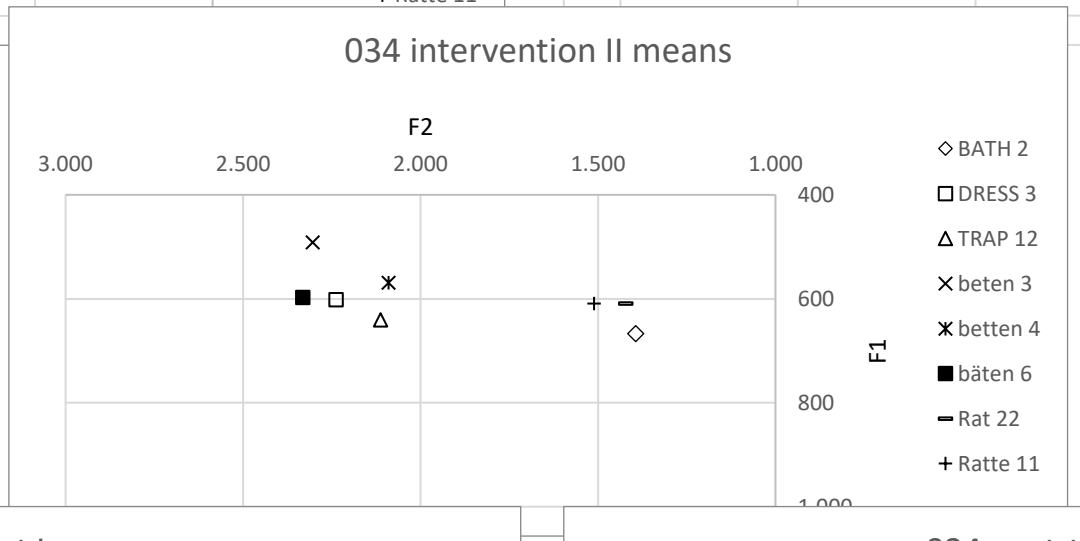
betten 4
bäten 6
Rat 22
Ratte 11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BATH 2
DRESS 3
TRAP 12
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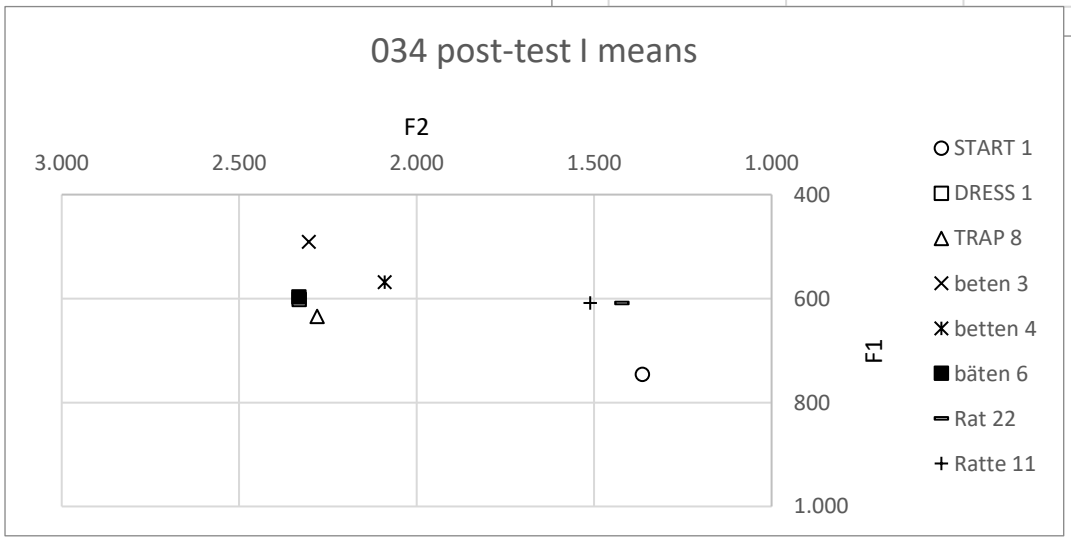
betten 4
bäten 6
Rat 22
Ratte 11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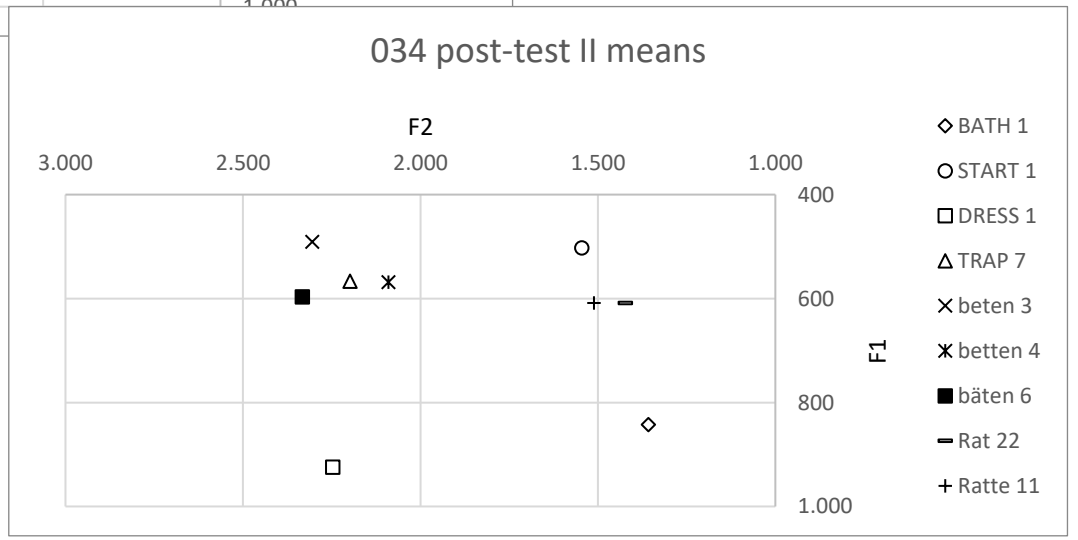
DRESS 1
TRAP 8
beten 3
betten 4
bäten 6
Rat 22
Ratte 11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DRESS 1
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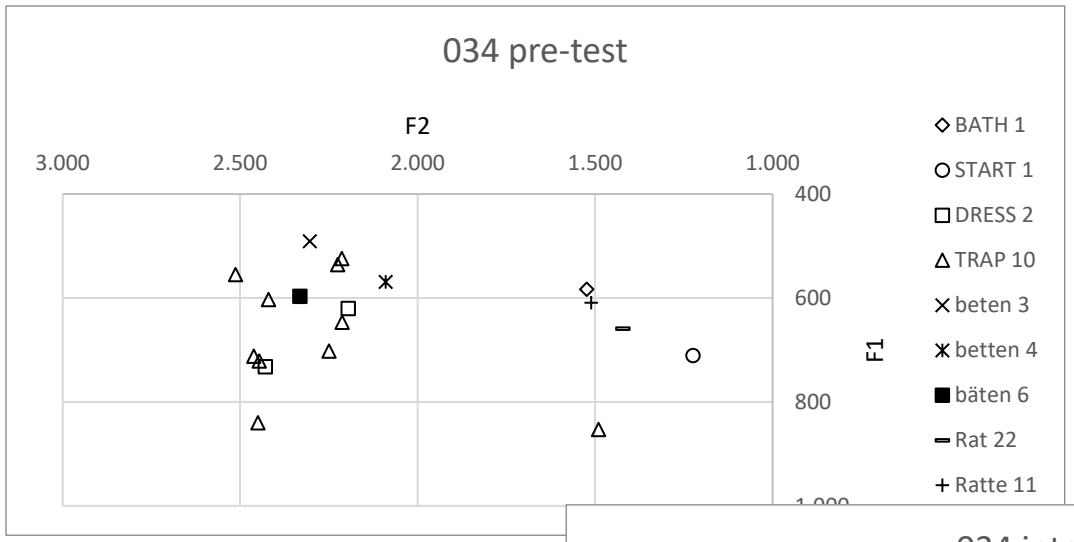
beten 3
betten 4
bäten 6
Rat 22
Ratte 11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START 1
DRESS 2
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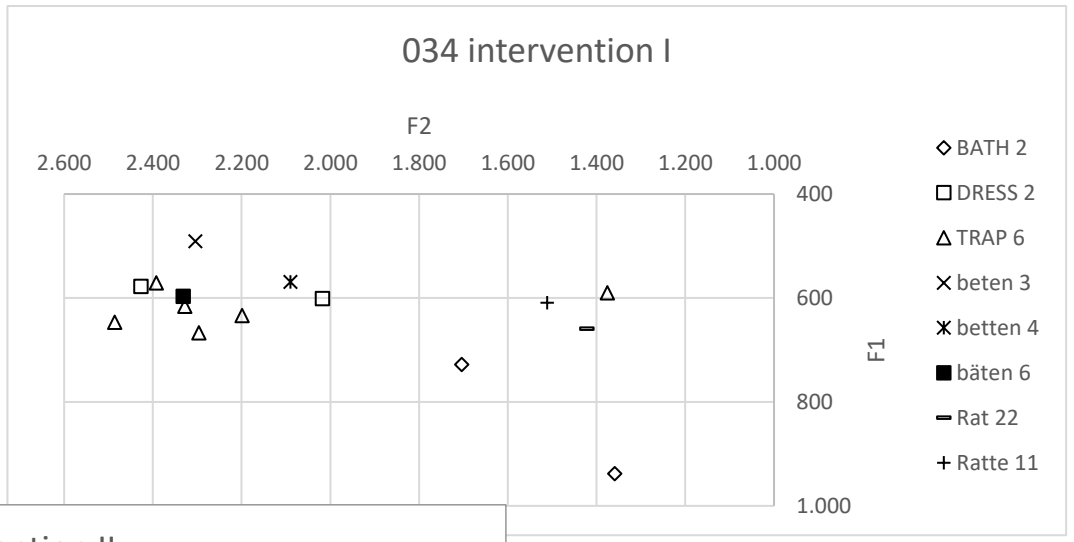
beten 3
betten 4
bäten 6
Rat 22
Ratte 11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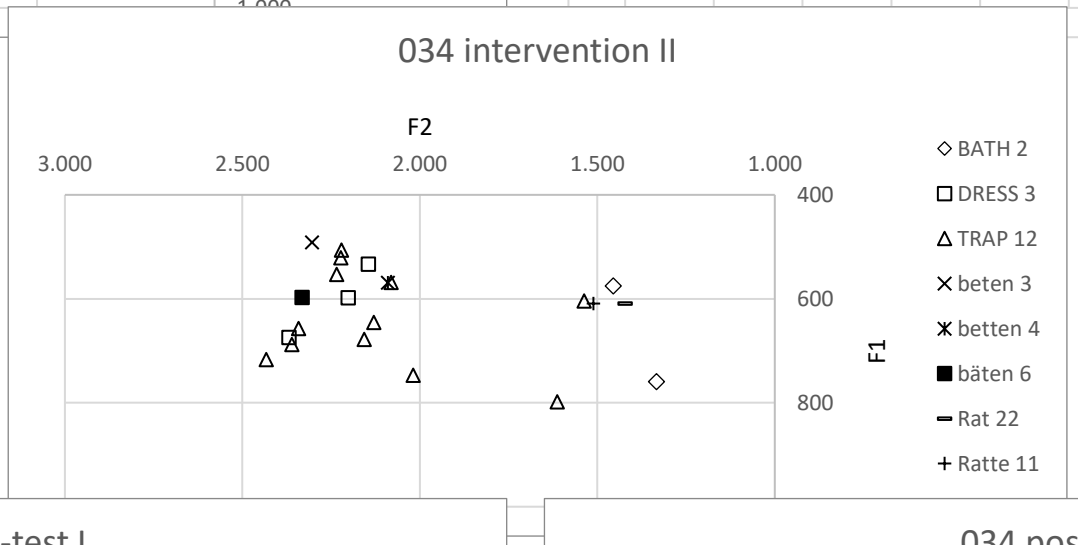
BATH 2
DRESS 2
TRAP 6
beten 3
betten 4
bäten 6
Rat 22
Ratte 11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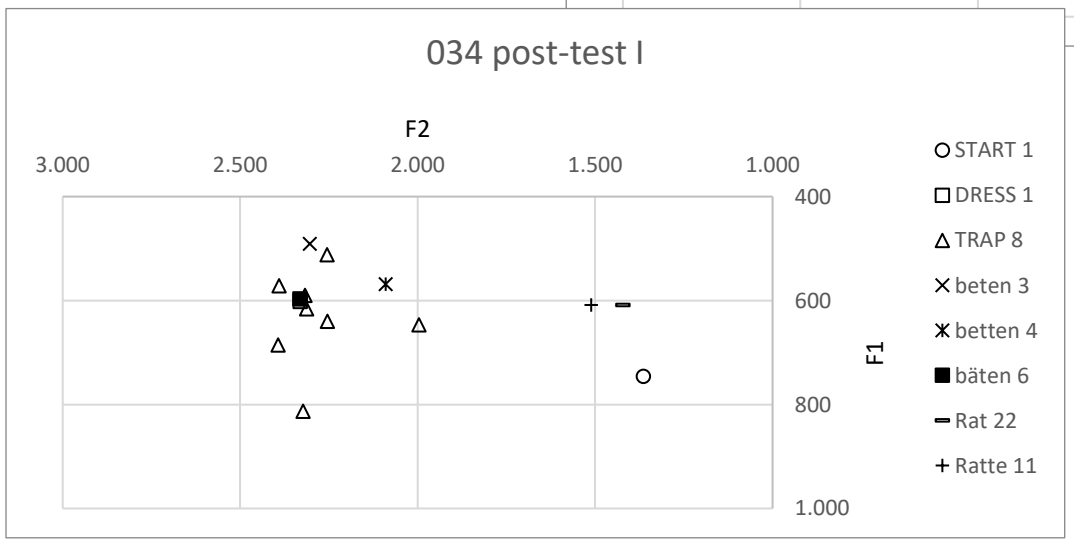
DRESS 3
TRAP 12
beten 3
betten 4
bäten 6
Rat 22
Ratte 11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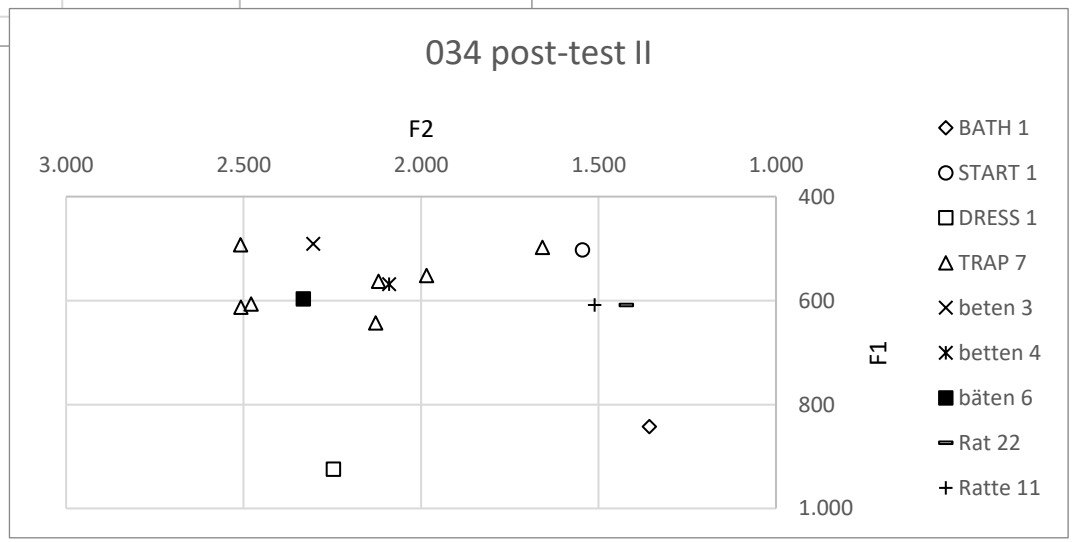
DRESS 1
TRAP 8
beten 3
betten 4
bäten 6
Rat 22
Ratte 11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DRESS 1
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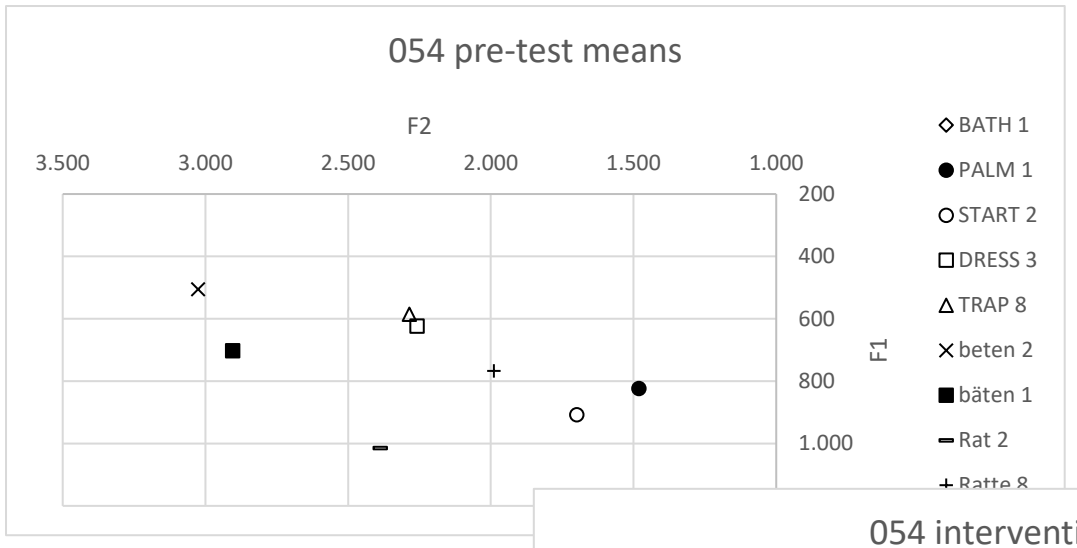
beten 3
betten 4
bäten 6
Rat 22
Ratte 11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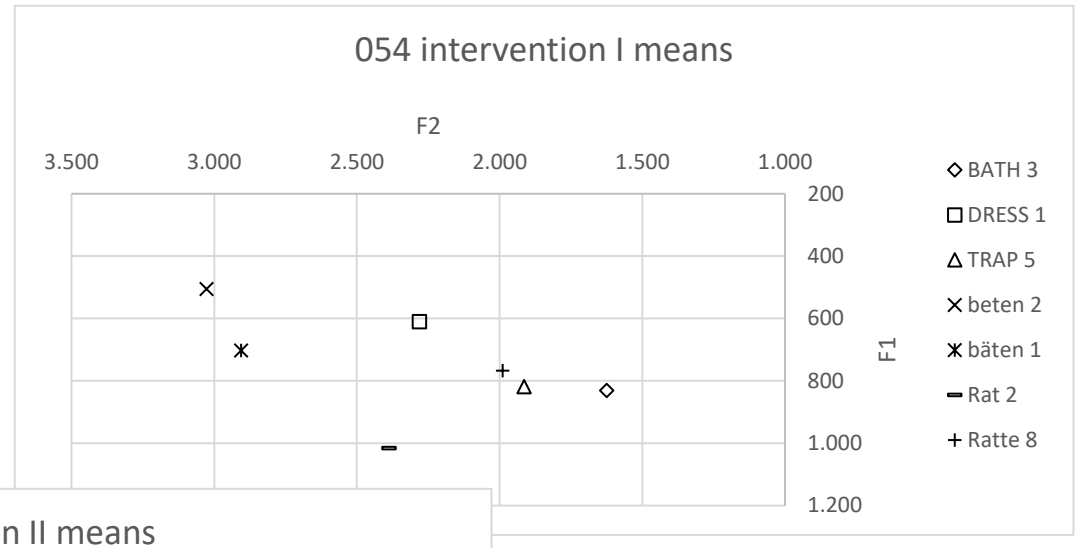
START 2
DRESS 3
TRAP 8
beten 2
bäten 1
Rat 2
Ratte 8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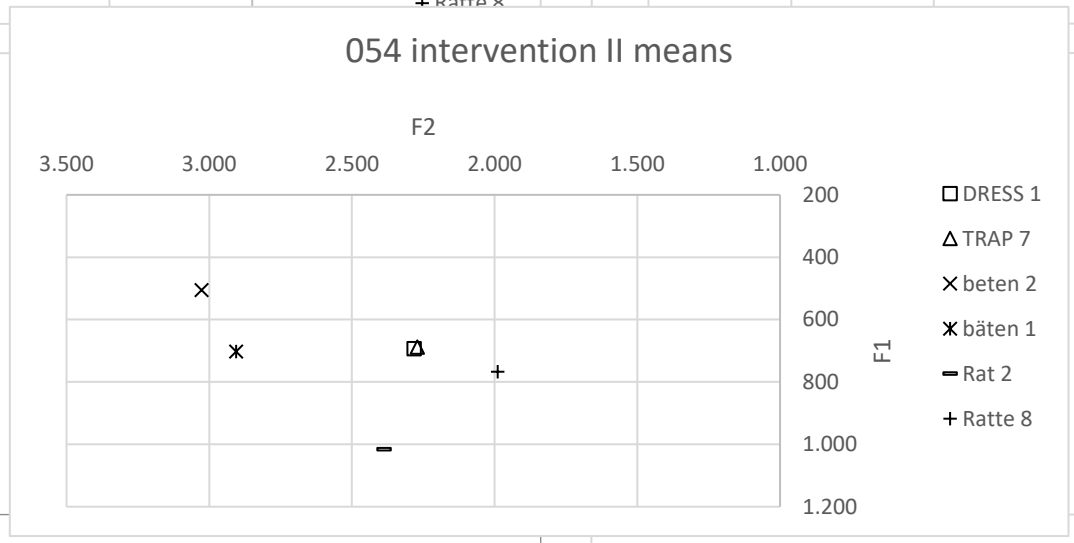
BATH 3
DRESS 1
TRAP 5
beten 2
bäten 1
Rat 2
Ratte 8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TRAP 7
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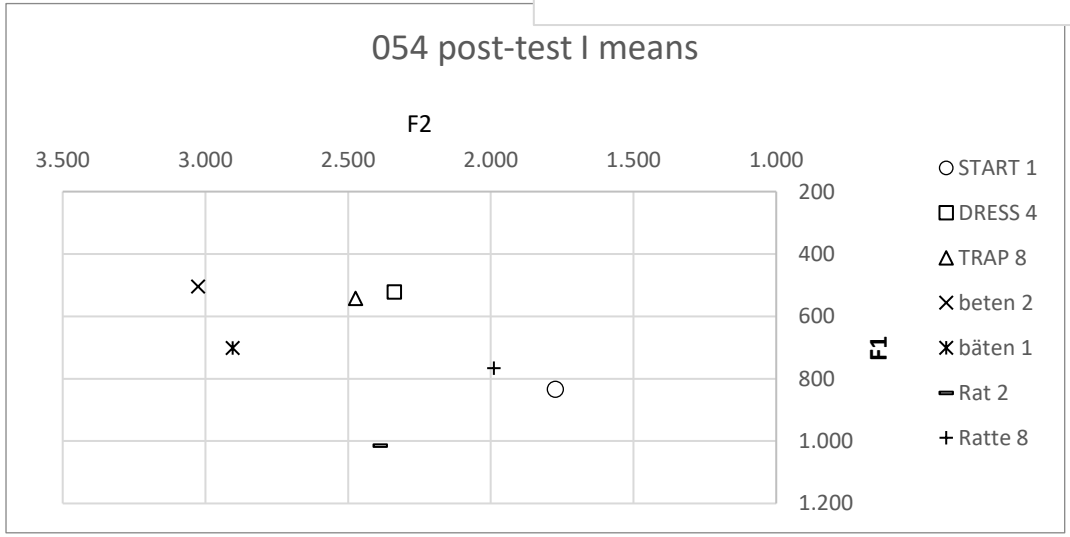
bäten 1
Rat 2
Ratte 8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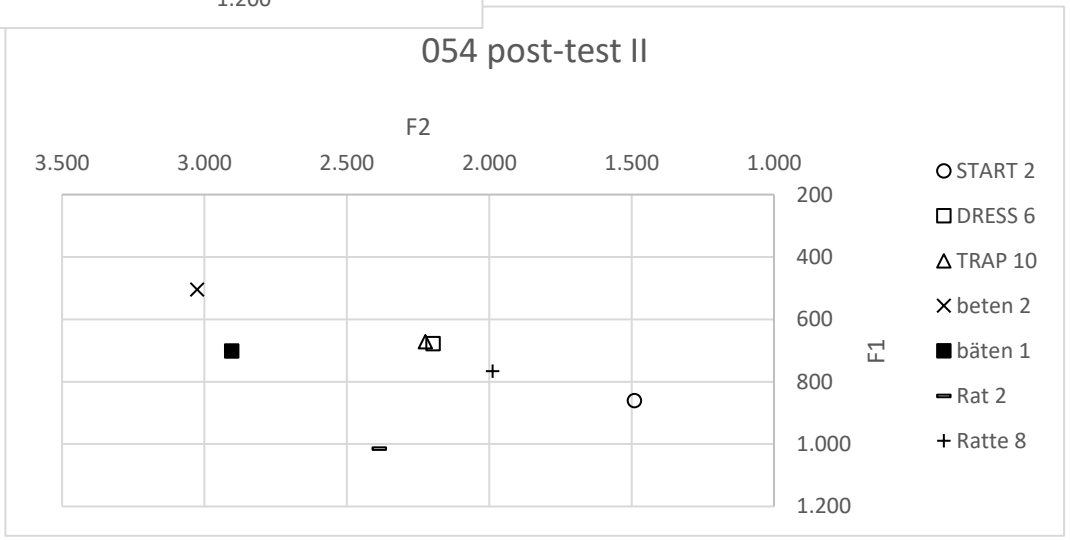
DRESS 4
TRAP 8
beten 2
bäten 1
Rat 2
Ratte 8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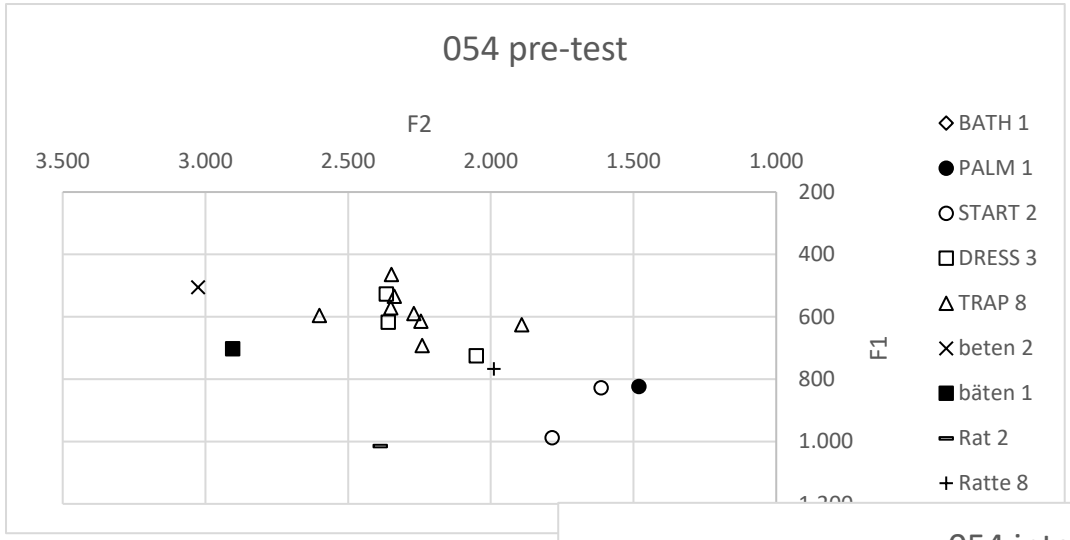
bäten 1
Rat 2
Ratte 8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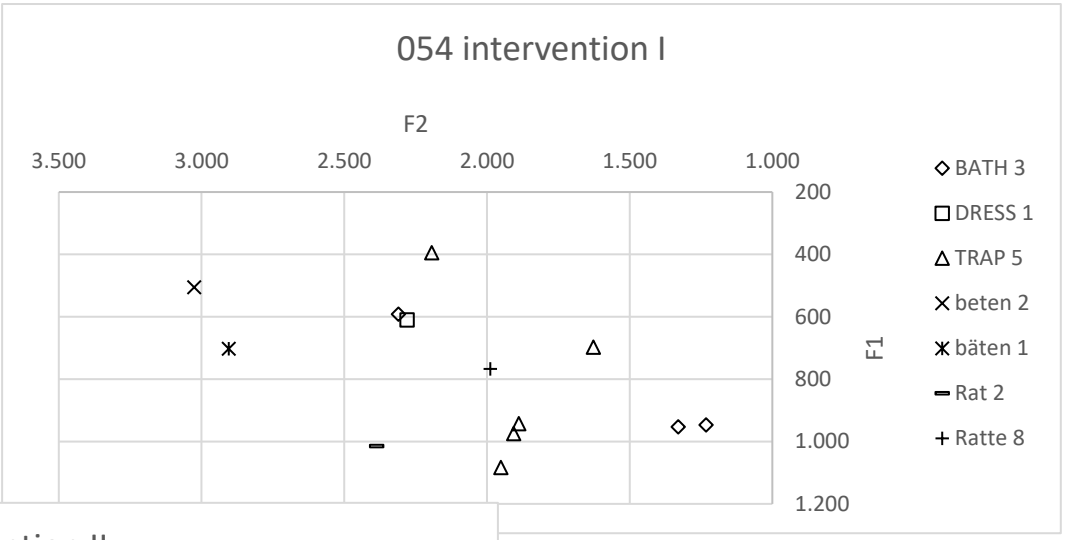
BATH 1
PALM 1
START 2
DRESS 3
TRAP 8
beten 2
bäten 1
Rat 2
Ratte 8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TRAP 5
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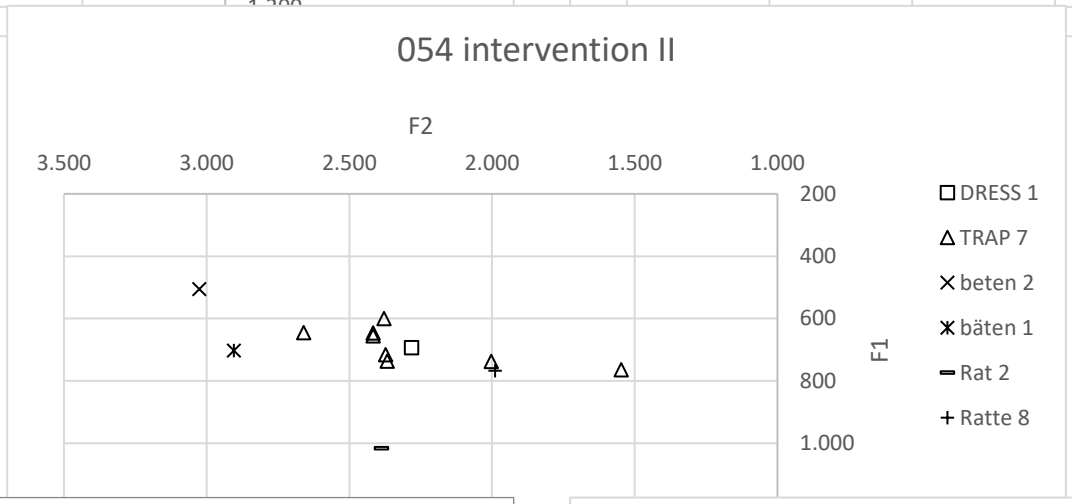
bäten 1
Rat 2
Ratte 8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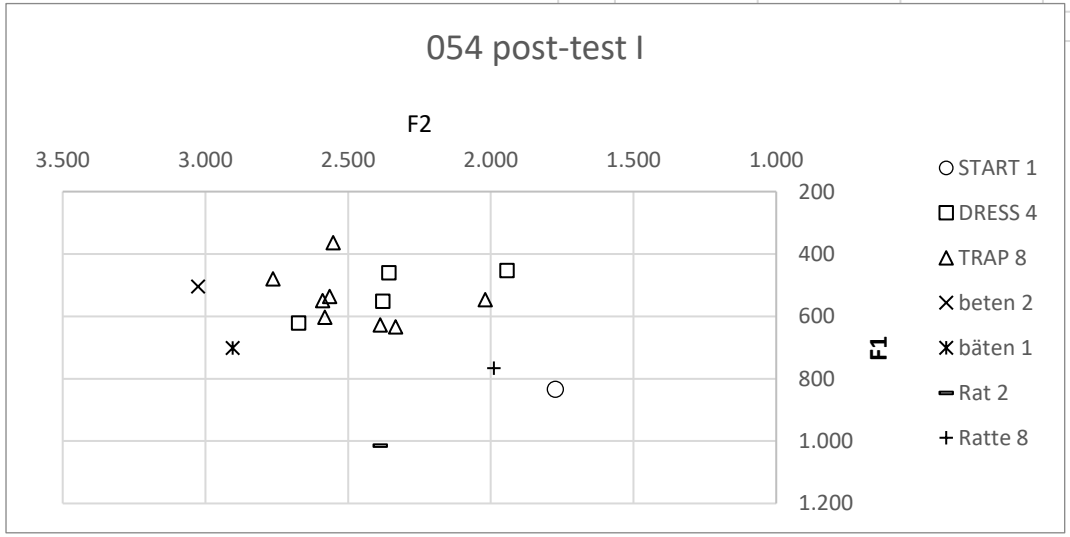
bäten 1
Rat 2
Ratte 8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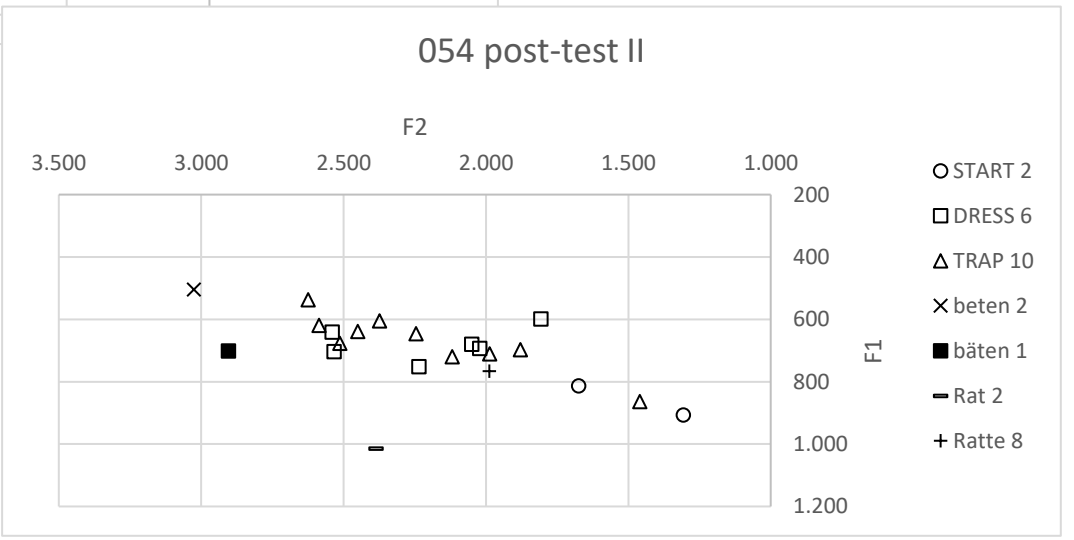
DRESS 4
TRAP 8
beten 2
bäten 1
Rat 2
Ratte 8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Rat 2
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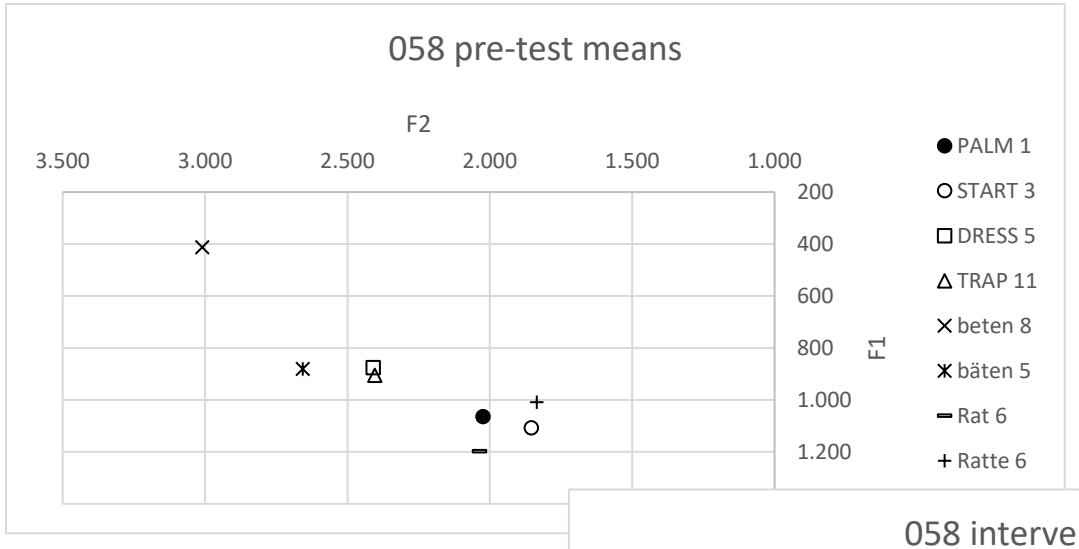
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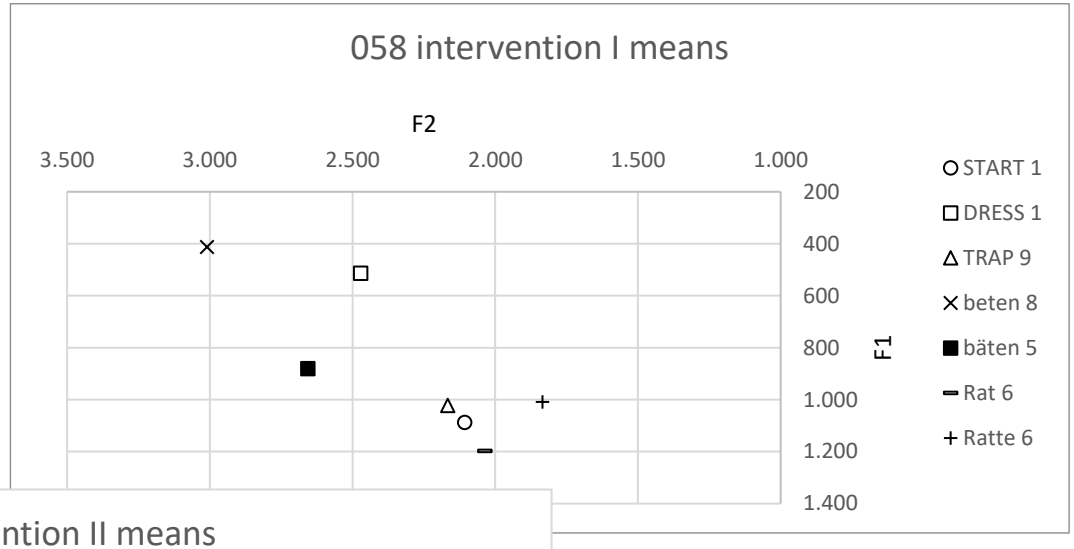
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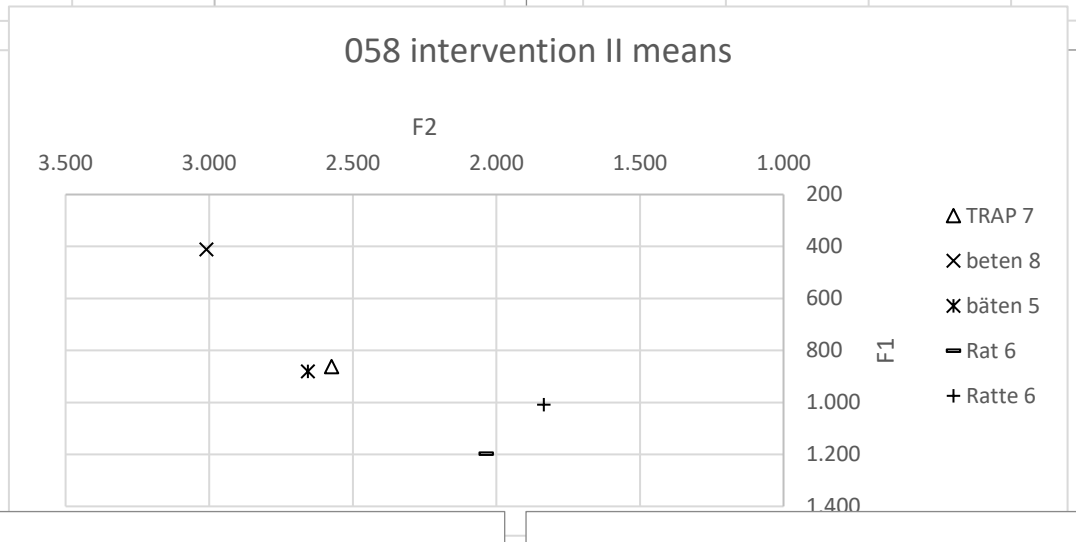
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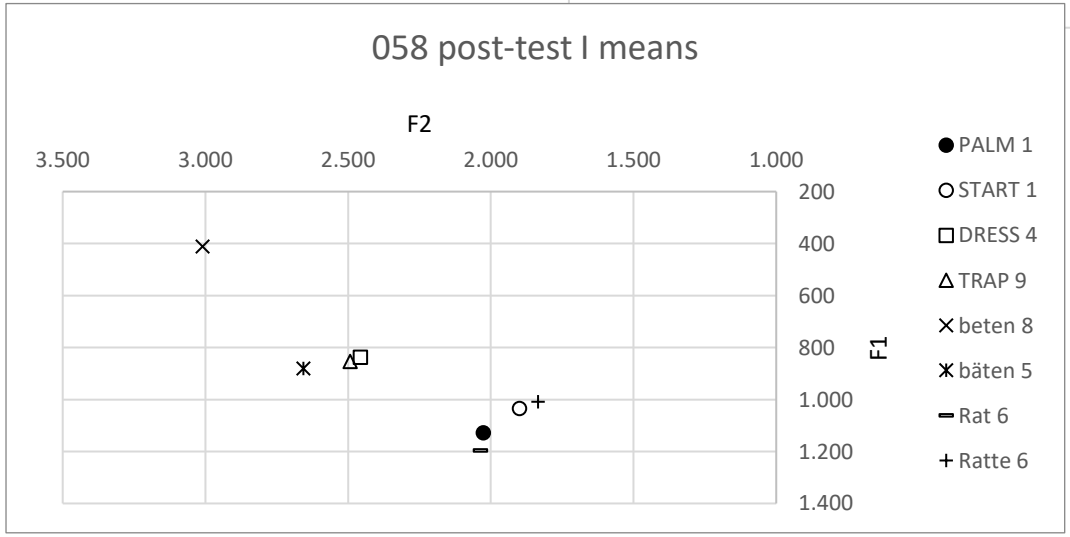
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bäten 5
Rat 6
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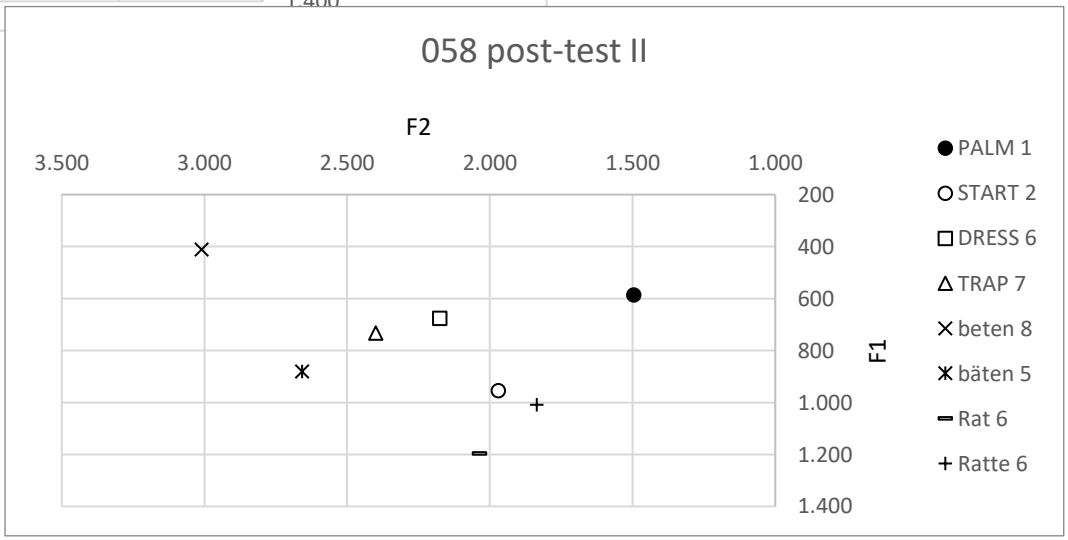
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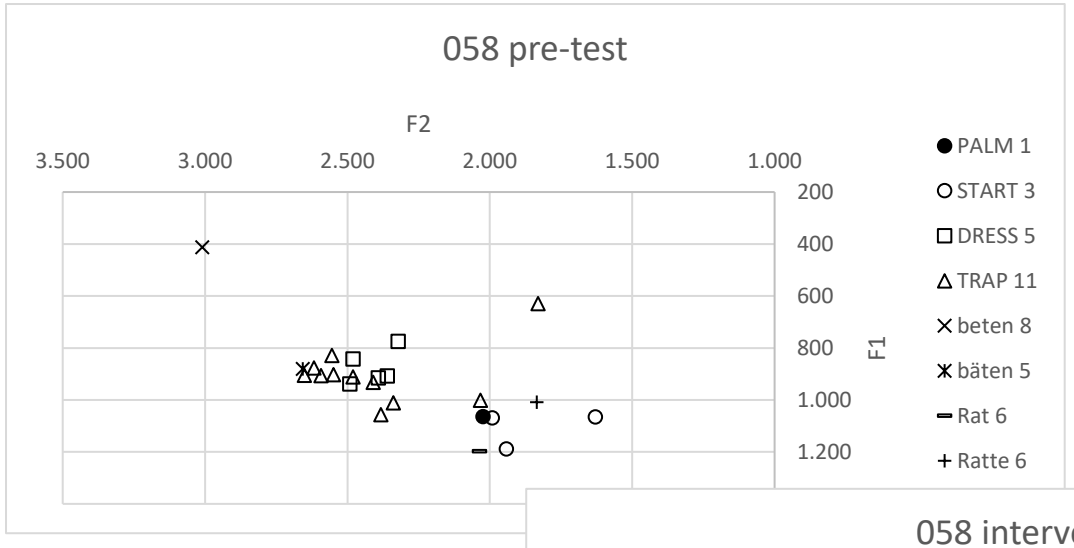
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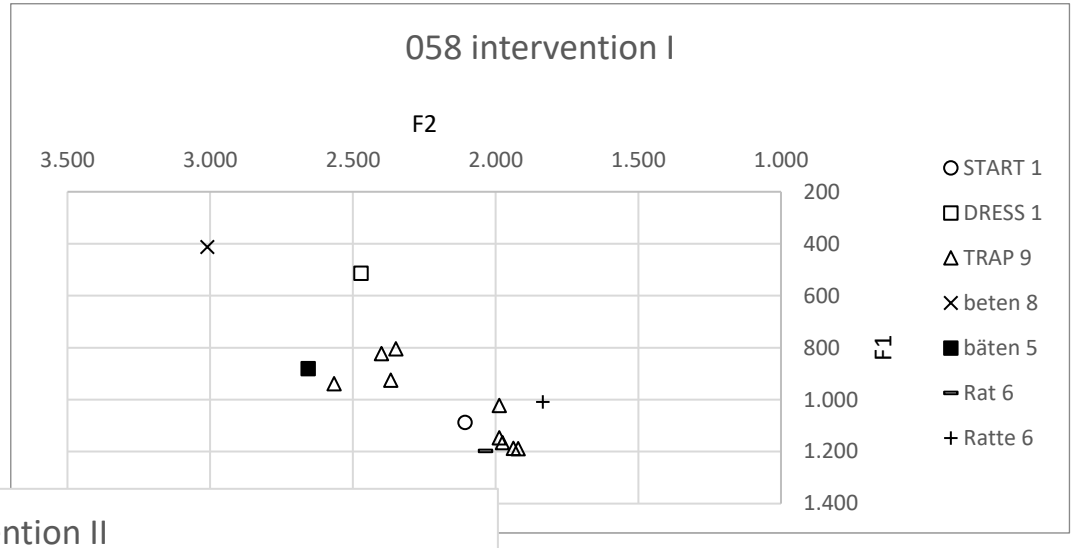
Ratte 6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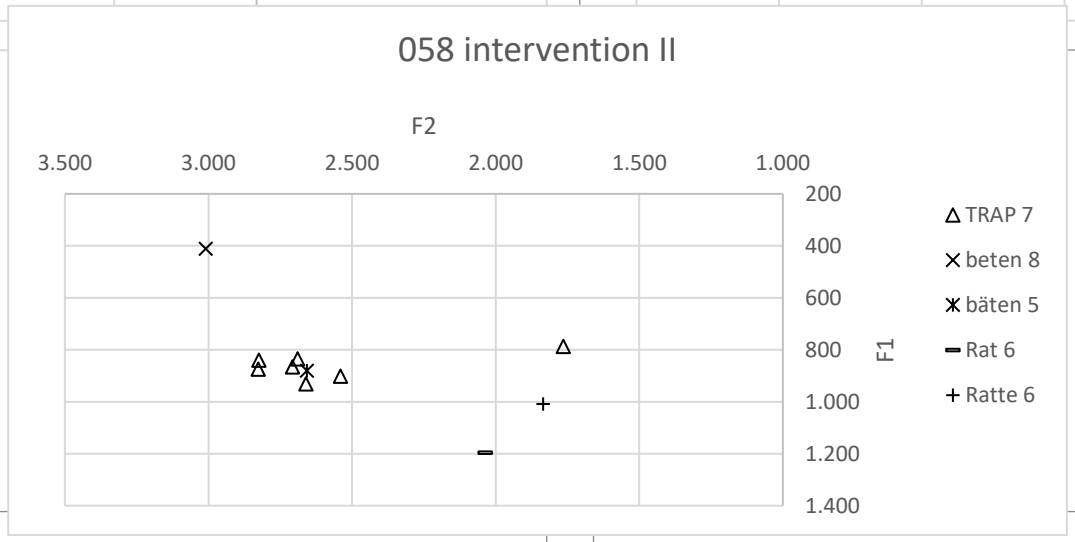
Rat 6
Ratte 6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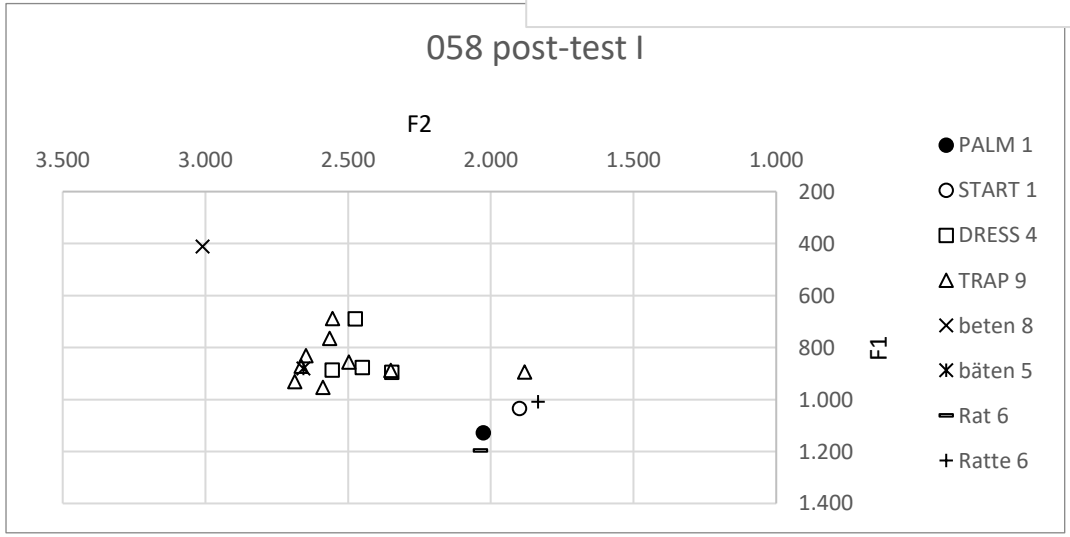
Rat 6
Ratte 6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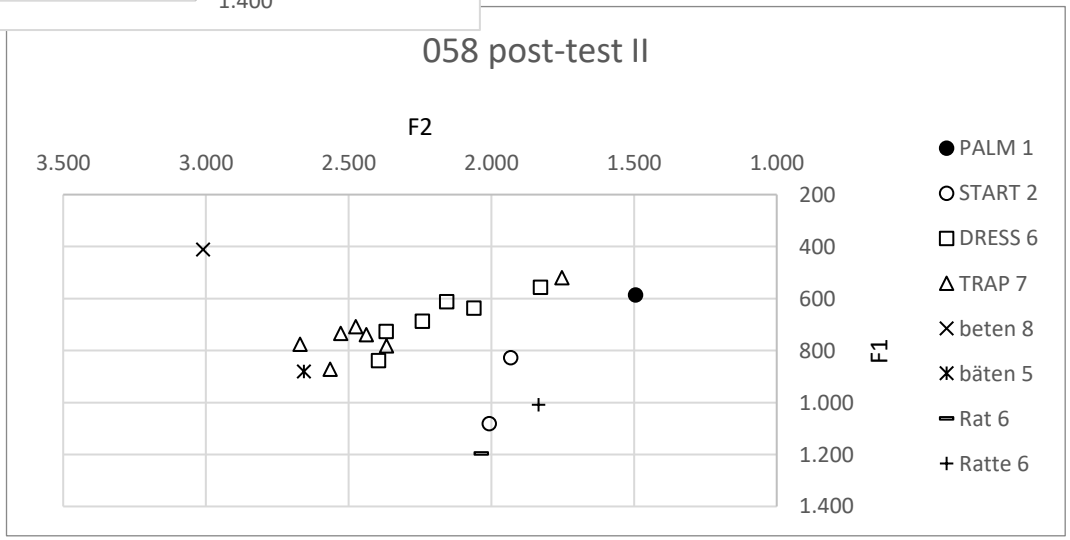
bäten 5
Rat 6
Ratte 6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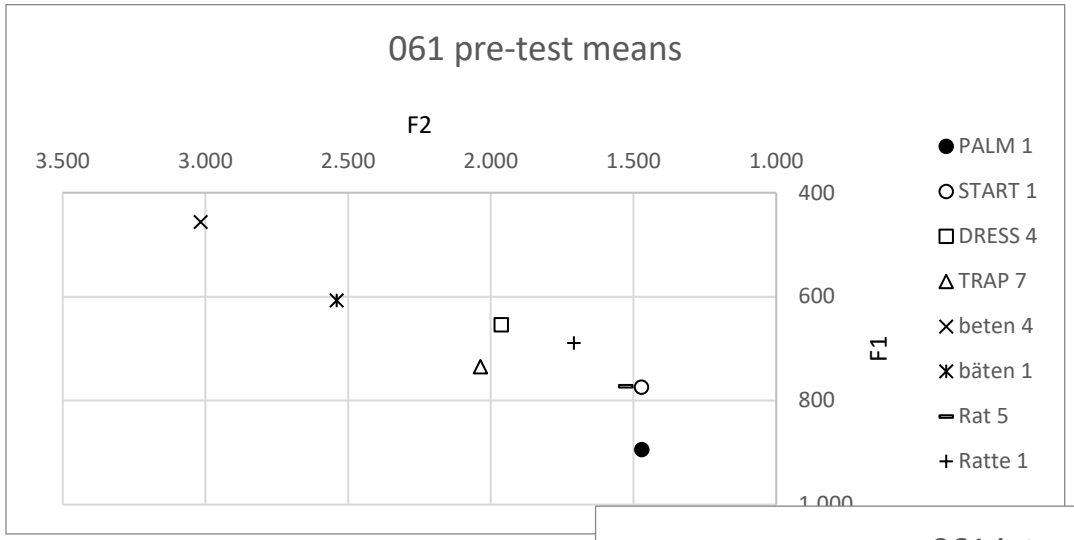
Rat 6
Ratte 6


061 pre-test means
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START 1
DRESS 4
TRAP 7
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bäten 1
Rat 5
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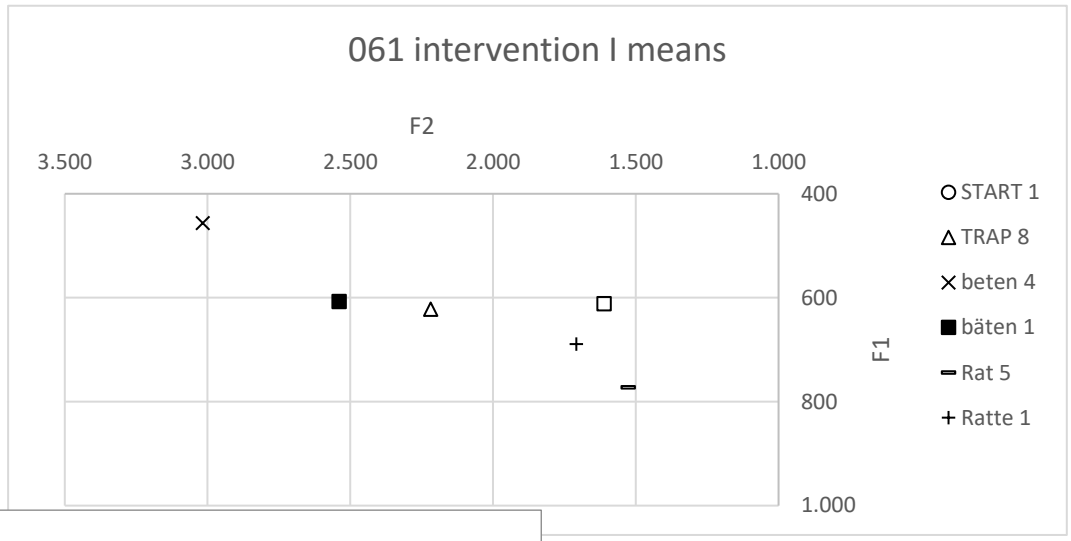
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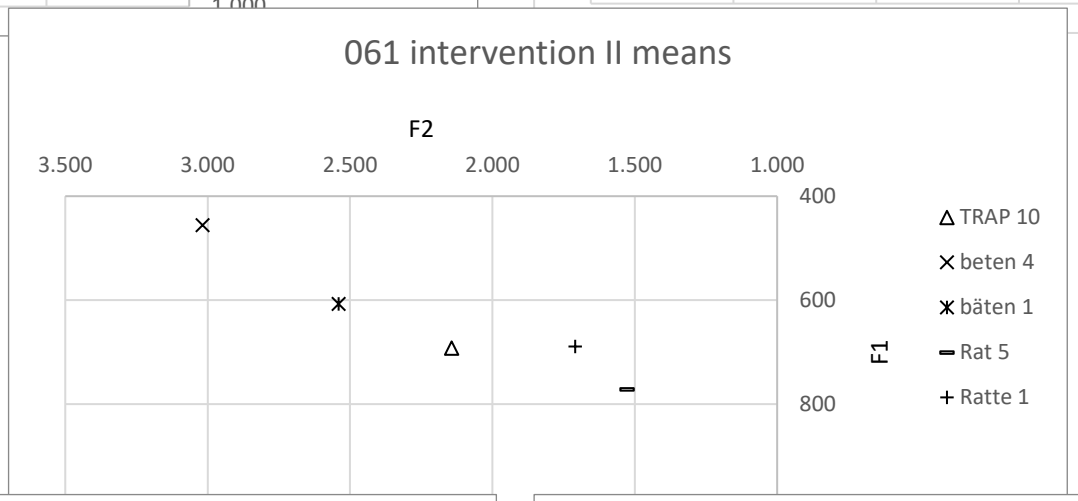
Rat 5
Ratte 1


061 intervention II means
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800
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TRAP 10
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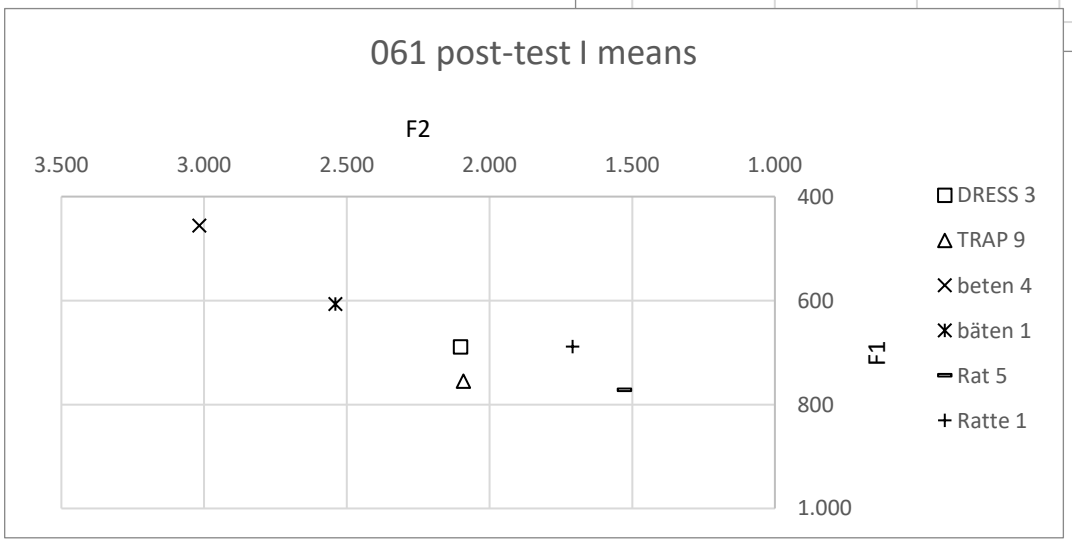
bäten 1
Rat 5
Ratte 1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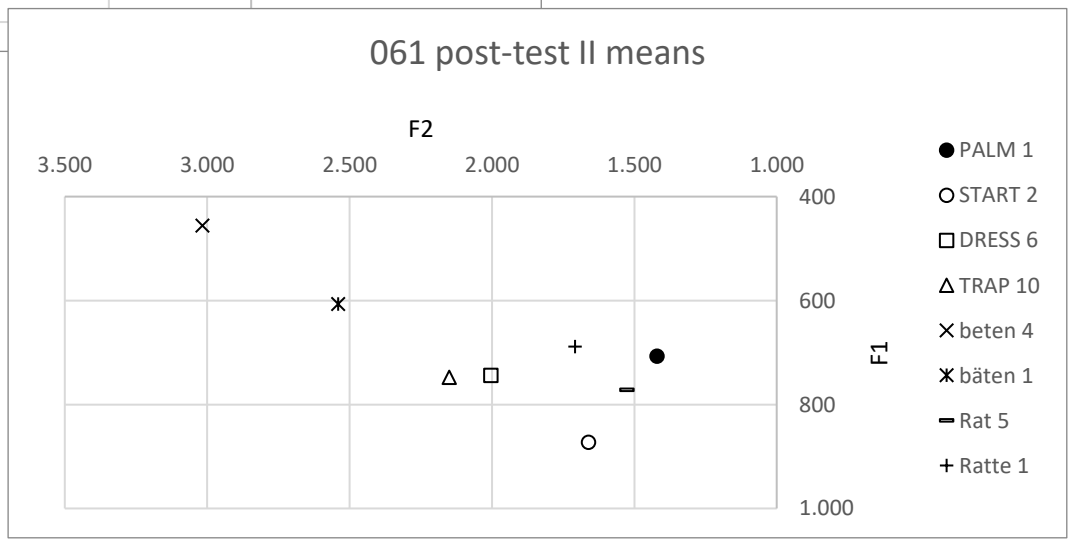
TRAP 9
beten 4
bäten 1
Rat 5
Ratte 1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START 2
DRESS 6
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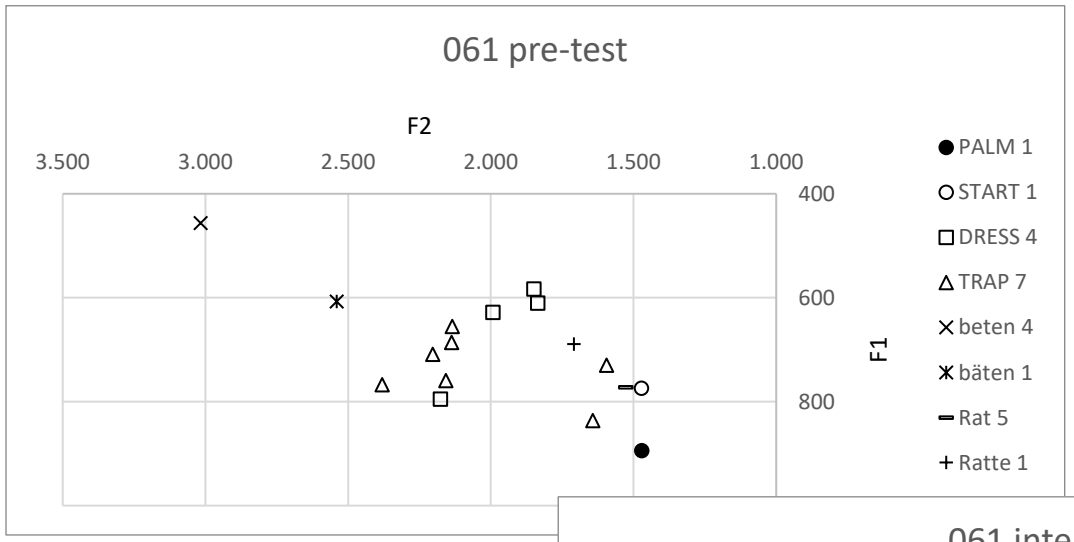
beten 4
bäten 1
Rat 5
Ratte 1


061 pre-test
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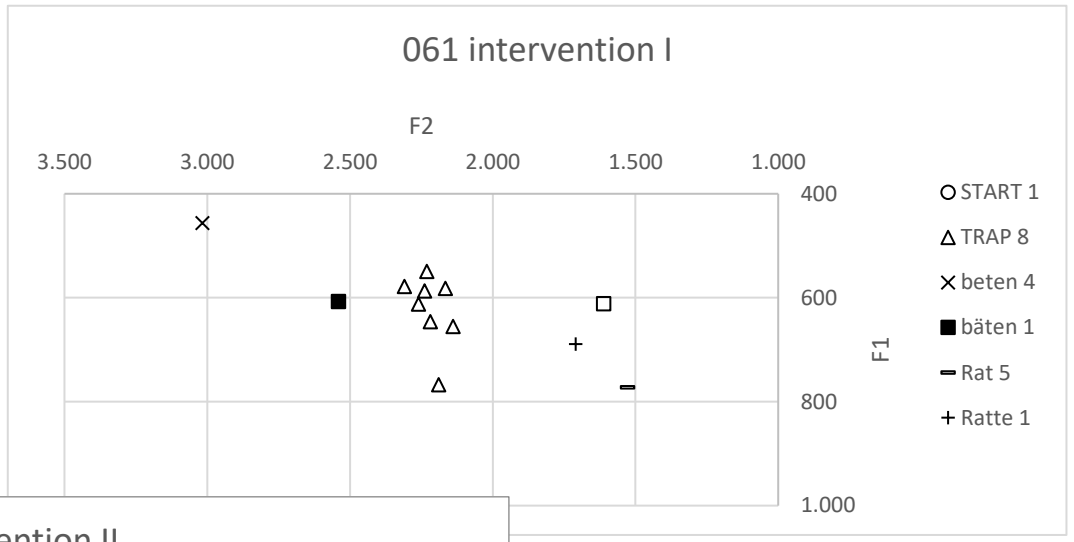
Ratte 1


061 intervention I
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TRAP 8
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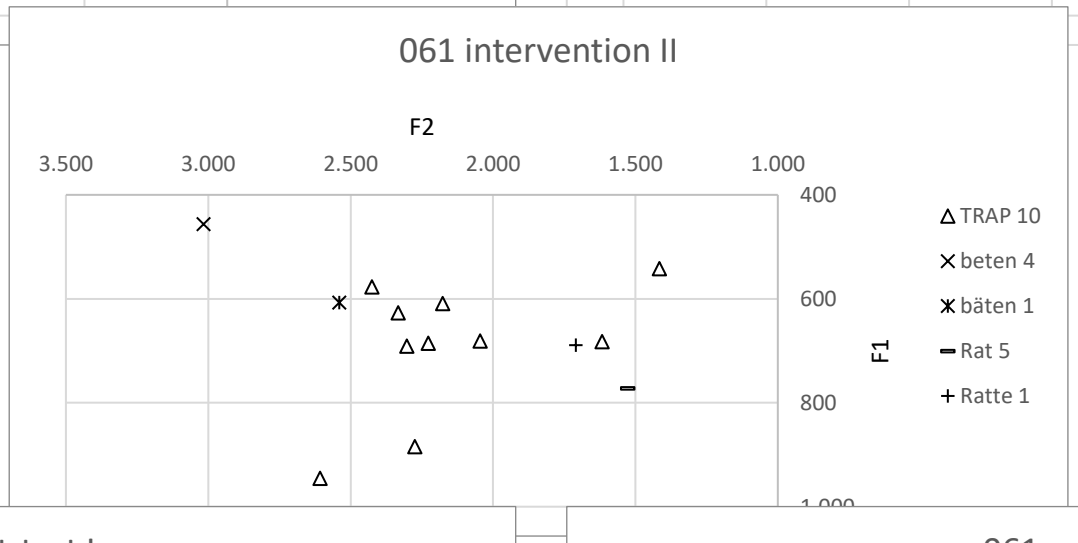
bäten 1
Rat 5
Ratte 1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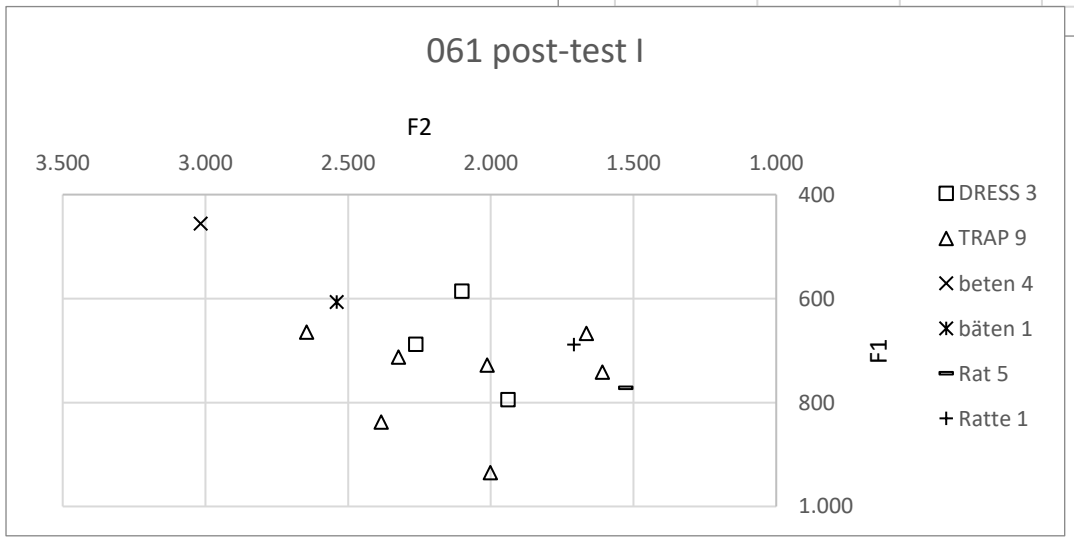
800
F1
TRAP 10
beten 4
bäten 1
Rat 5
Ratte 1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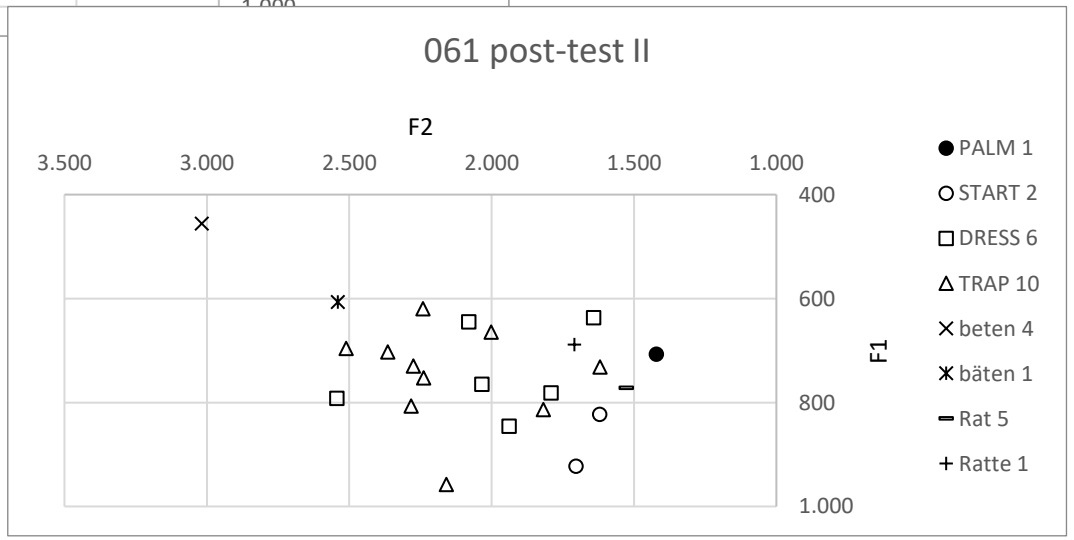
bäten 1
Rat 5
Ratte 1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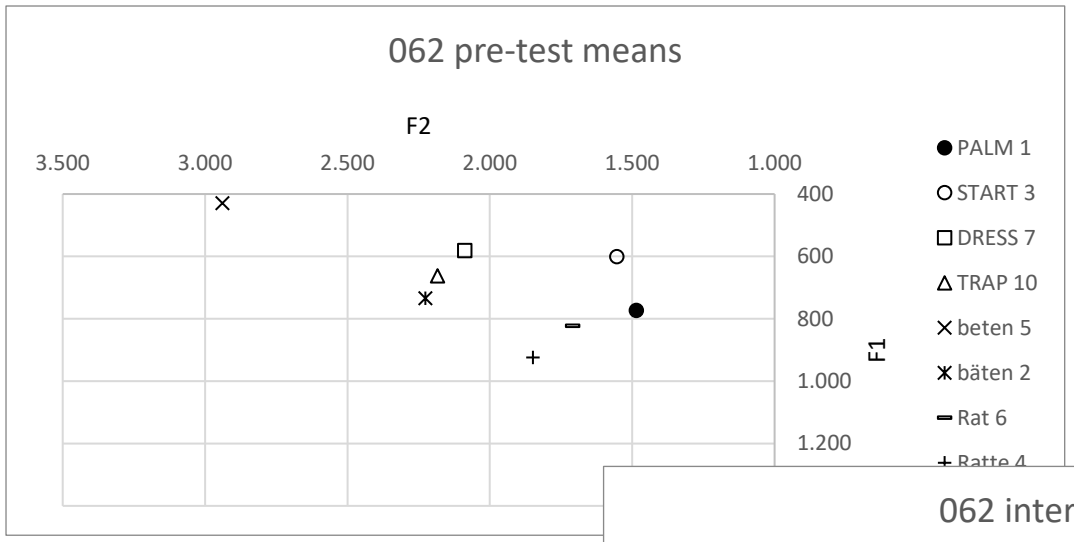
Rat 5
Ratte 1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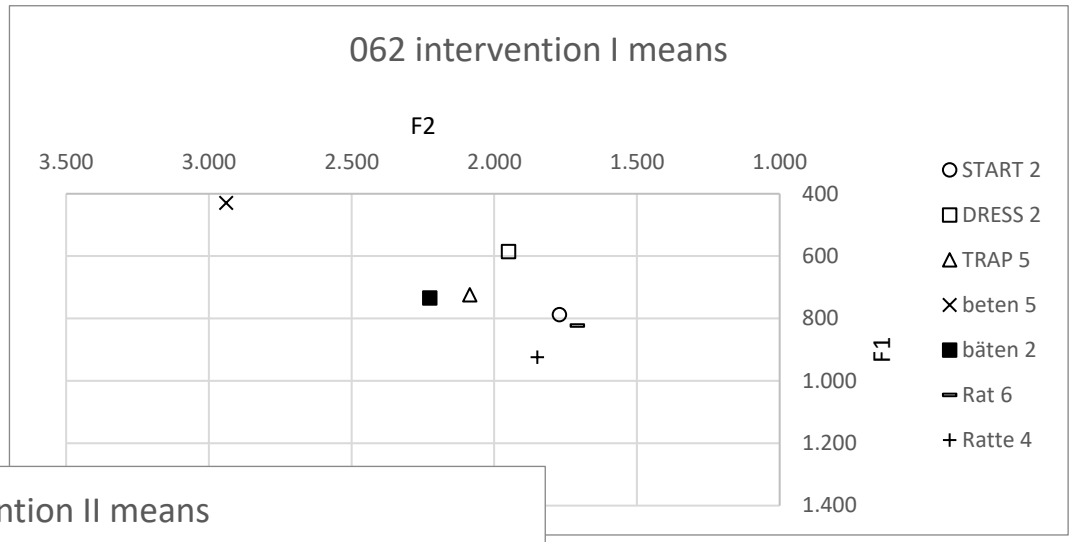
bäten 2
Rat 6
Ratte 4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TRAP 5
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bäten 2
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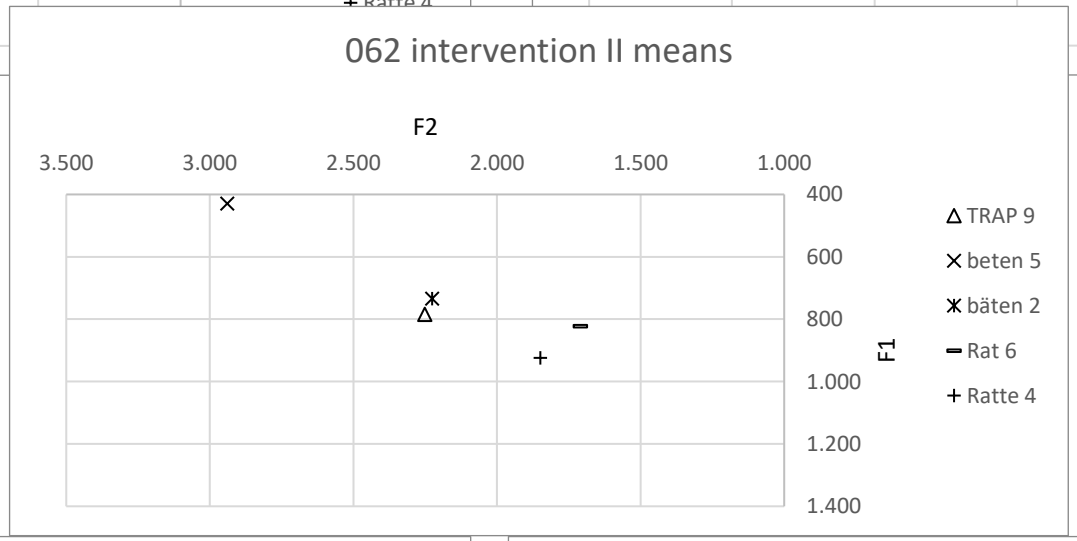
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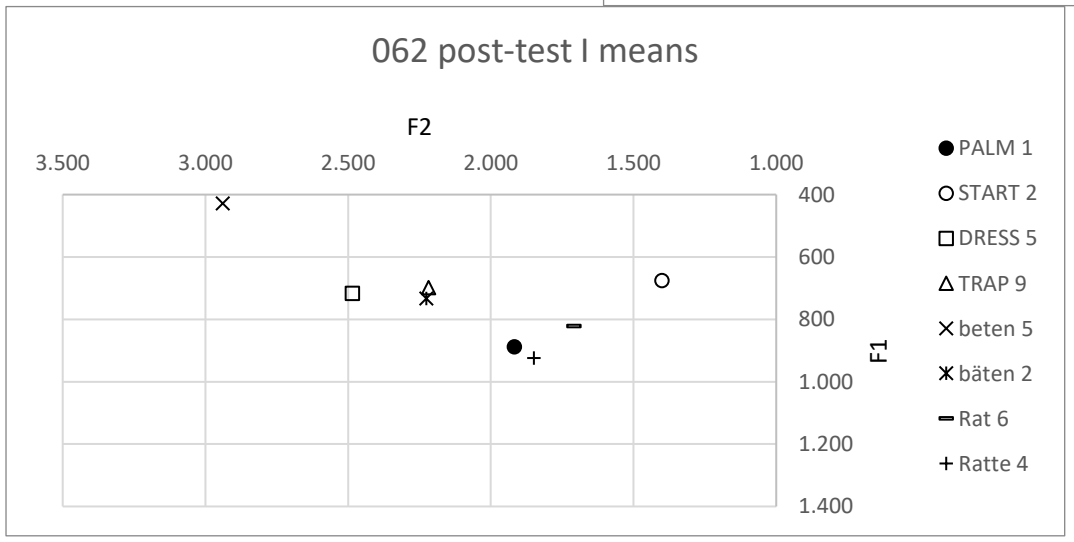
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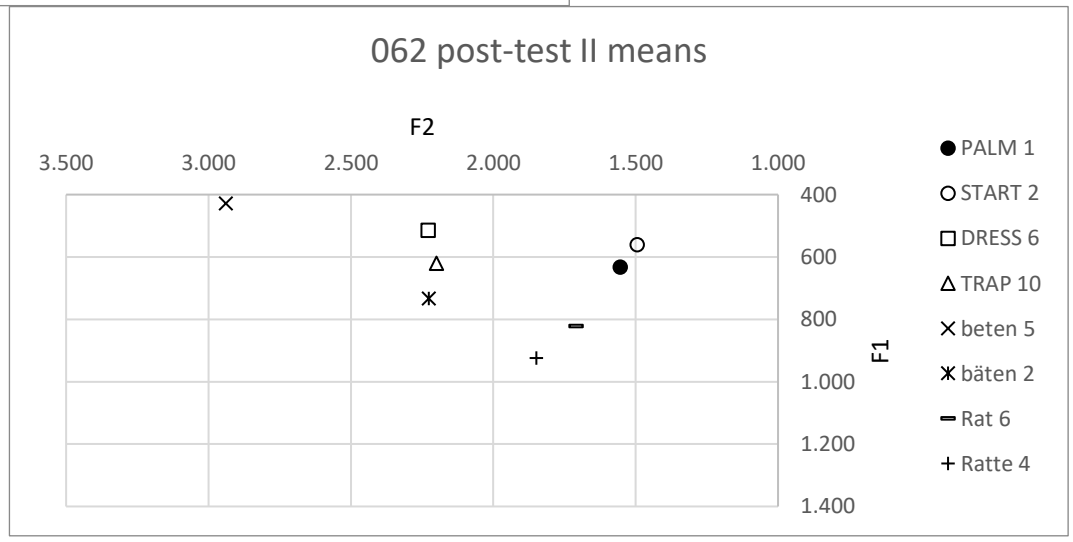
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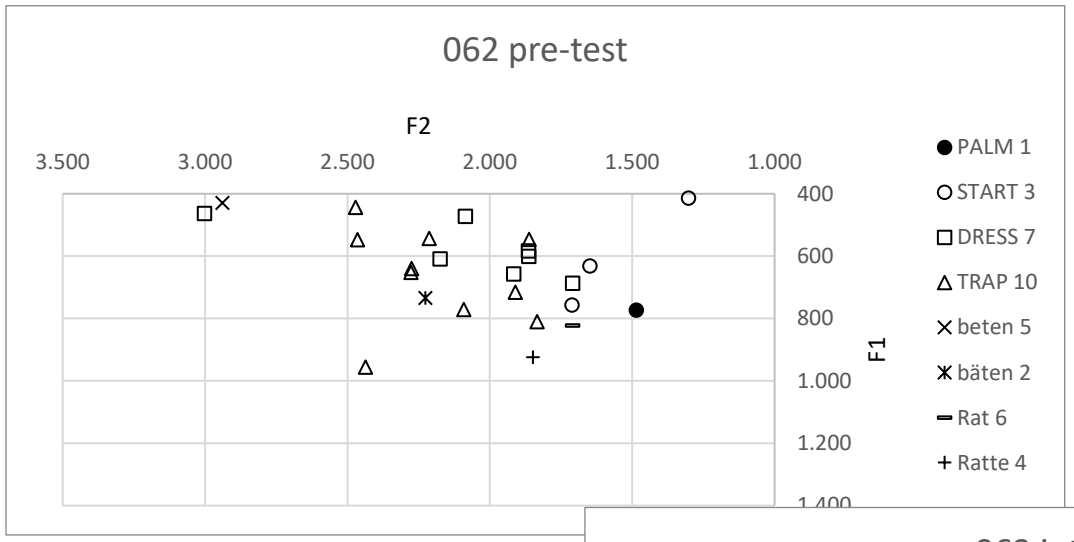
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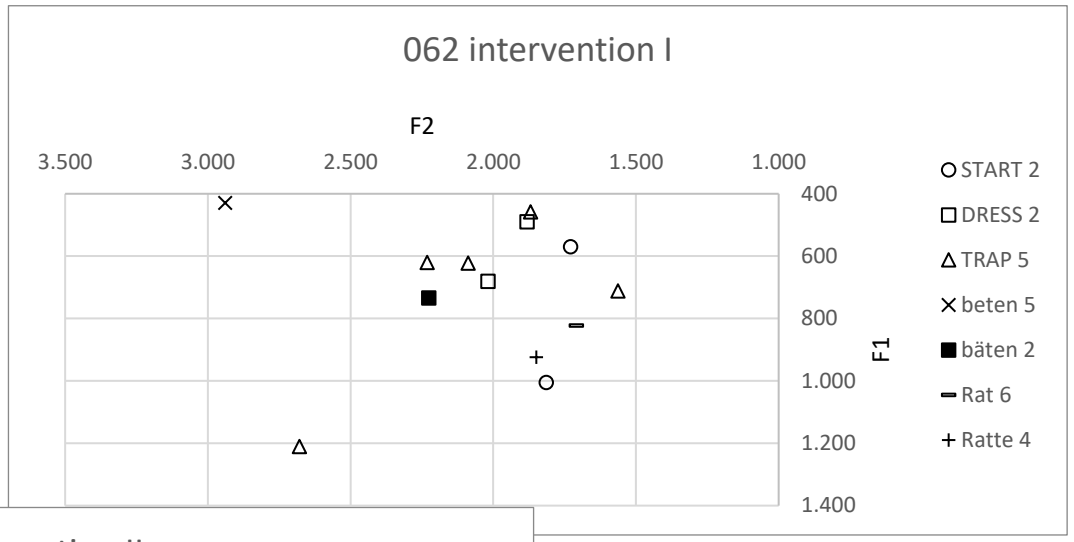
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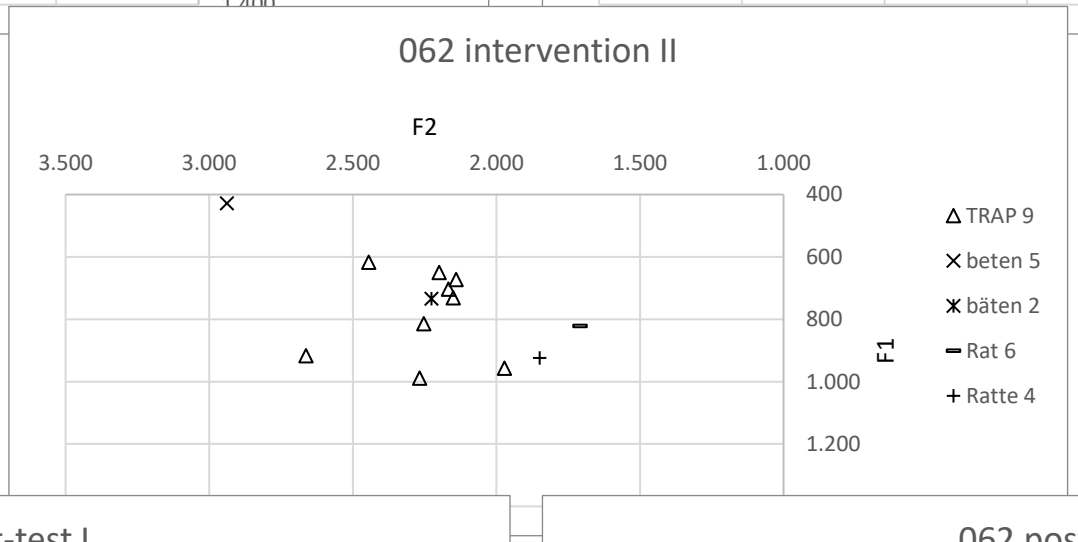
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bäten 2
Rat 6
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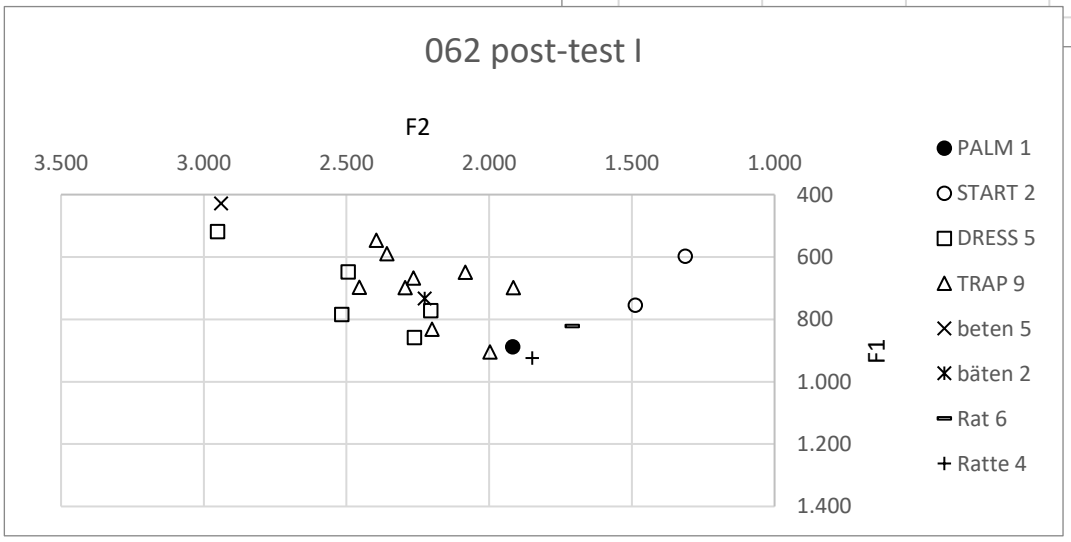
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bäten 2
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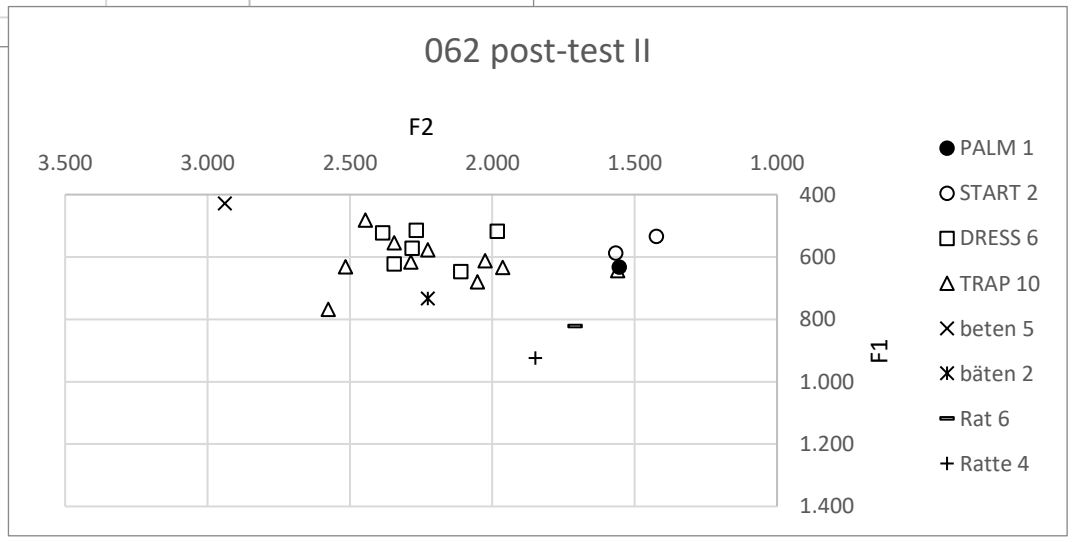
Ratte 4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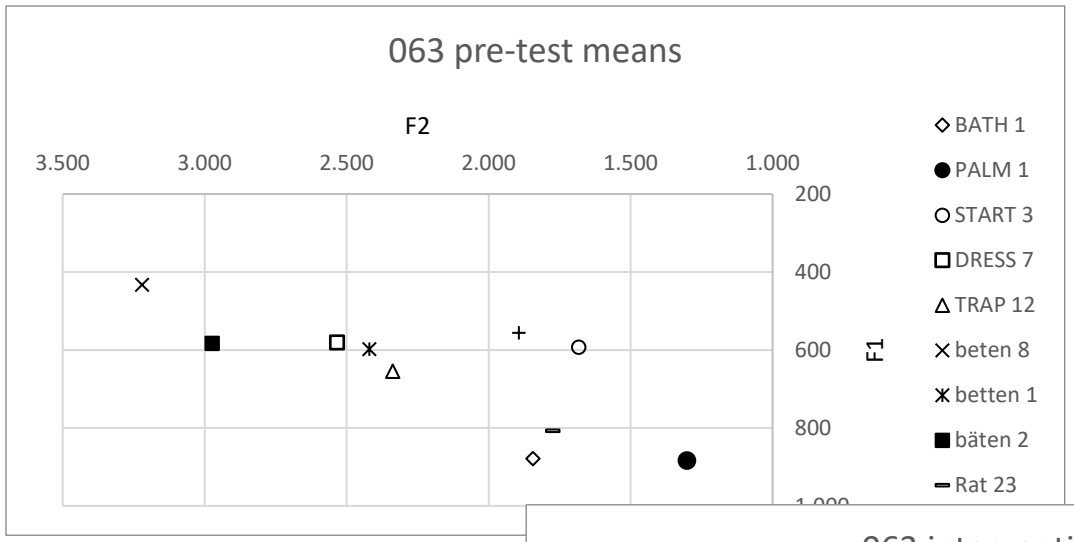
bäten 2
Rat 6
Ratte 4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betten 1
bäten 2
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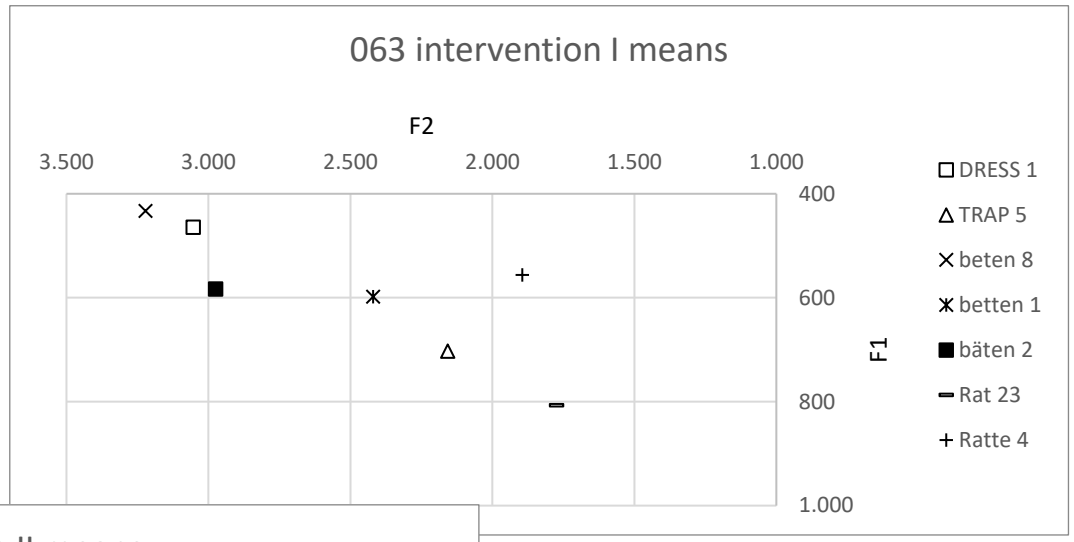
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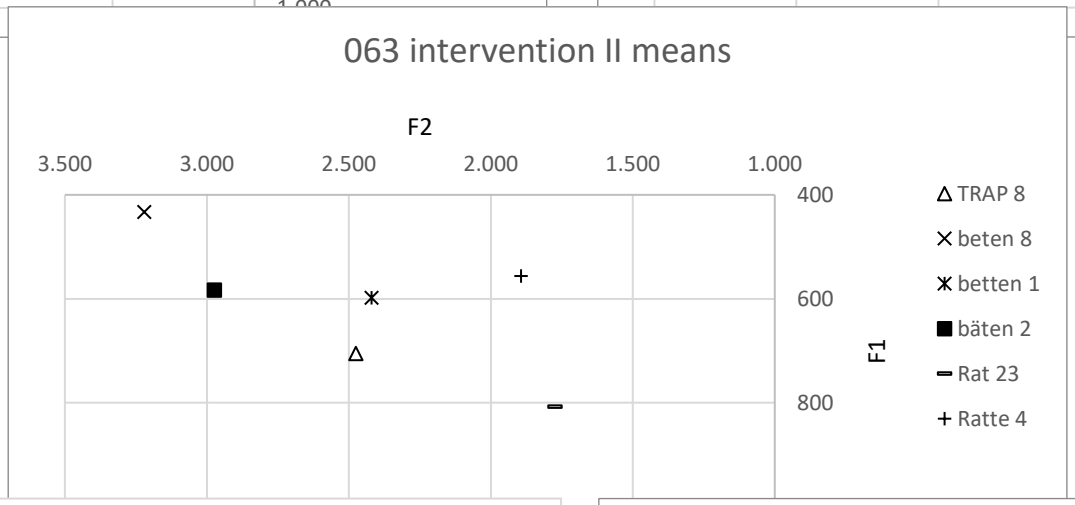
bäten 2
Rat 23
Ratte 4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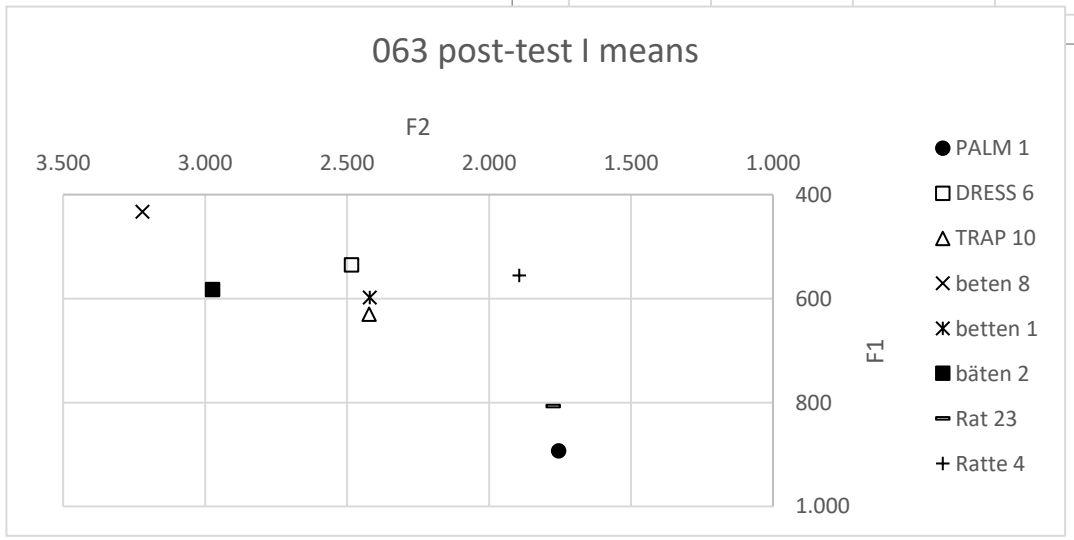
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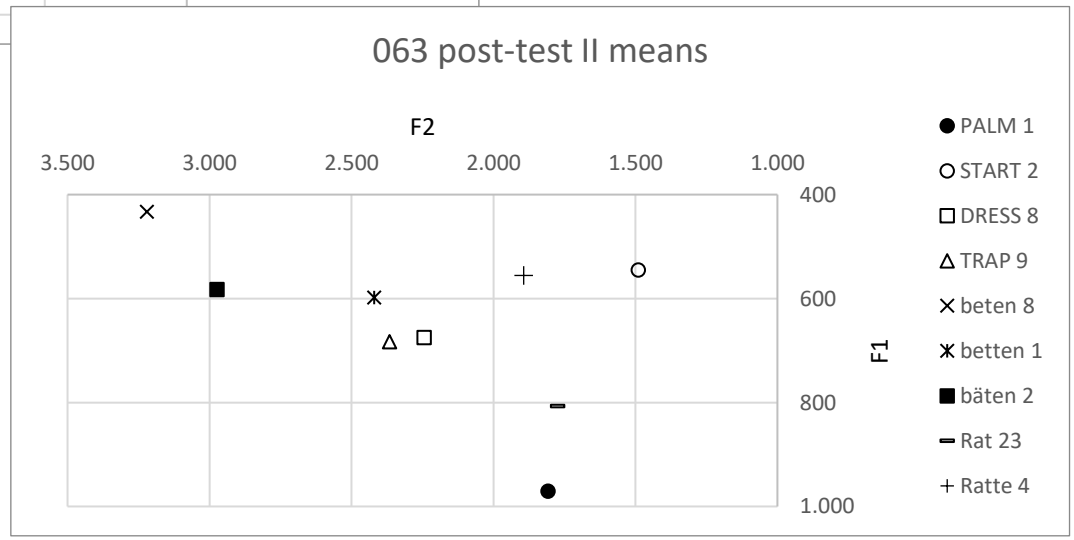
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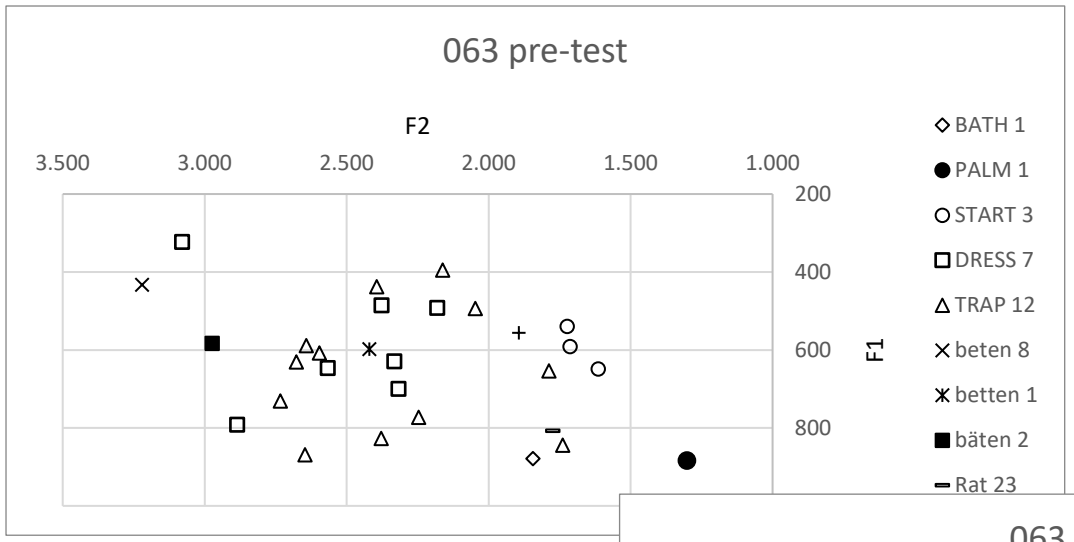
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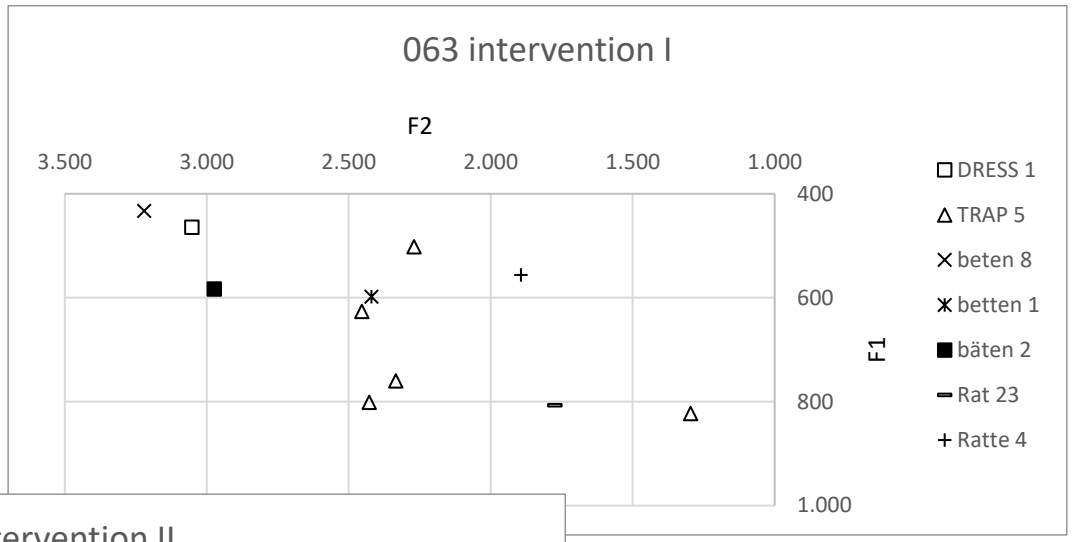
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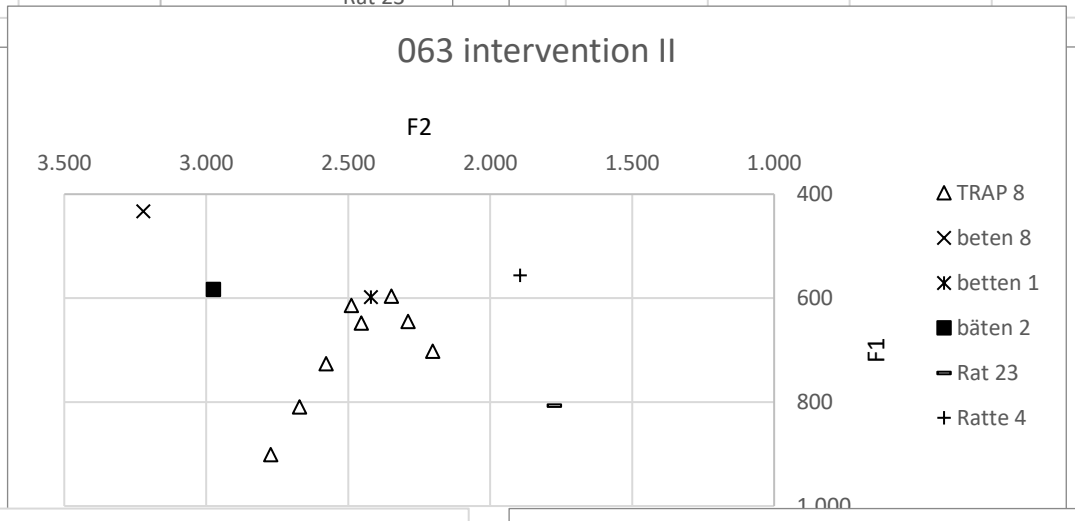
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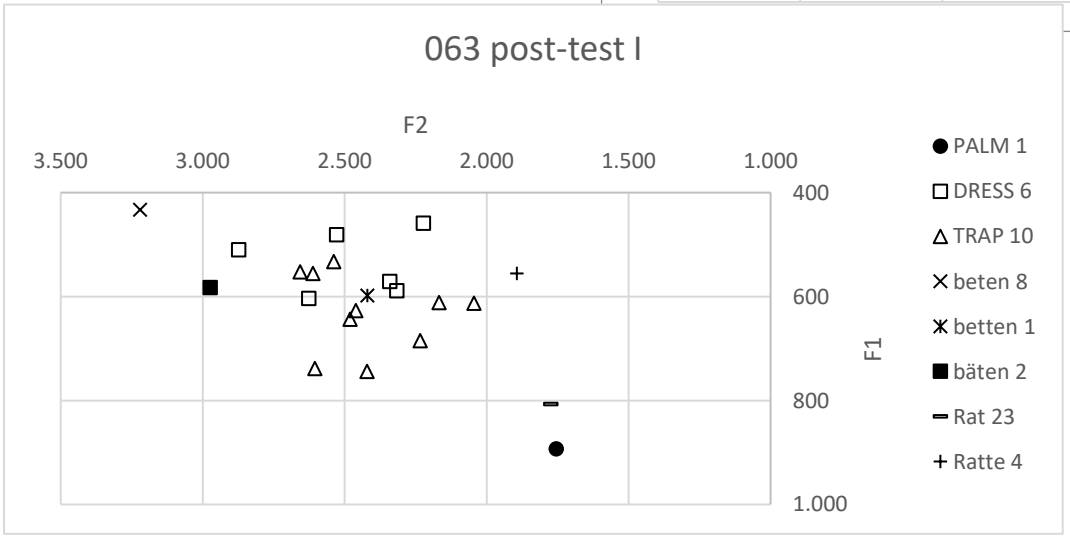
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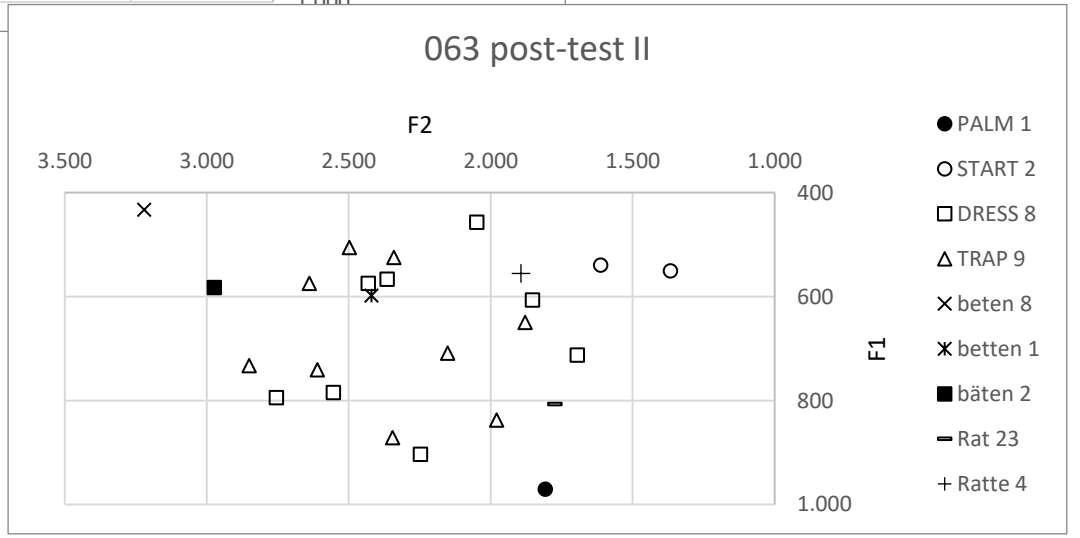
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bäten 2
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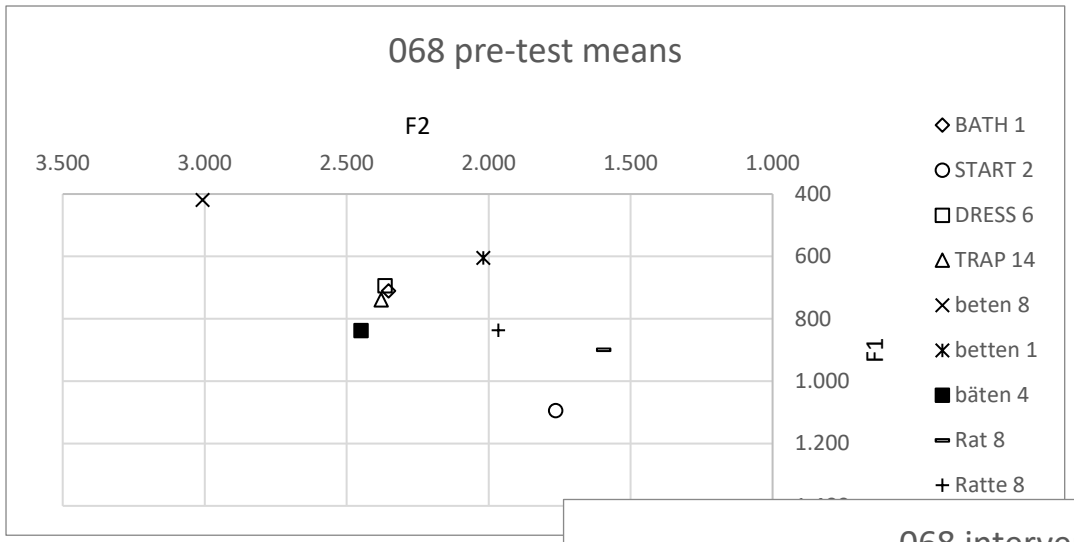
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START 2
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bäten 4
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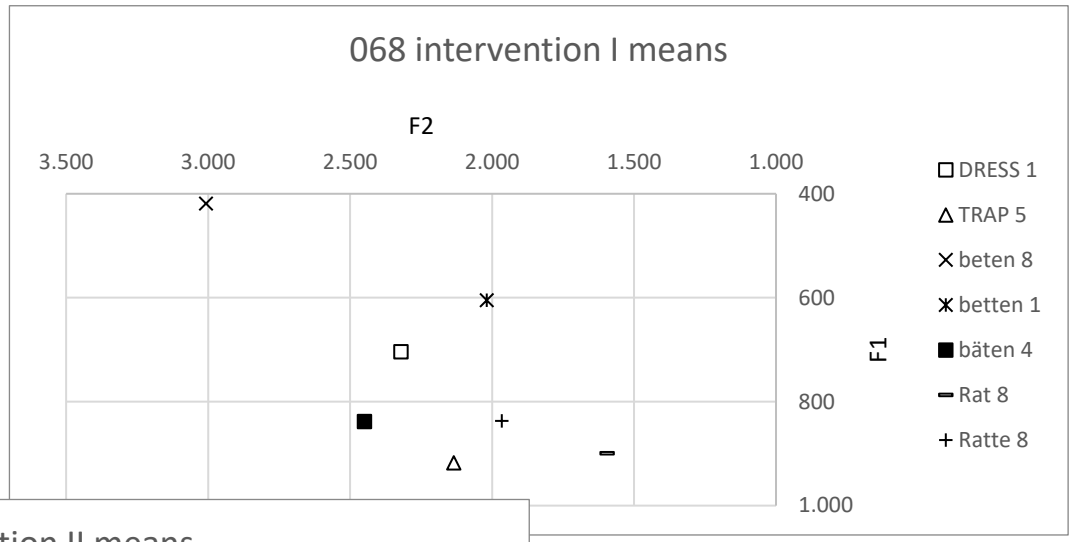
Ratte 8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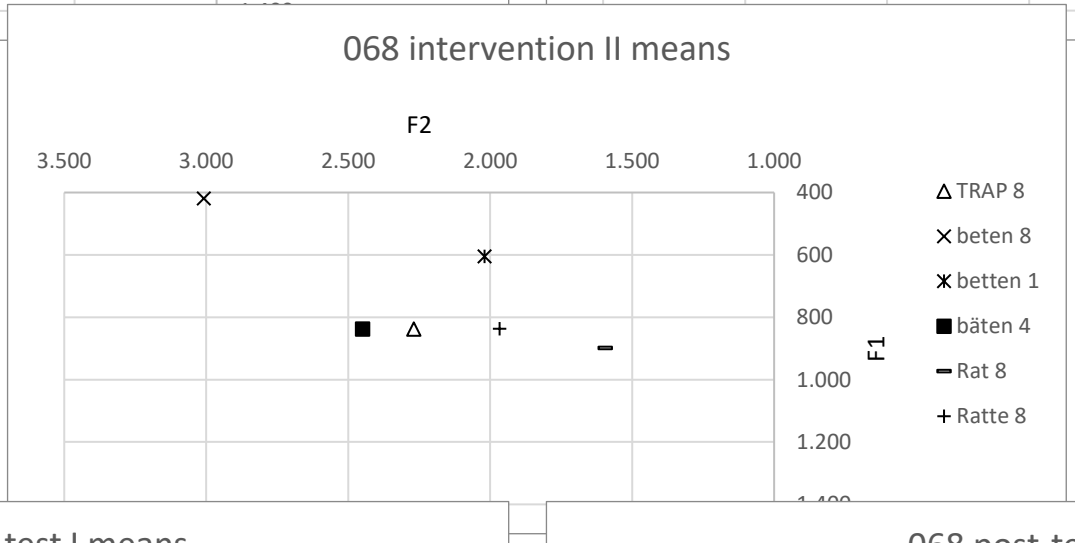
bäten 4
Rat 8
Ratte 8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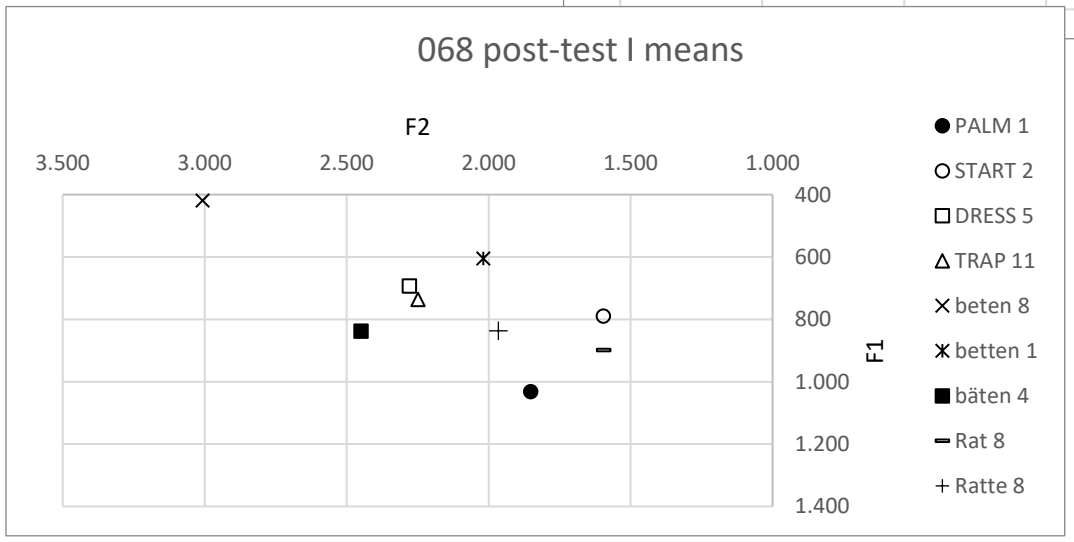
betten 1
bäten 4
Rat 8
Ratte 8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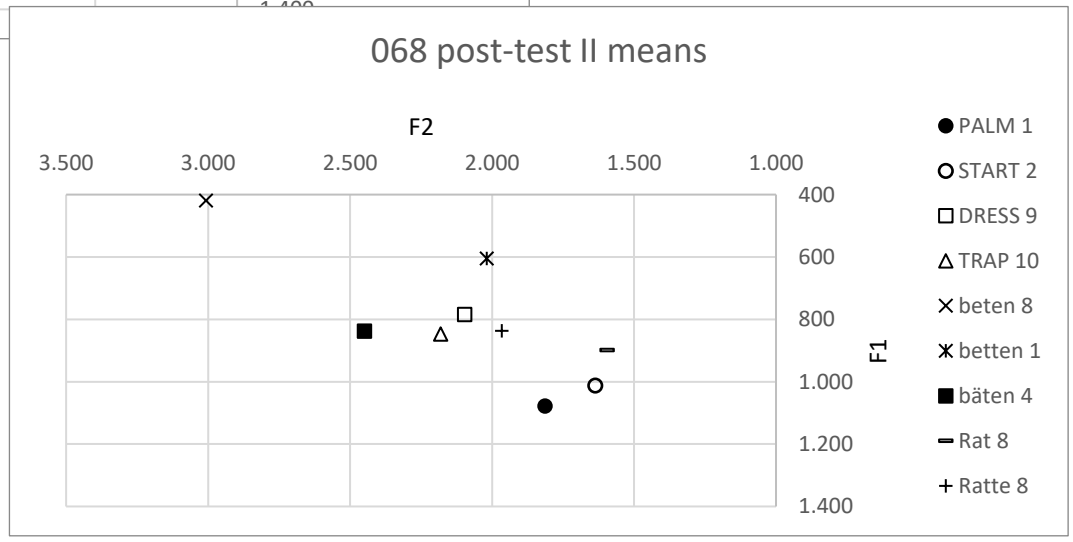
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bäten 4
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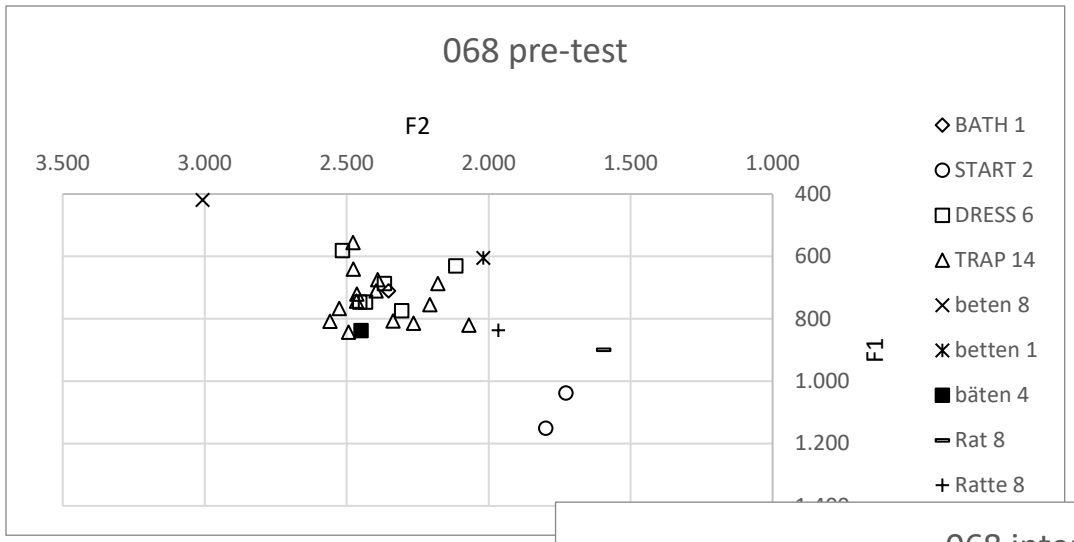
Ratte 8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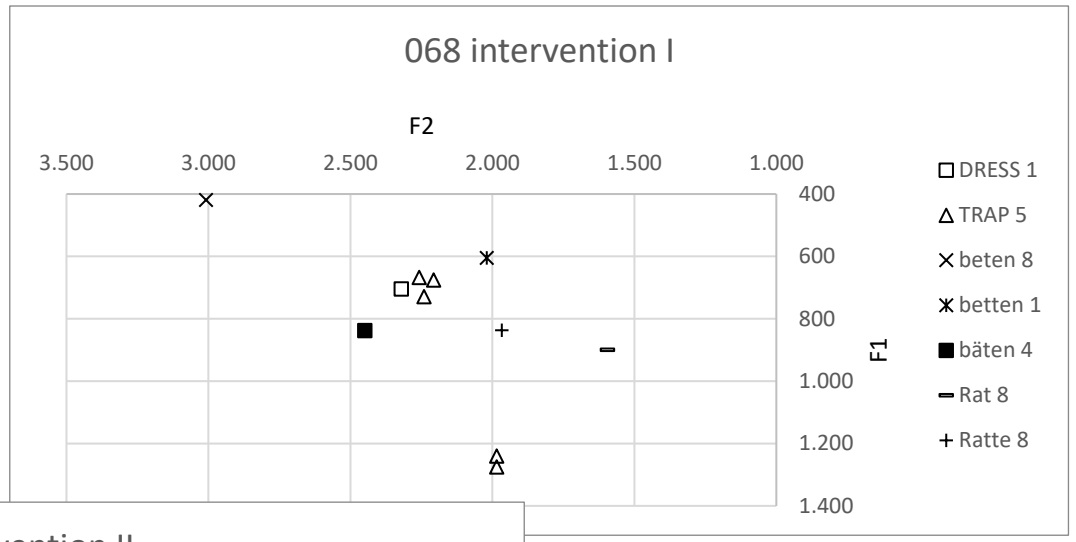
Ratte 8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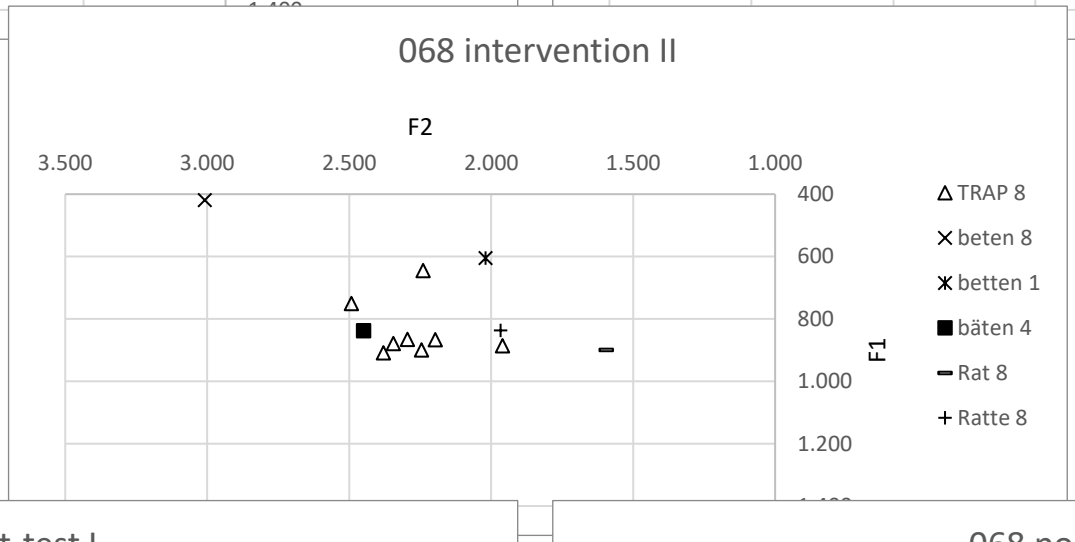
Ratte 8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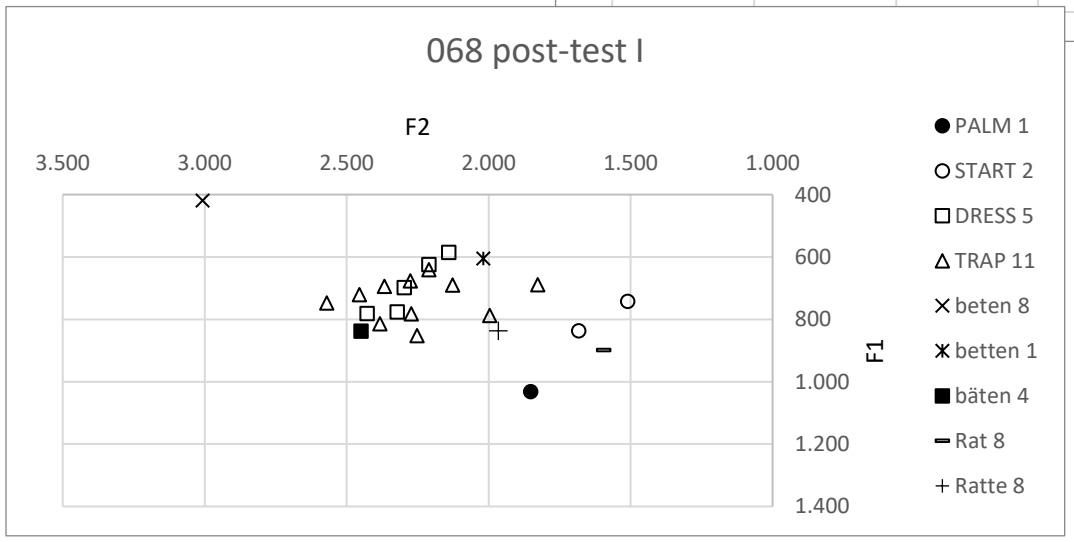
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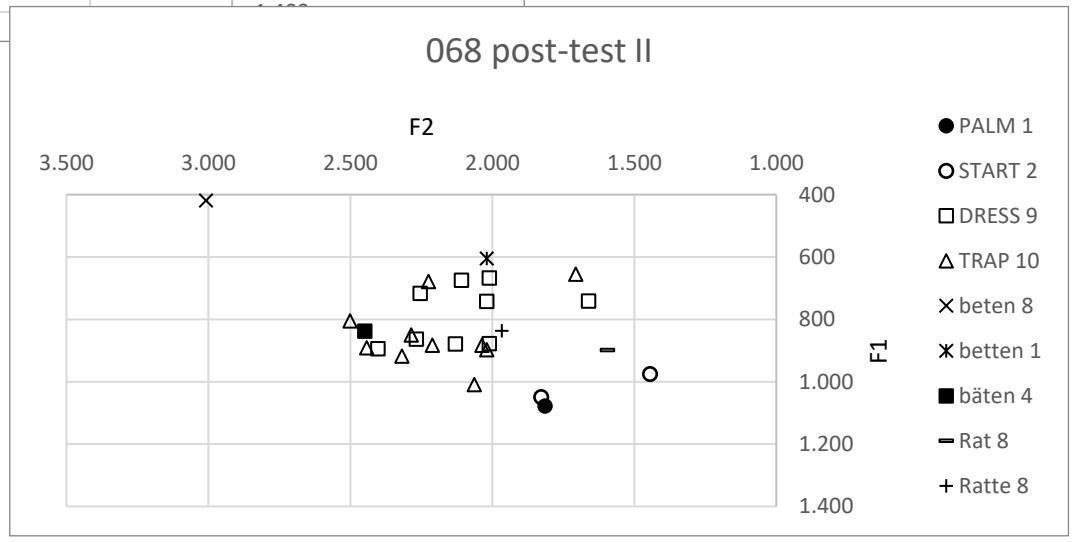
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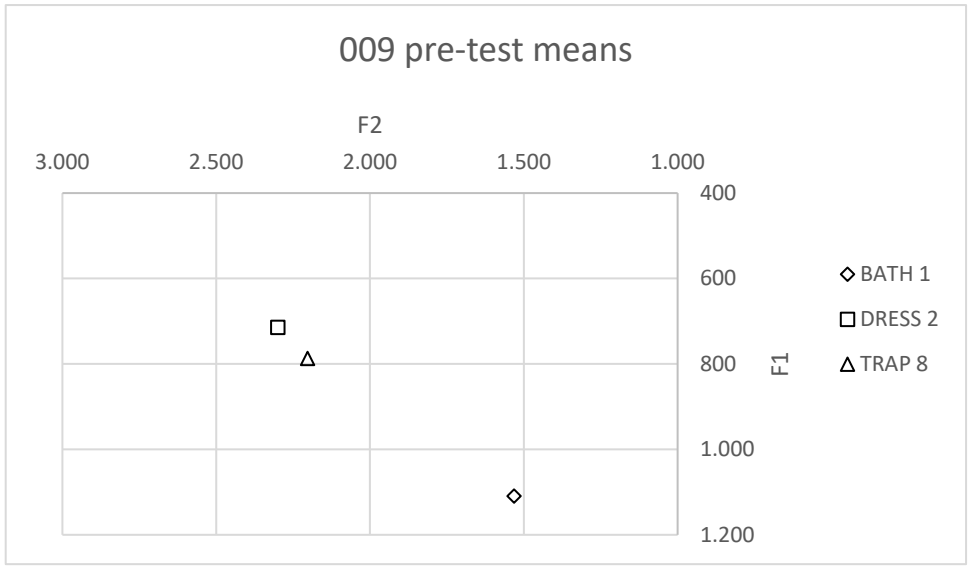
1.400
F1
PALM 1
START 2
DRESS 9
TRAP 10
beten 8
betten 1
bäten 4
Rat 8
Ratte 8

Analysis of TRAP

Vowel plots for participants of the control group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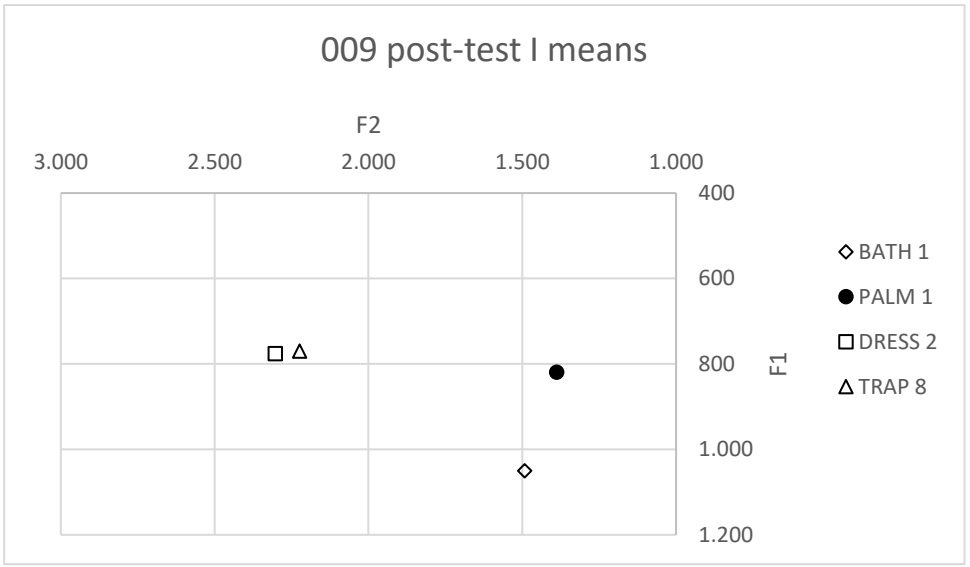
F1
BATH 1
DRESS 2
TRAP 8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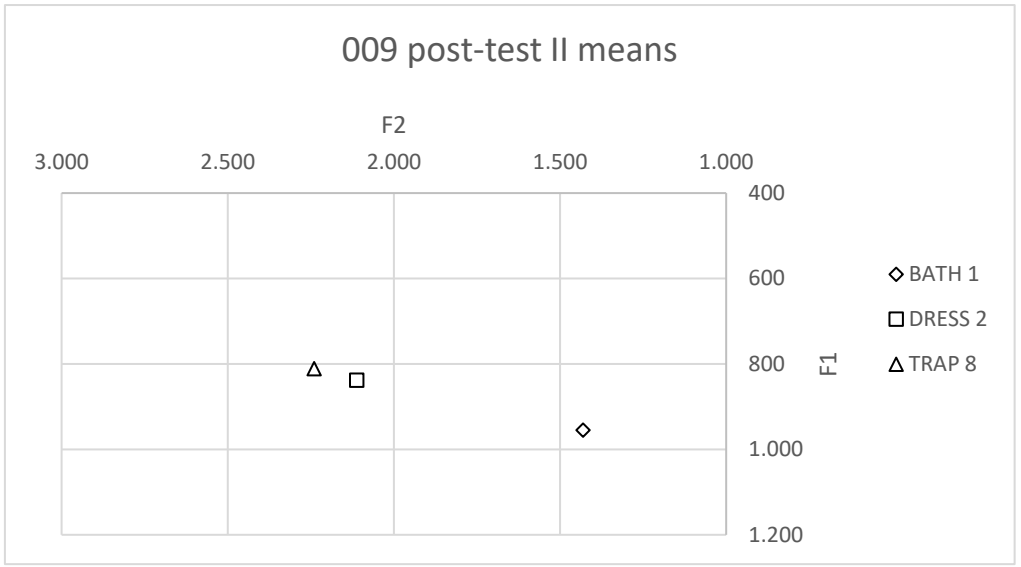
BATH 1
PALM 1
DRESS 2
TRAP 8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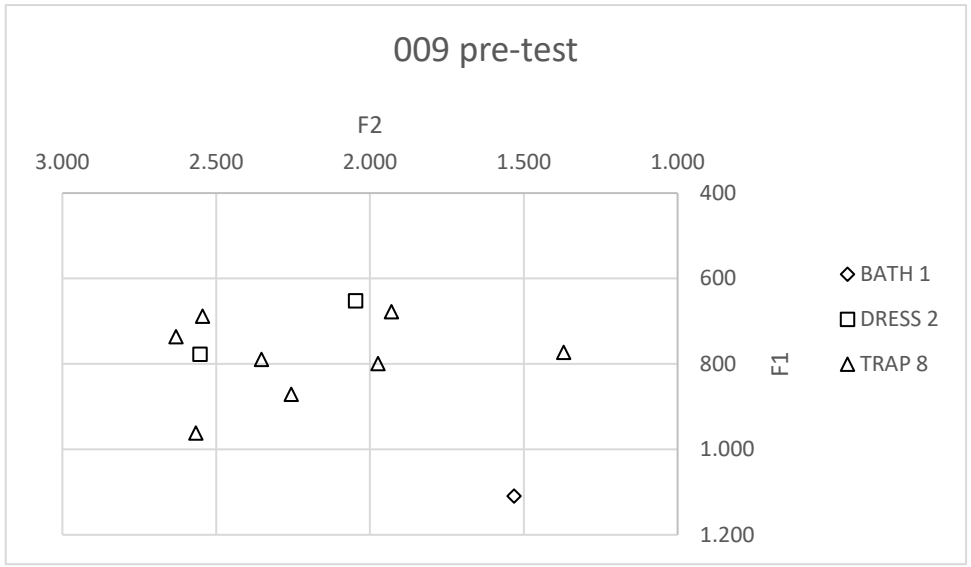
BATH 1
DRESS 2
TRAP 8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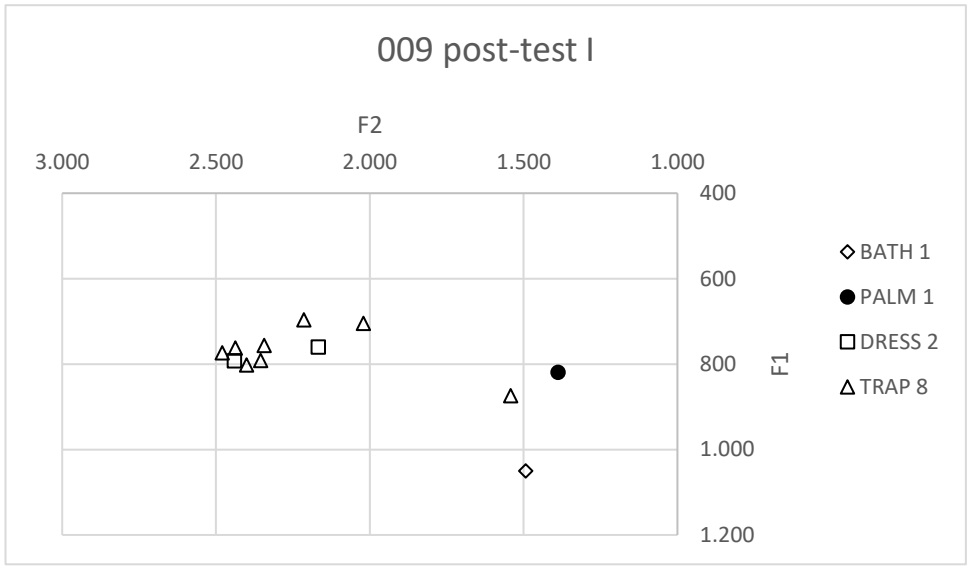
BATH 1
DRESS 2
TRAP 8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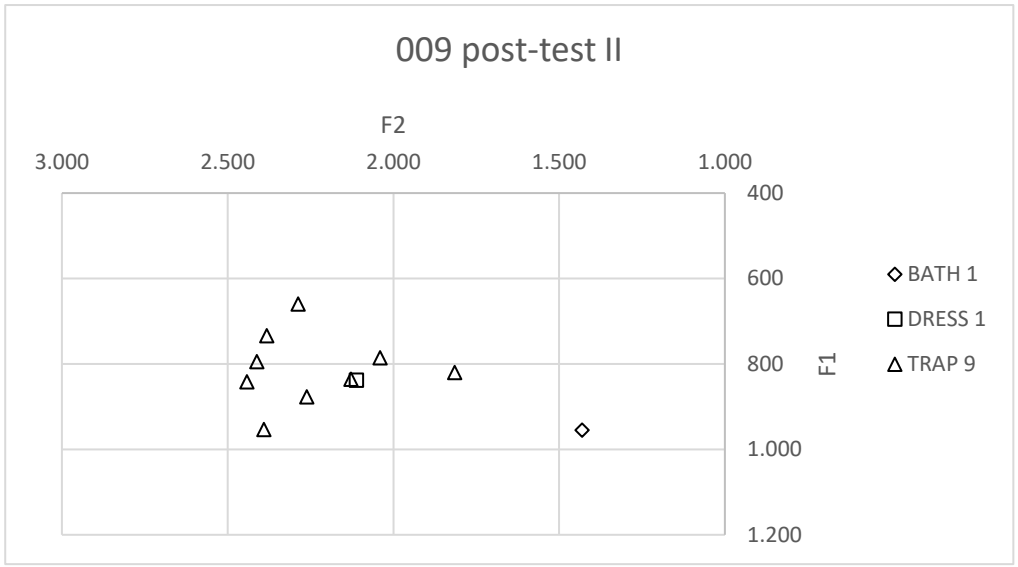
F1
BATH 1
PALM 1
DRESS 2
TRAP 8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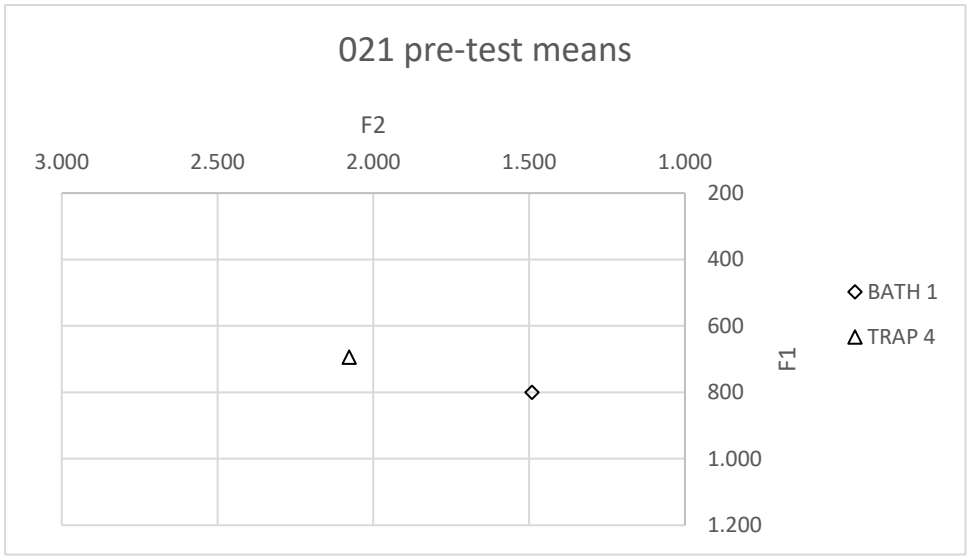
DRESS 1
TRAP 9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1.000
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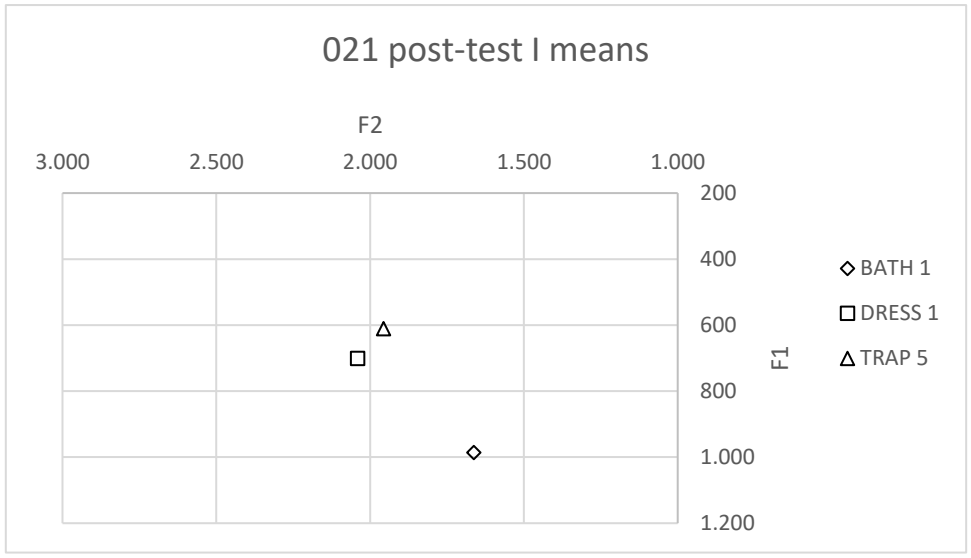
F1
BATH 1
TRAP 4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3.000
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F1
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DRESS 1
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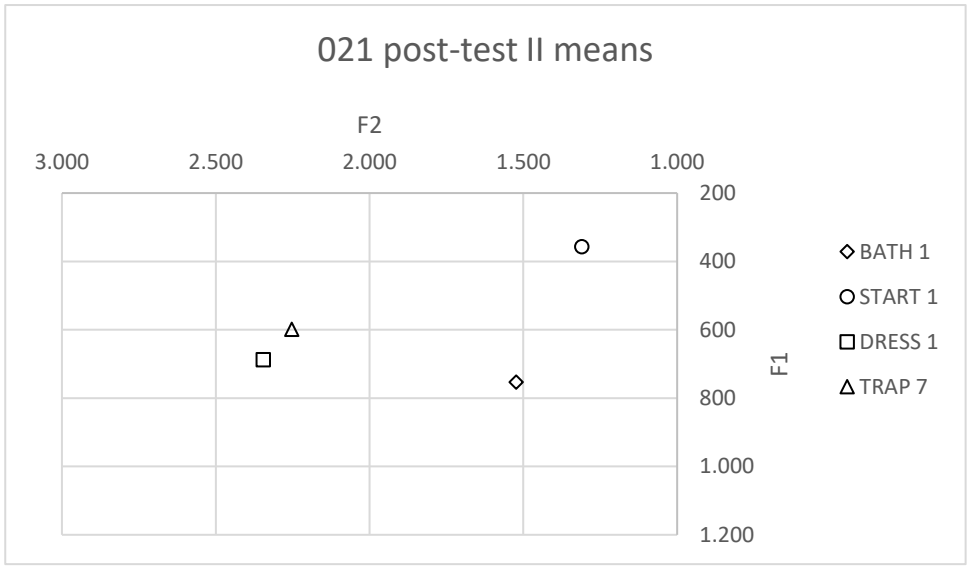
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F1
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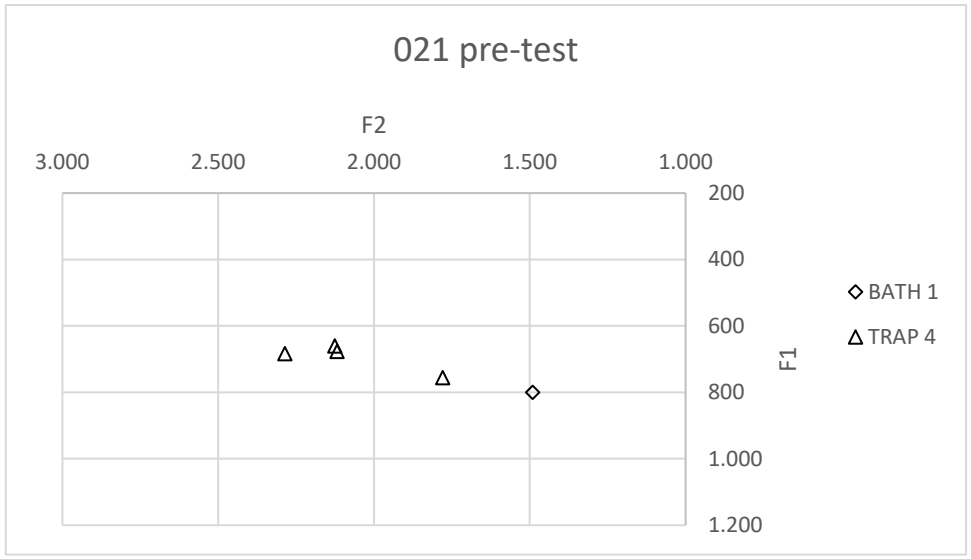
START 1
DRESS 1
TRAP 7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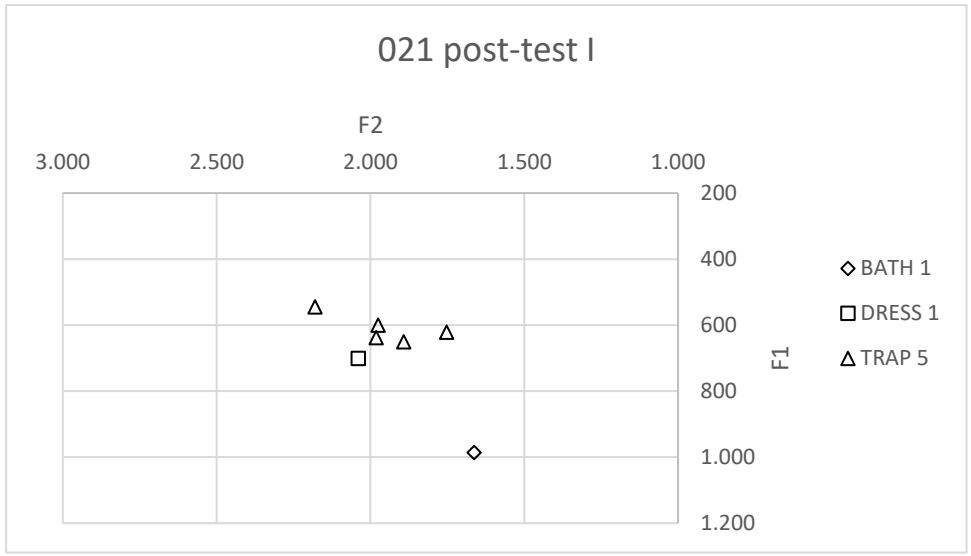
BATH 1
TRAP 4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DRESS 1
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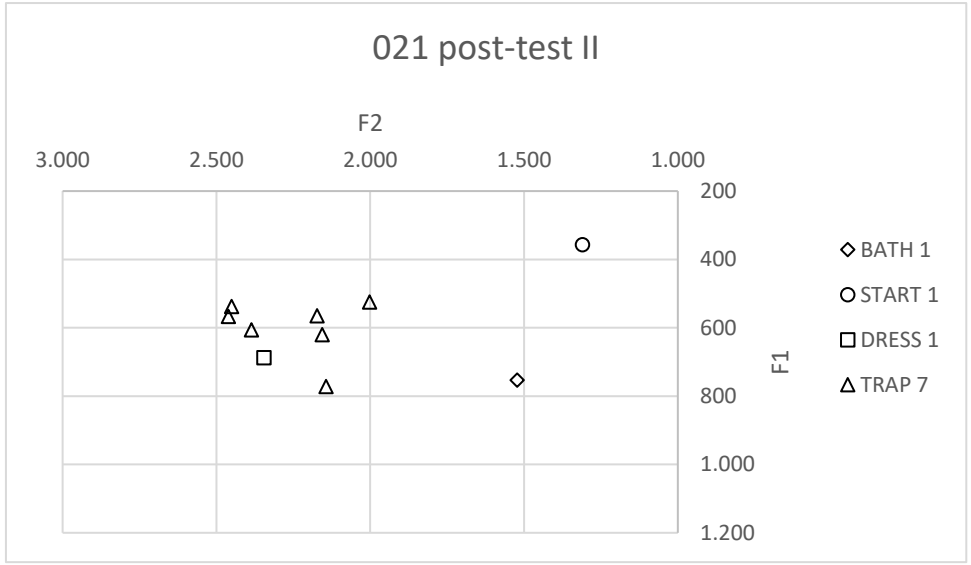
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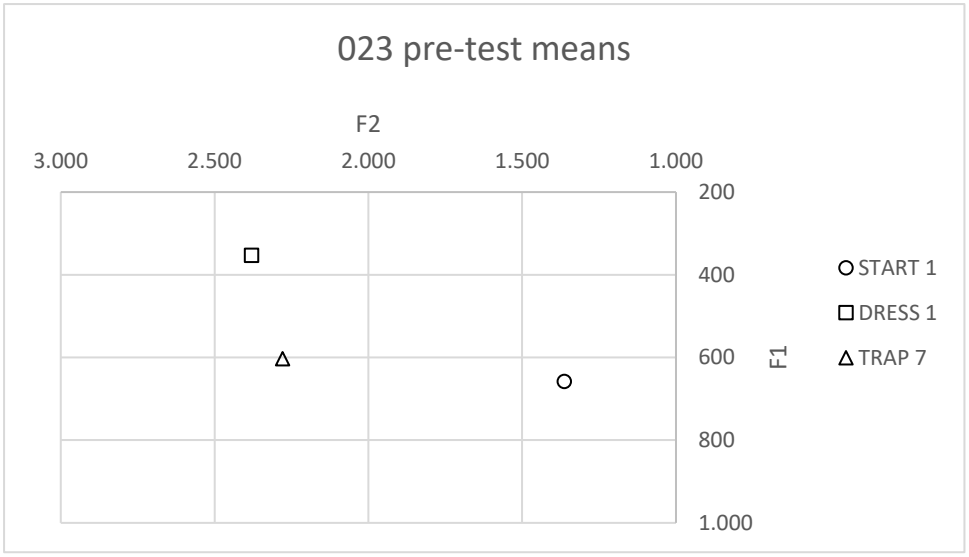
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START 1
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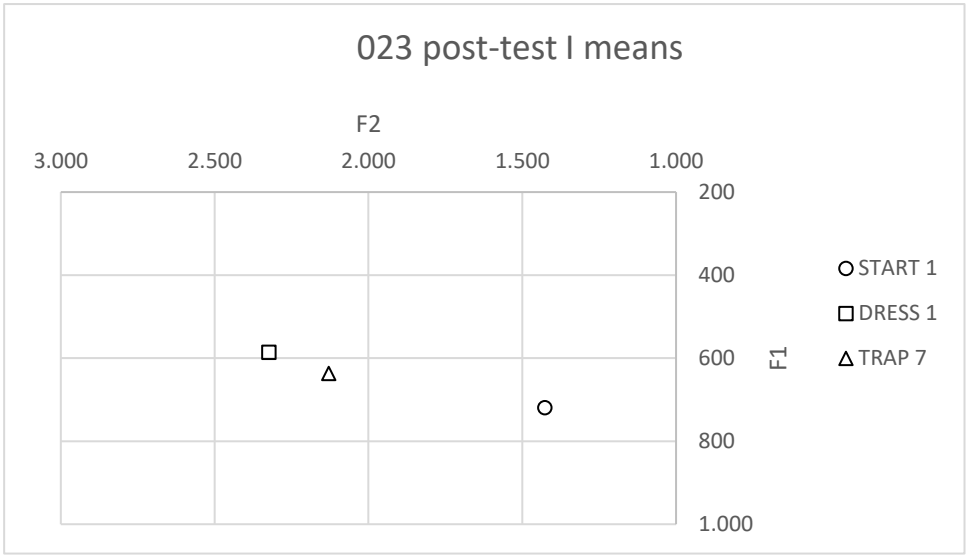
023 post-test I means
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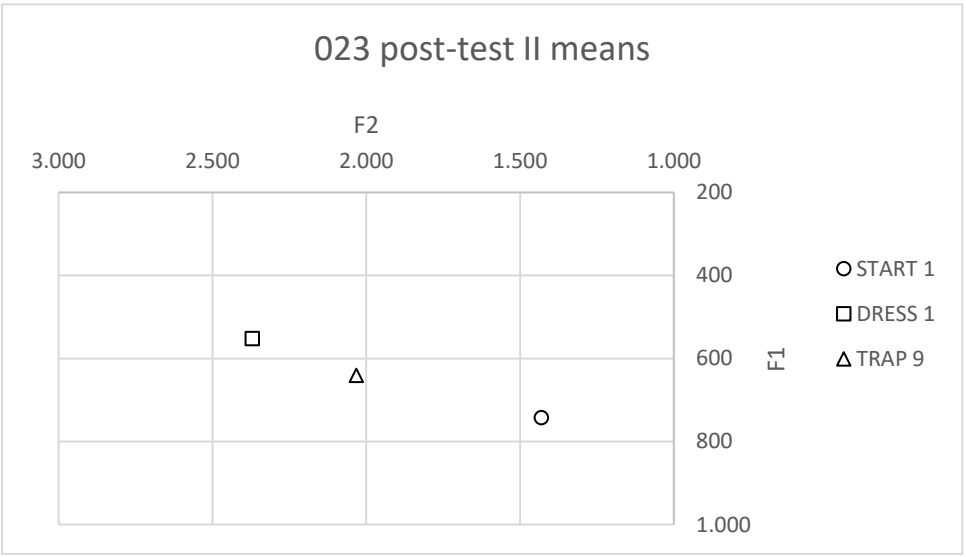
START 1
DRESS 1
TRAP 7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1.000
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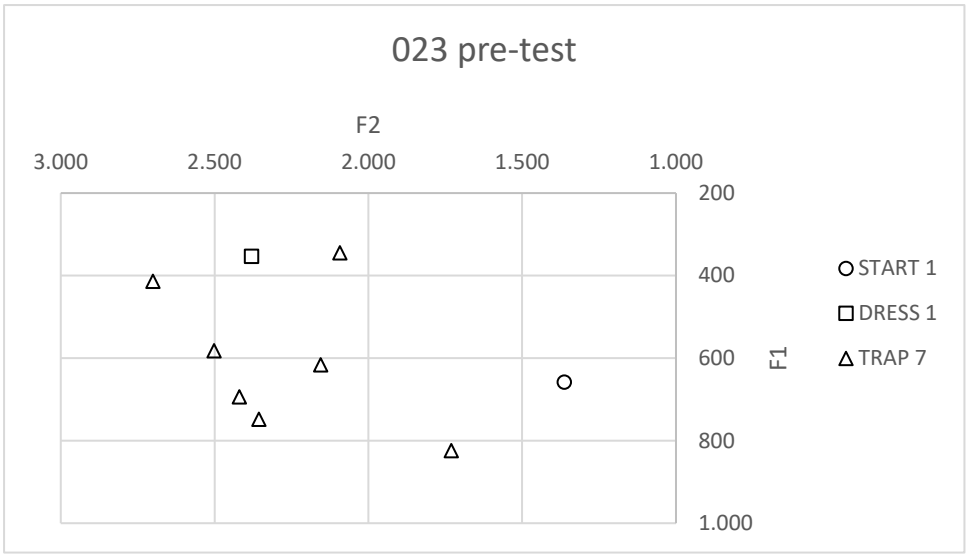
START 1
DRESS 1
TRAP 9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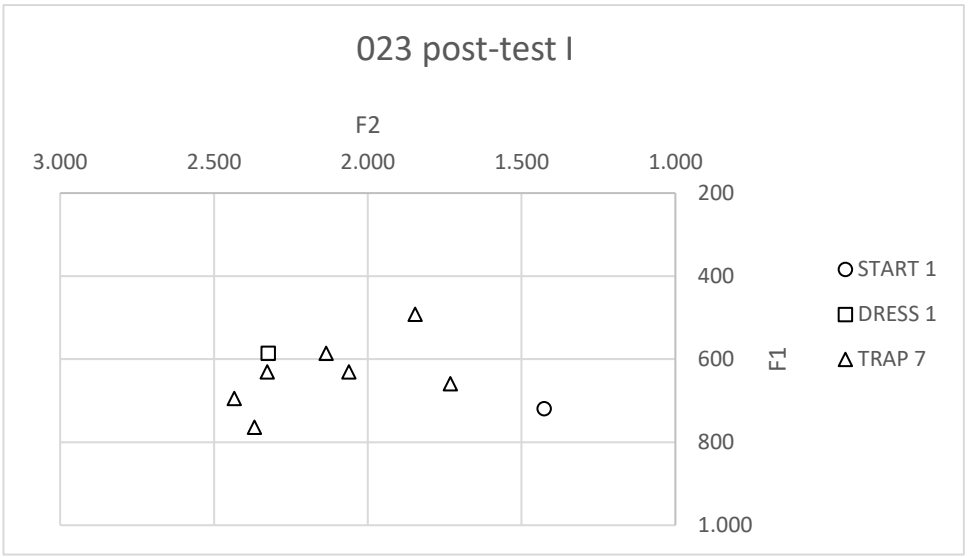
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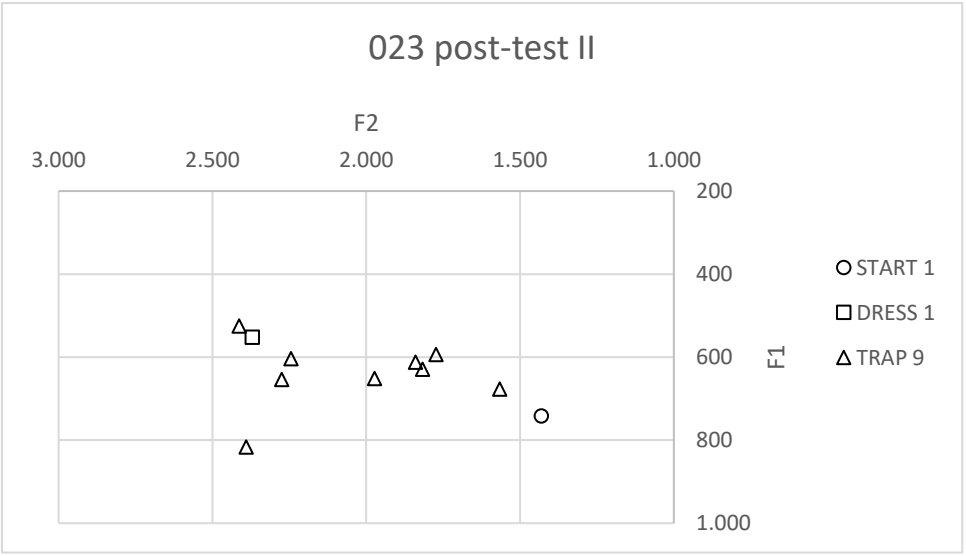
START 1
DRESS 1
TRAP 7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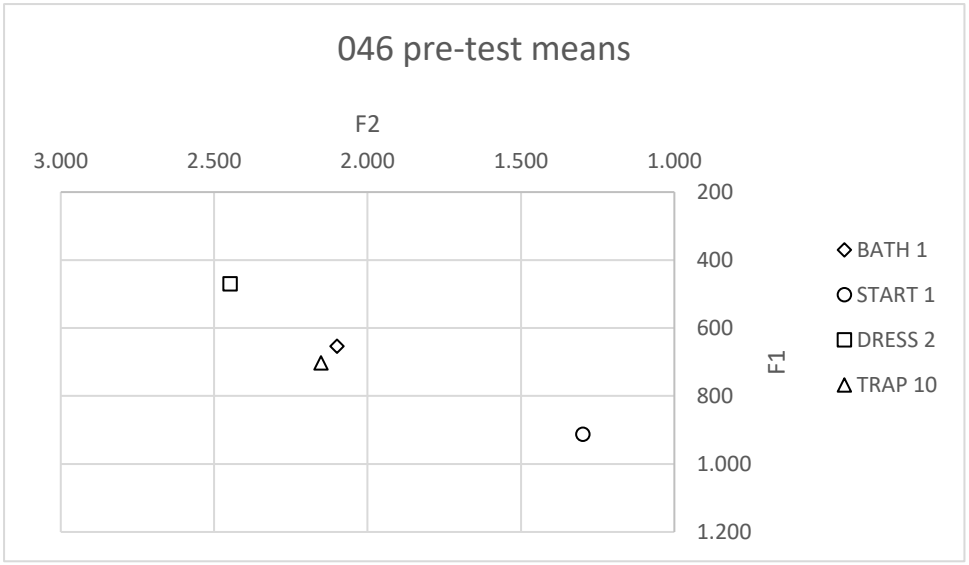
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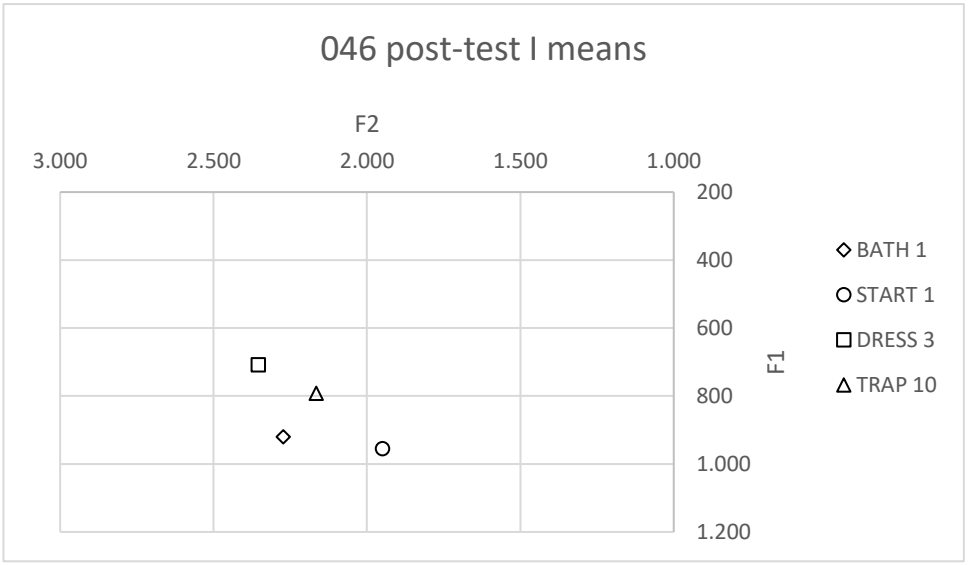
START 1
DRESS 2
TRAP 10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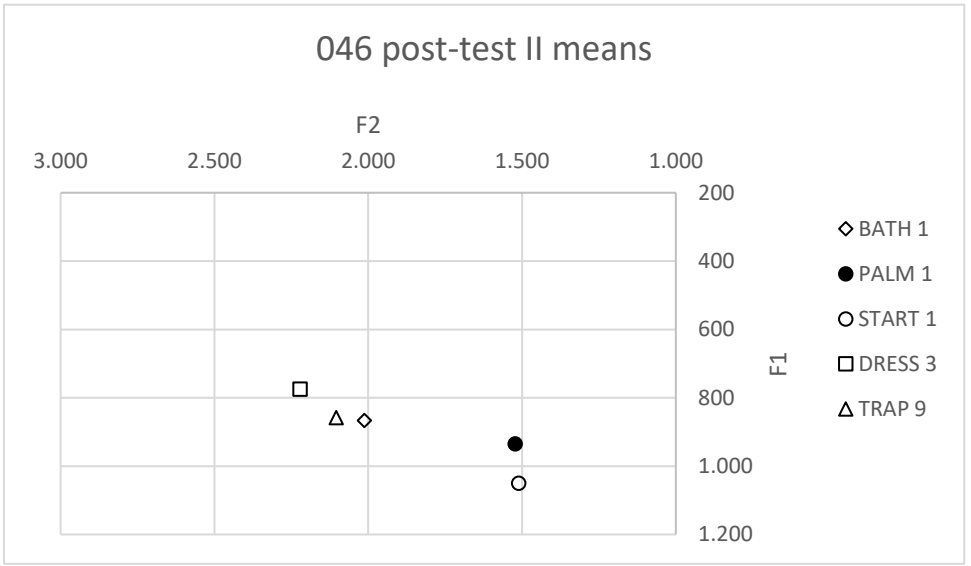
START 1
DRESS 3
TRAP 10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PALM 1
START 1
DRESS 3
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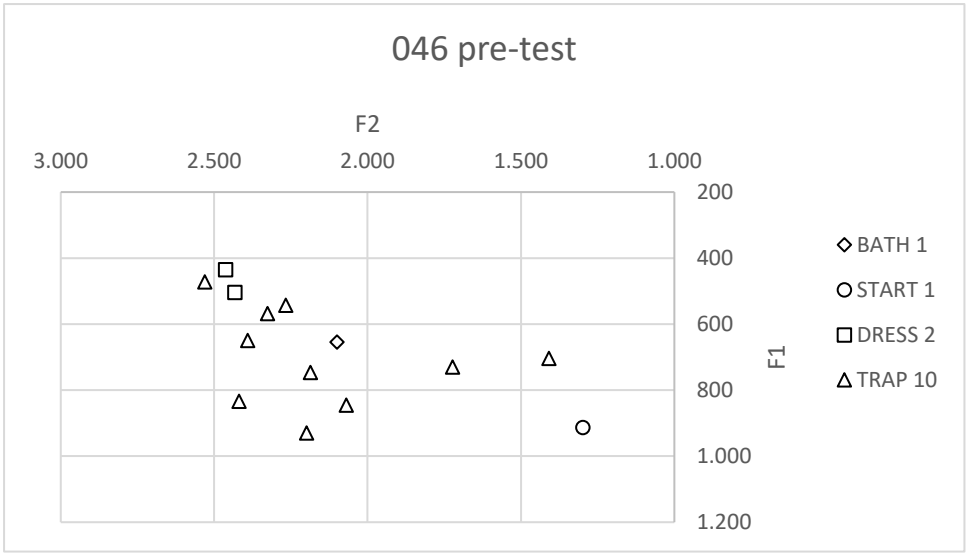
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START 1
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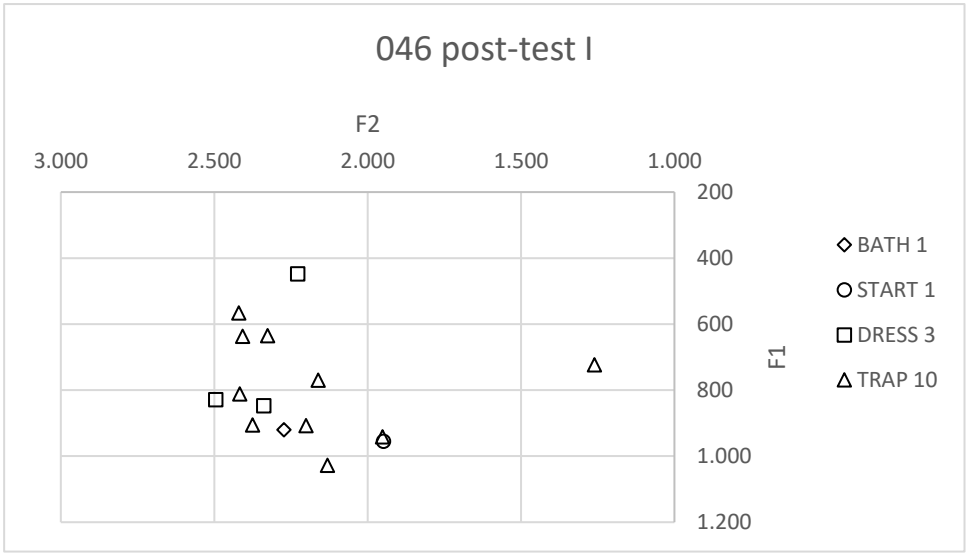
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START 1
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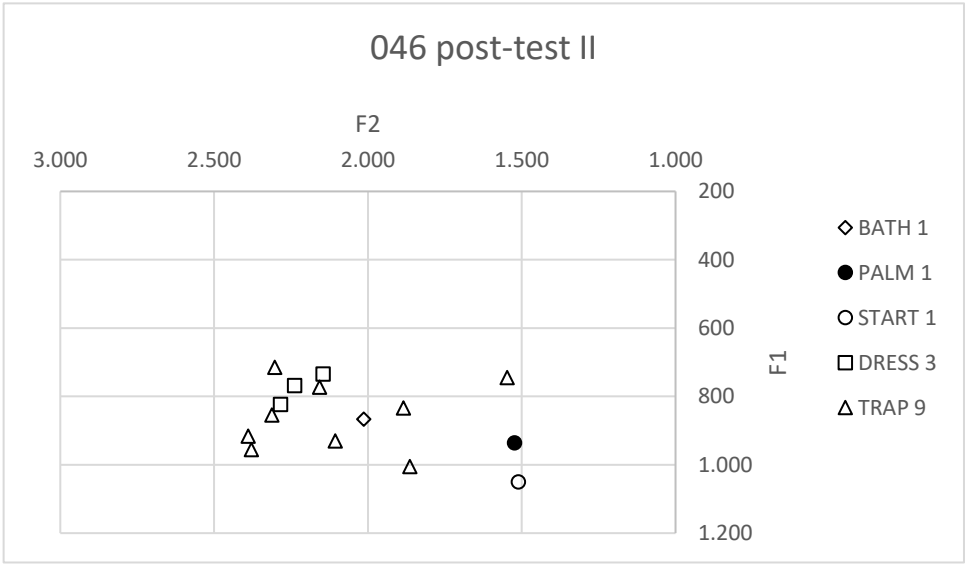
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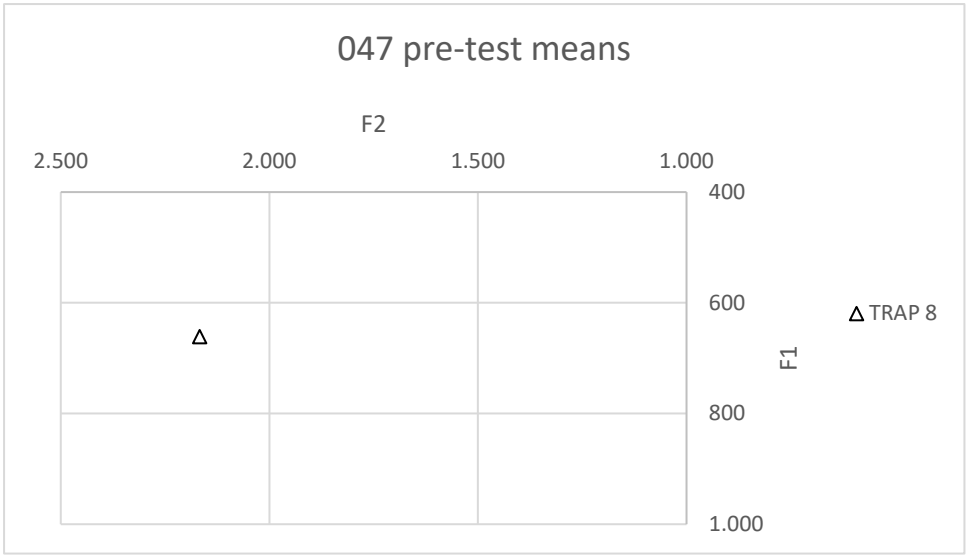
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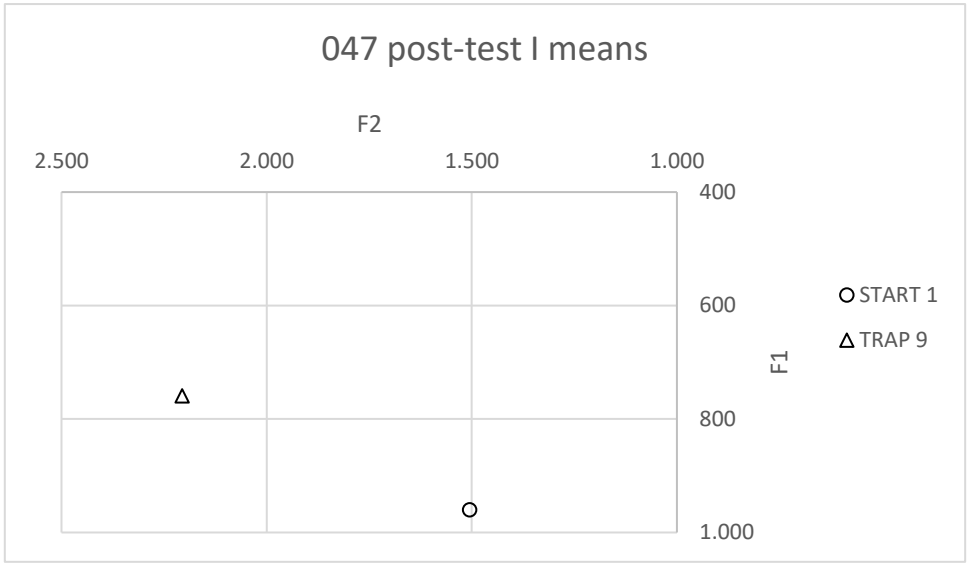
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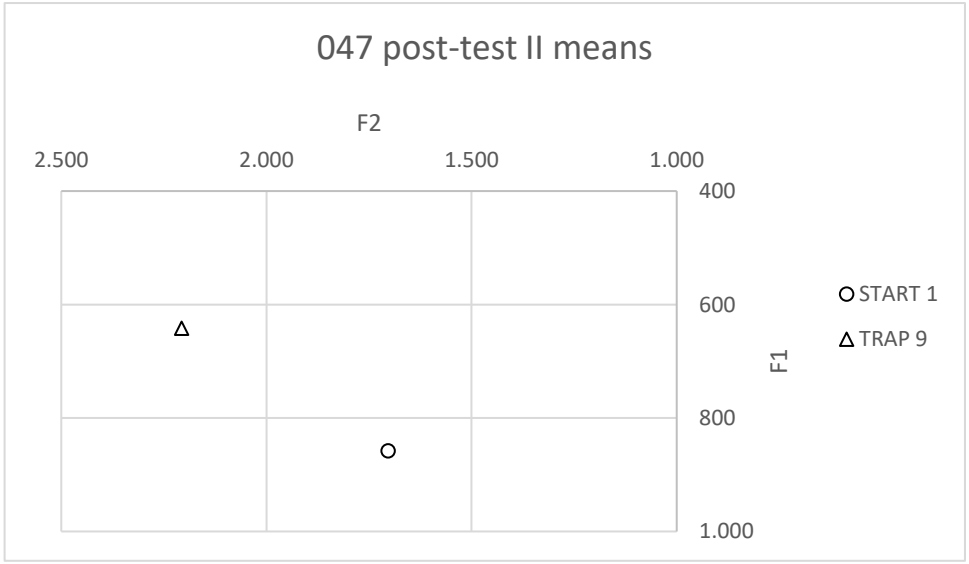
TRAP 9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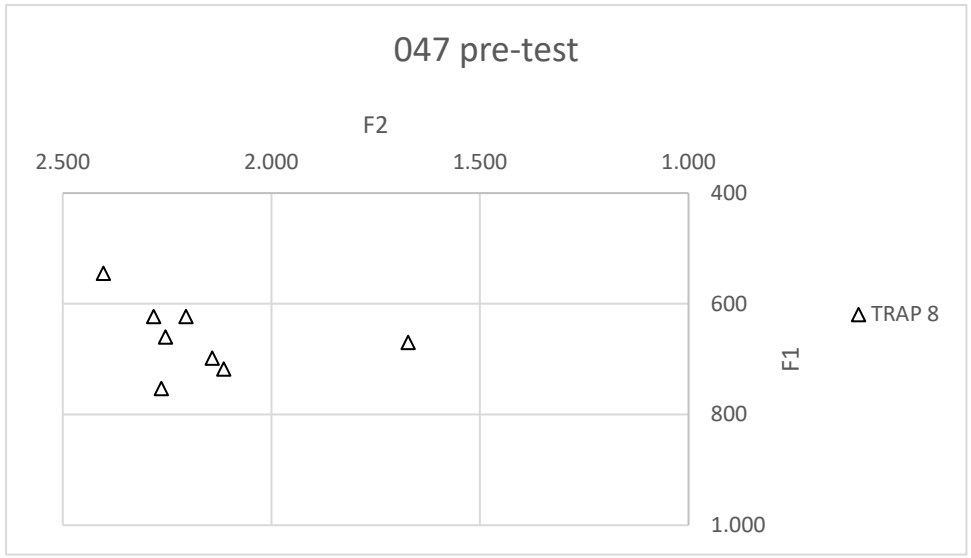
F1
START 1
TRAP 9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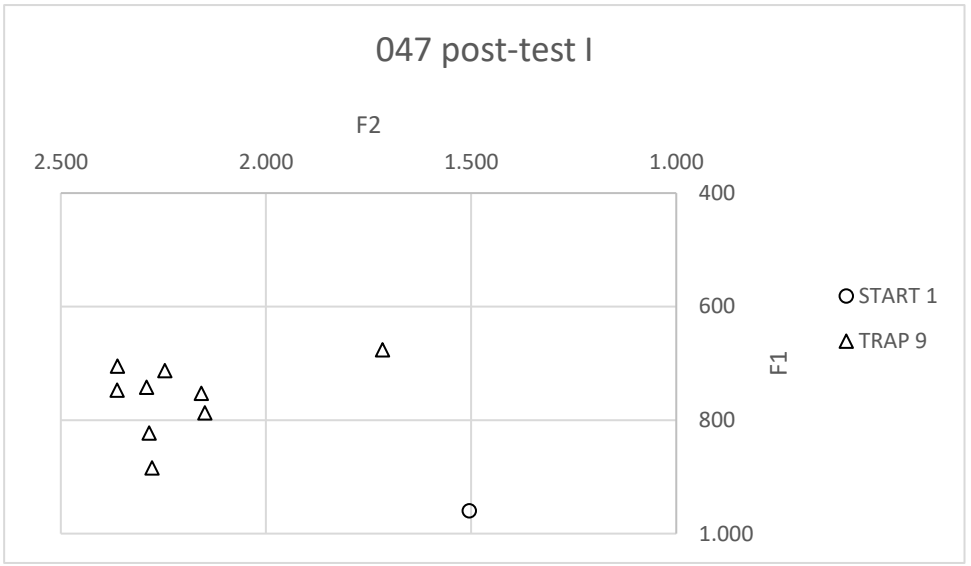
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START 1
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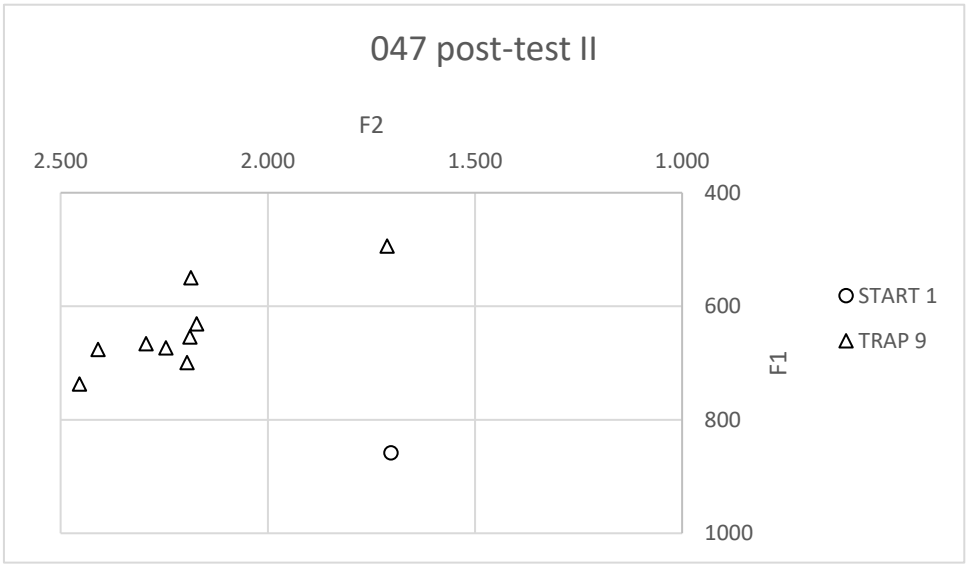
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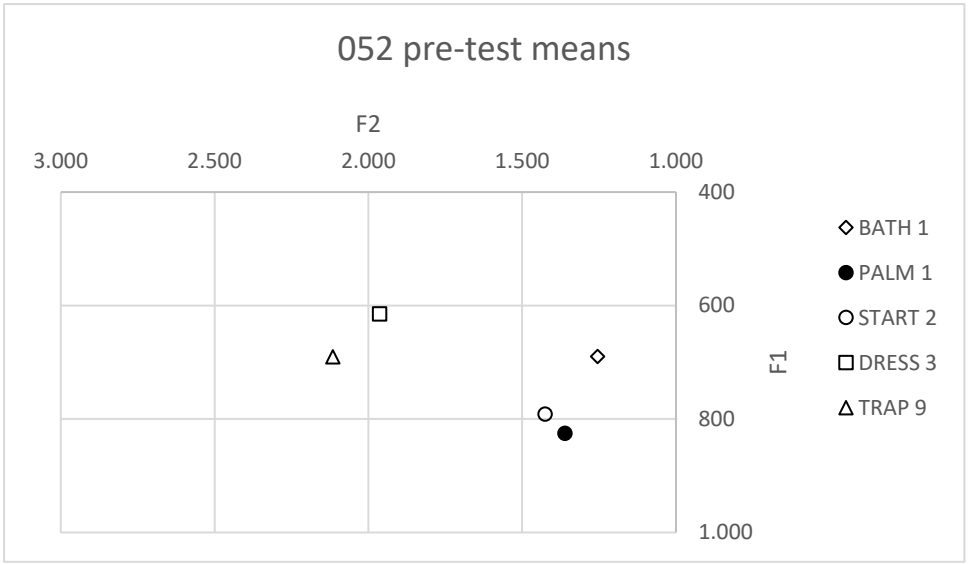
START 1
TRAP 9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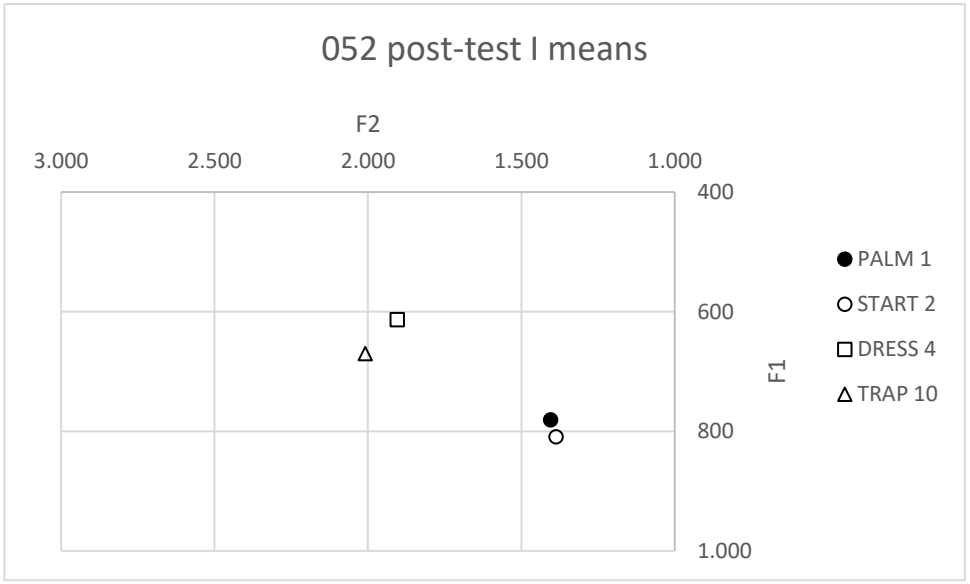
BATH 1
PALM 1
START 2
DRESS 3
TRAP 9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START 2
DRESS 4
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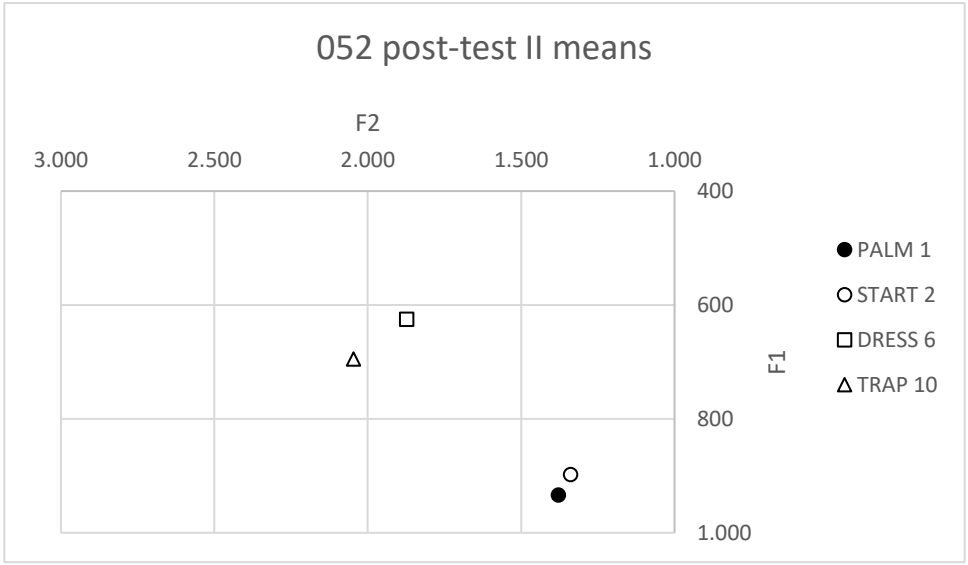
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DRESS 6
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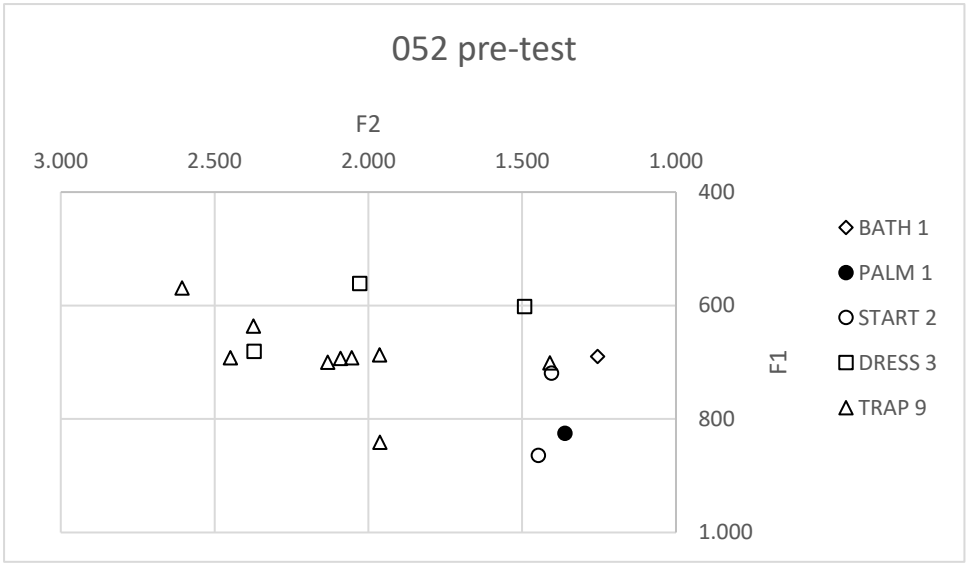
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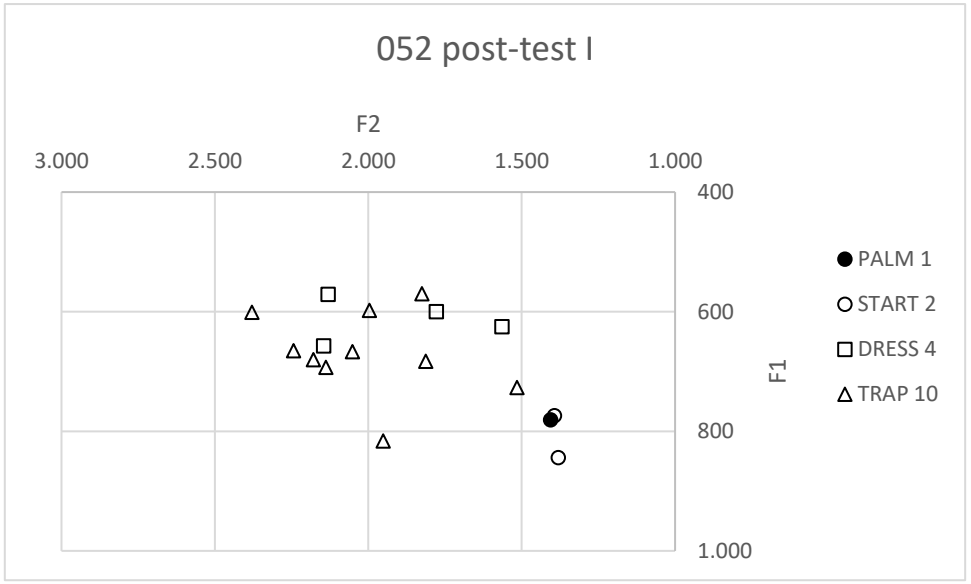
BATH 1
PALM 1
START 2
DRESS 3
TRAP 9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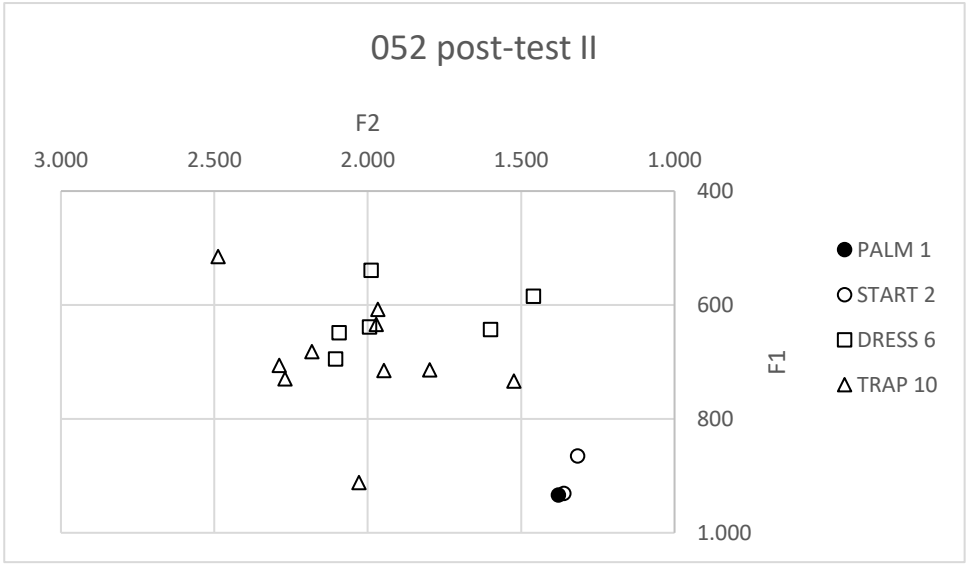
PALM 1
START 2
DRESS 4
TRAP 10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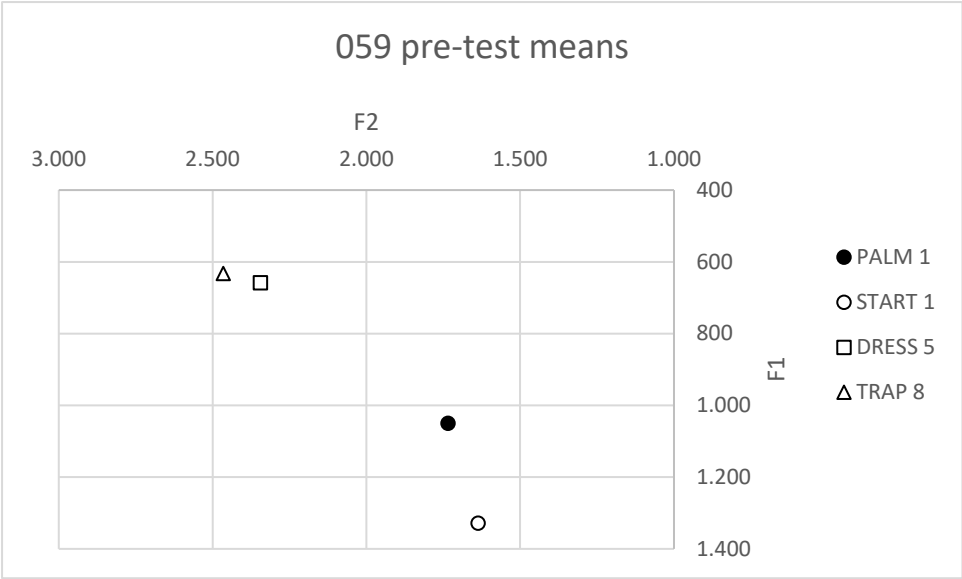
DRESS 6
TRAP 10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F1
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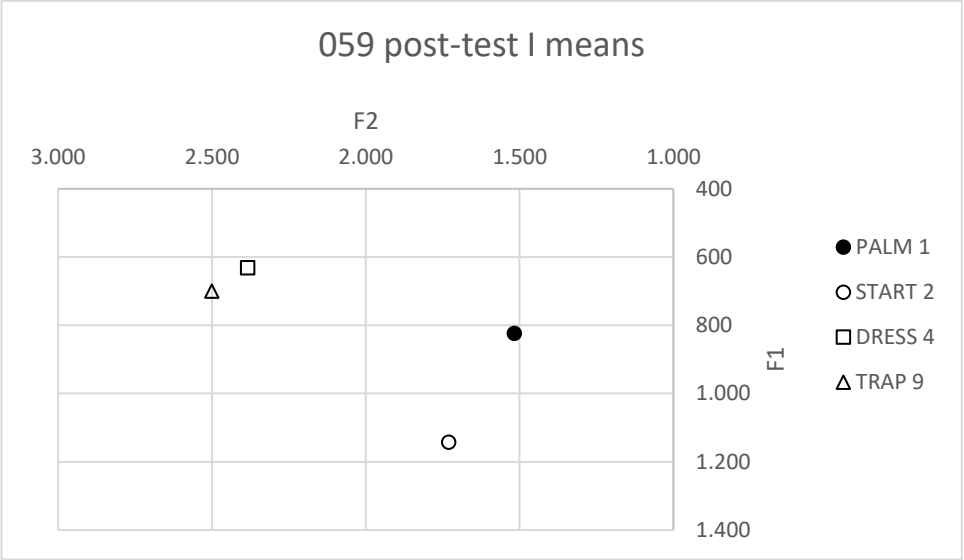
START 1
DRESS 5
TRAP 8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F1
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START 2
DRESS 4
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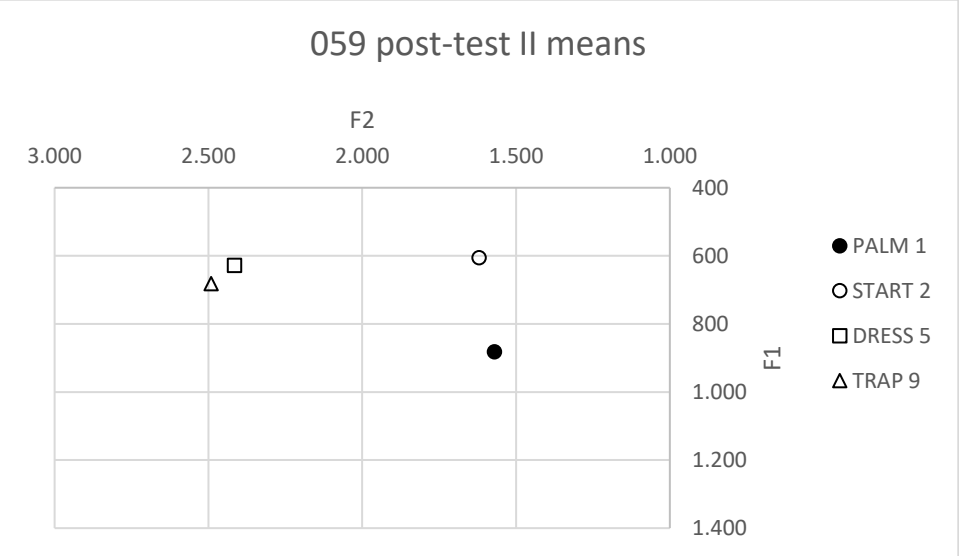
059 post-test II means
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F1
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START 2
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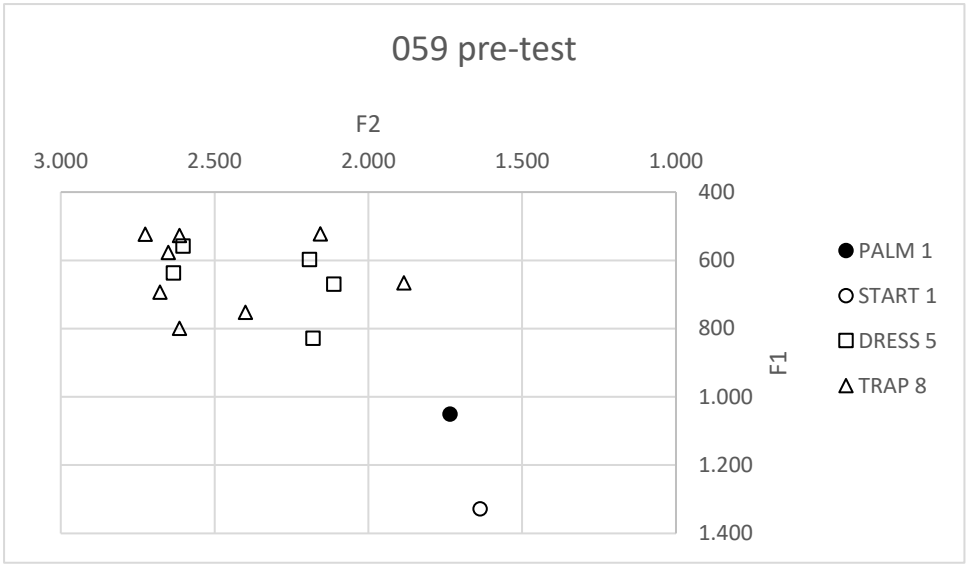
059 pre-test
F2
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F1
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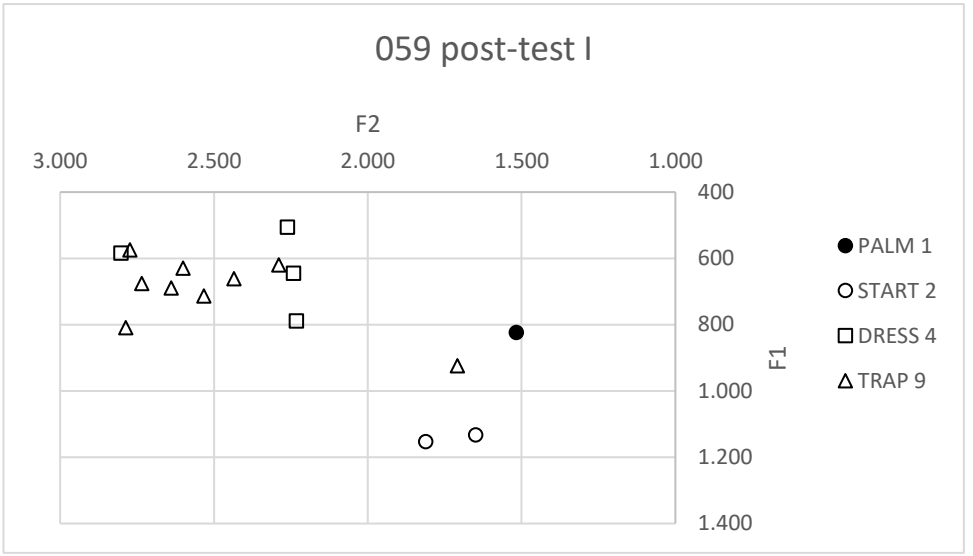
START 1
DRESS 5
TRAP 8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F1
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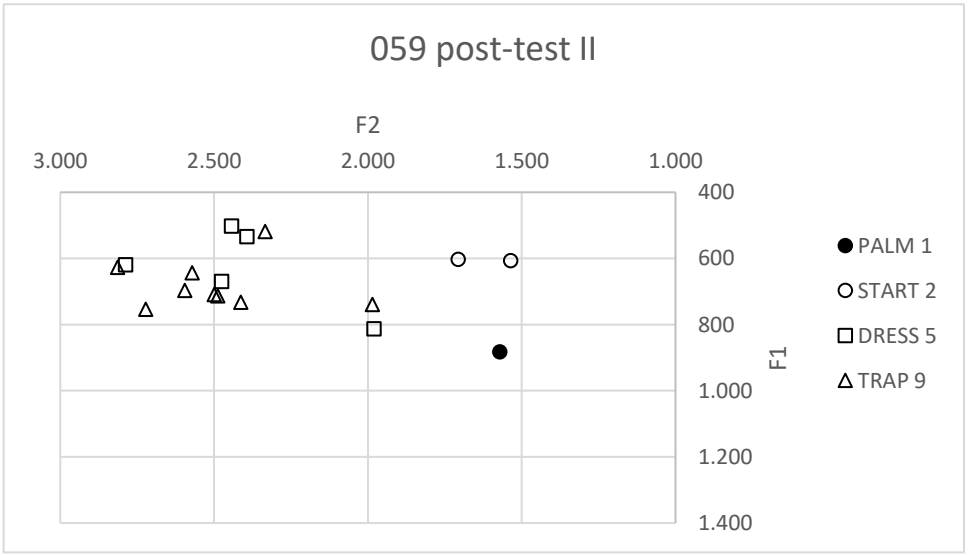
START 2
DRESS 4
TRAP 9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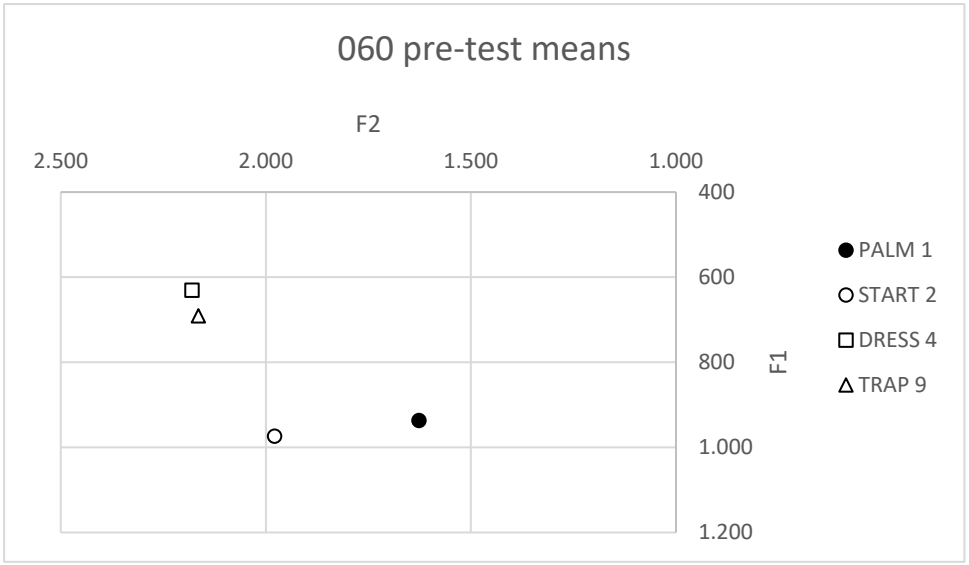
START 2
DRESS 5
TRAP 9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F1
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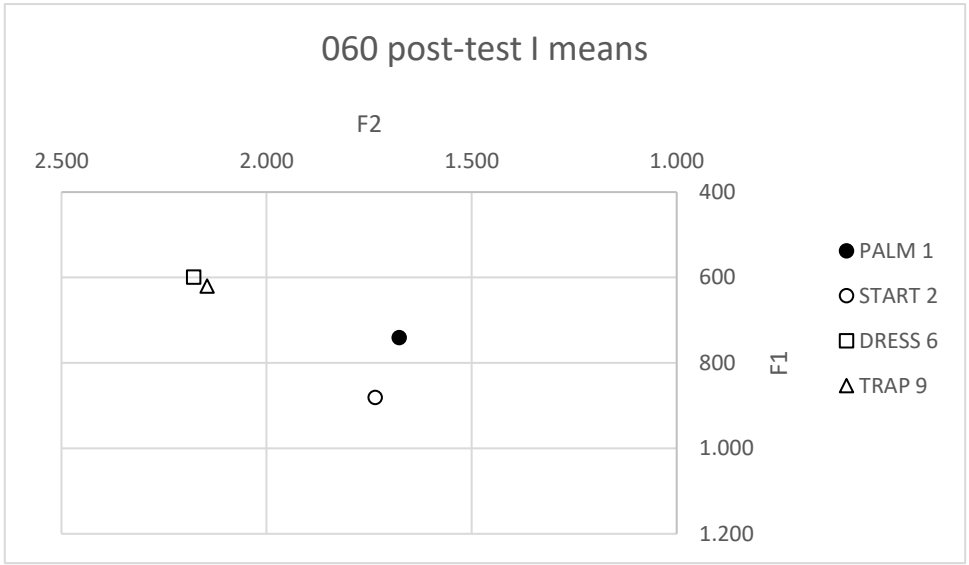
START 2
DRESS 4
TRAP 9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600
800
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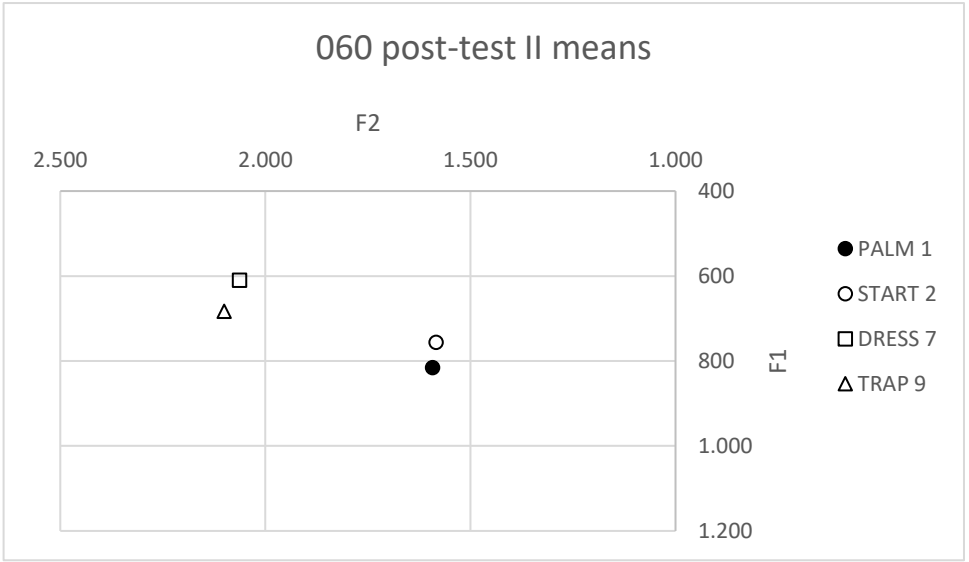
1.200
F1
PALM 1
START 2
DRESS 6
TRAP 9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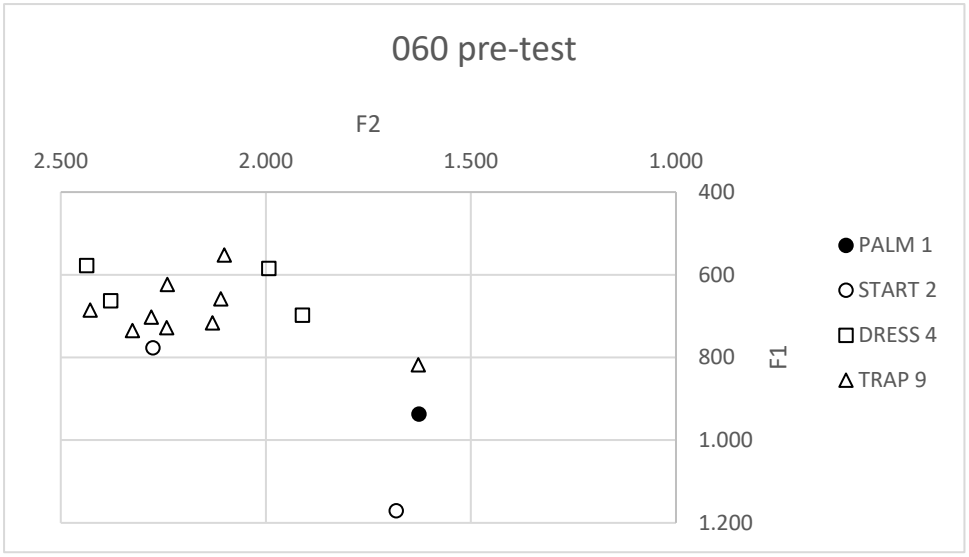
1.000
400
600
800
1.000
1.200
F1
PALM 1
START 2
DRESS 7
TRAP 9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START 2
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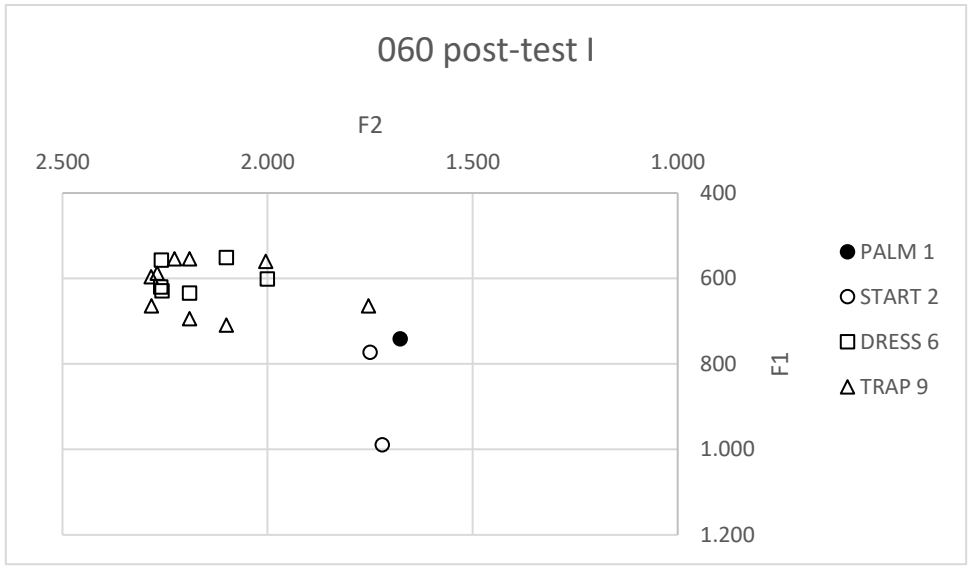
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DRESS 6
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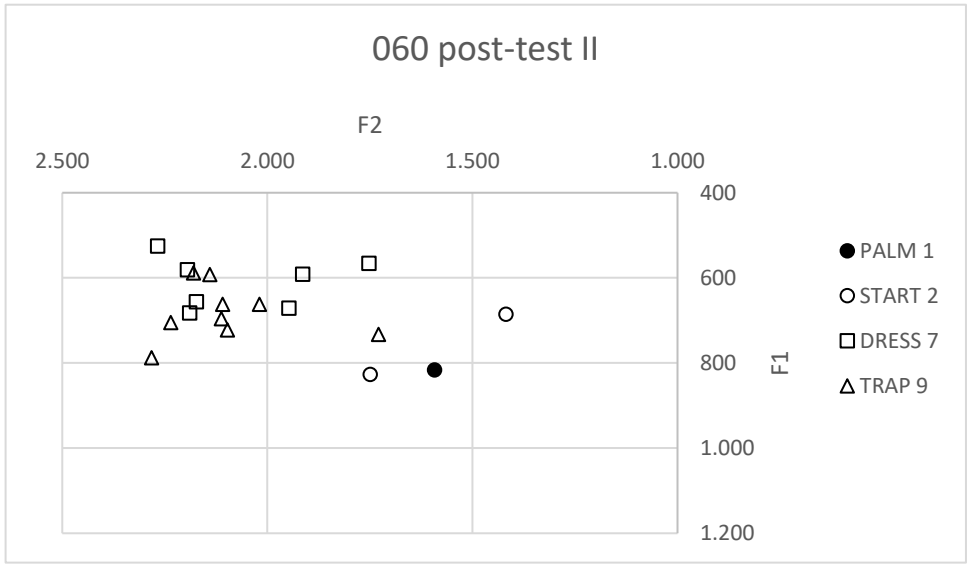
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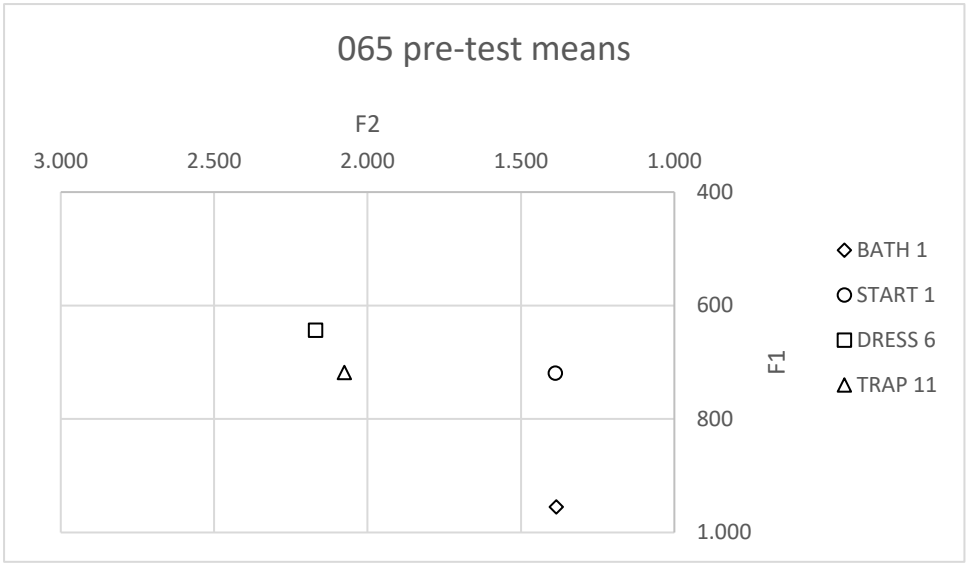
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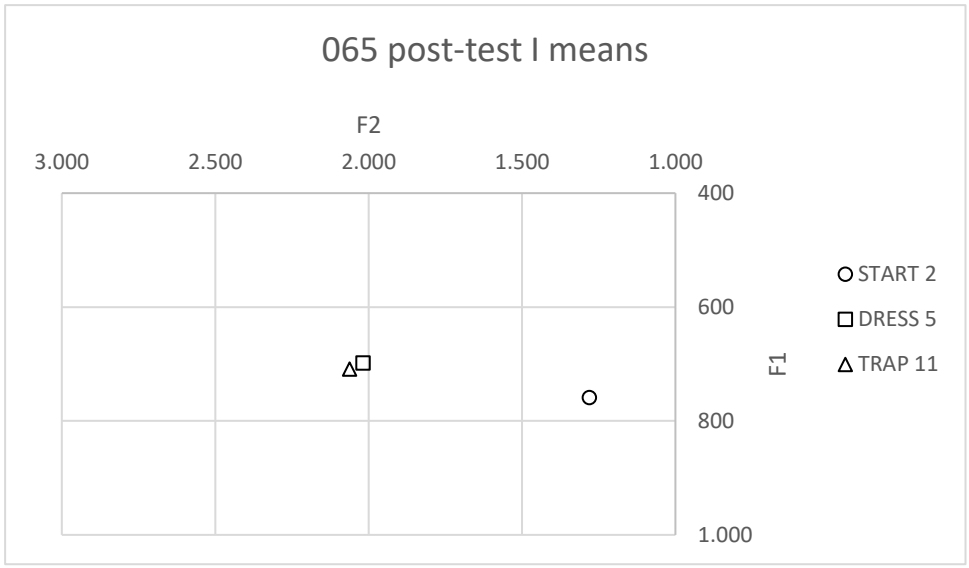
BATH 1
START 1
DRESS 6
TRAP 11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1.500
1.000
400
600
800
1.000
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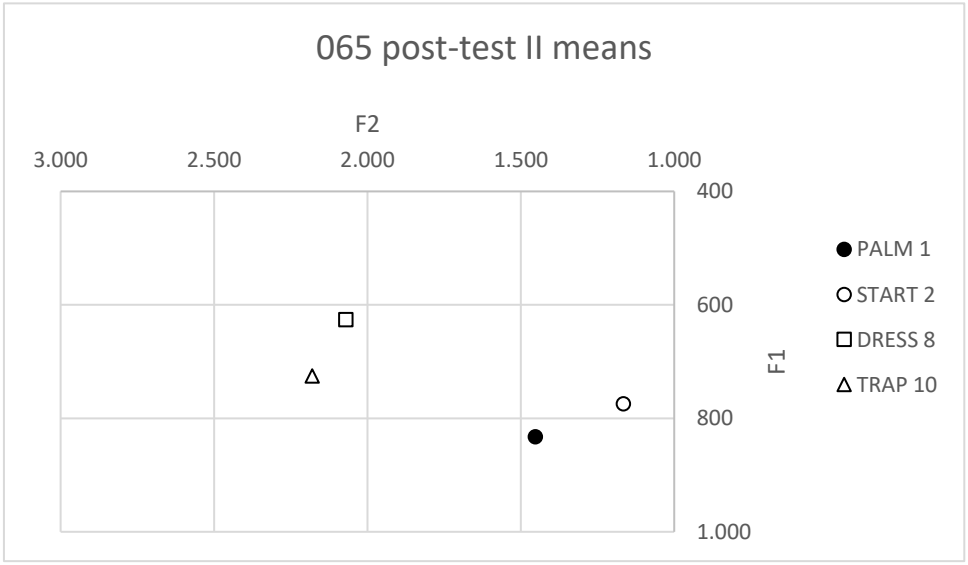
START 2
DRESS 5
TRAP 11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1.000
400
600
800
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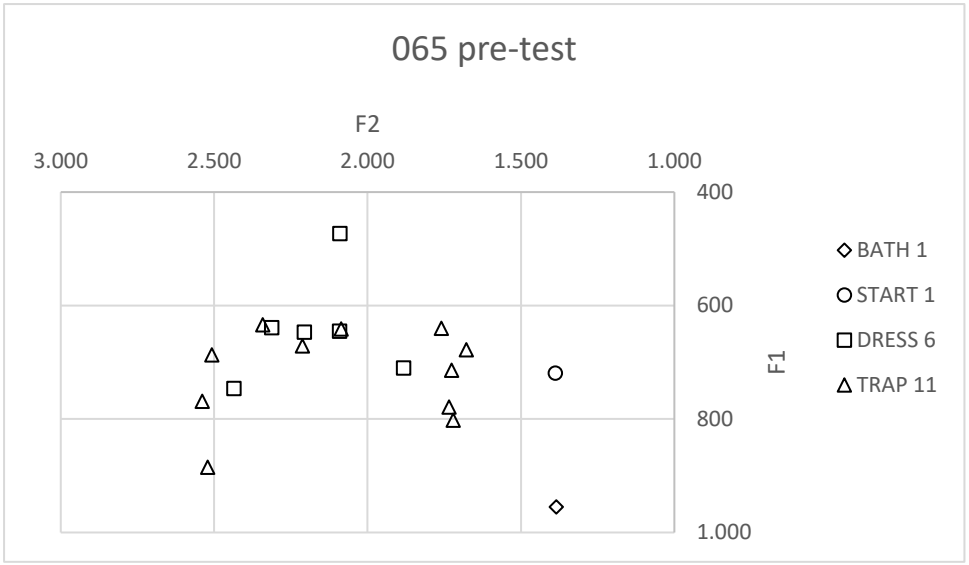
PALM 1
START 2
DRESS 8
TRAP 10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400
600
800
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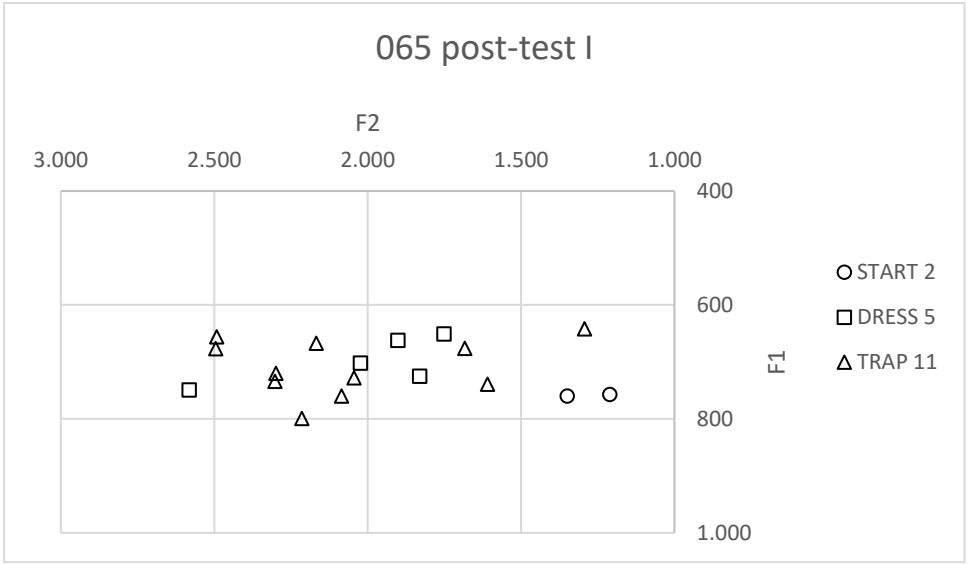
F1
BATH 1
START 1
DRESS 6
TRAP 11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400
600
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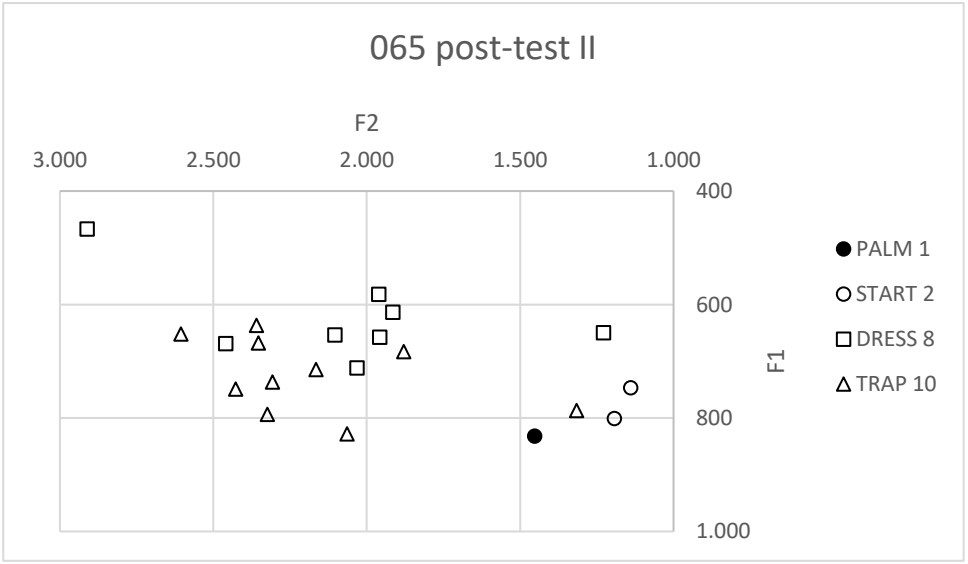
START 2
DRESS 5
TRAP 11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START 2
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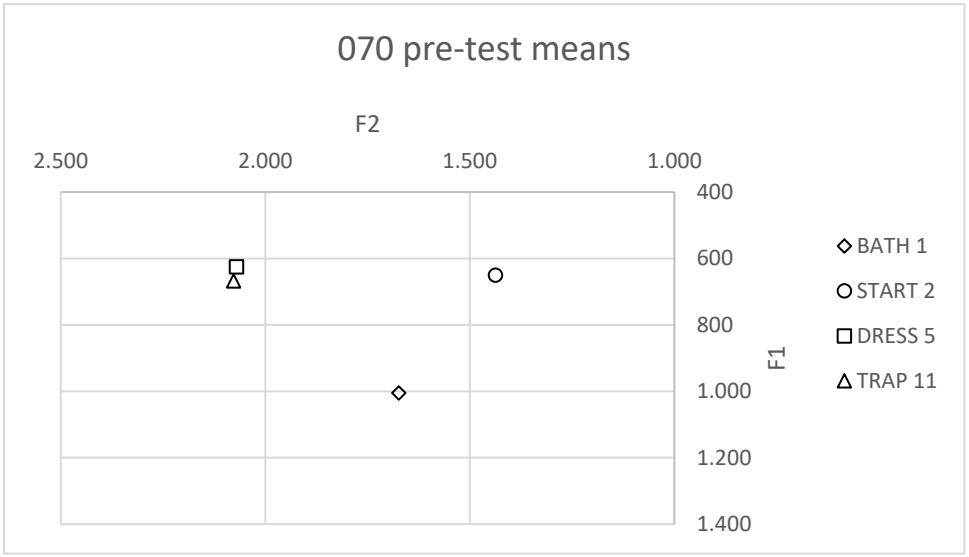
TRAP 10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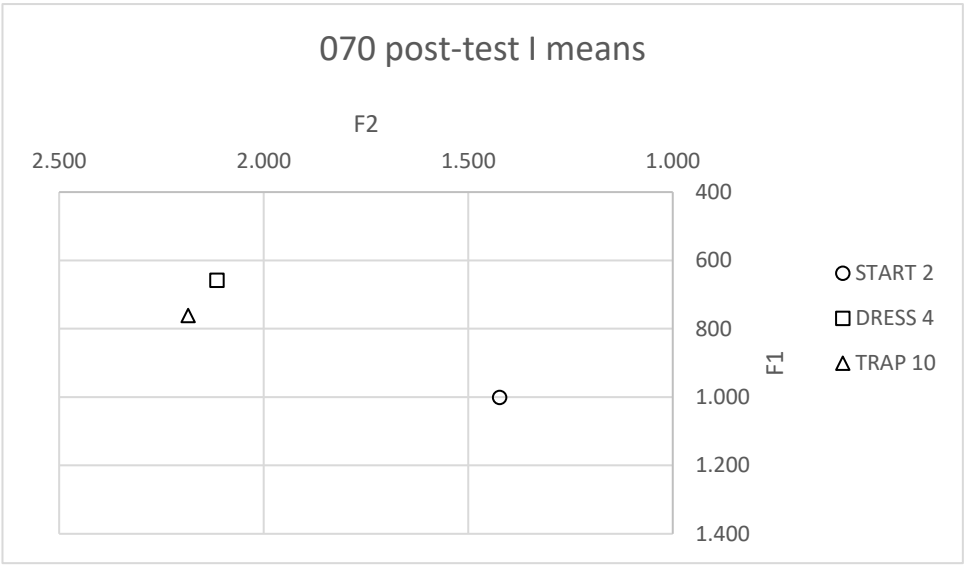
600
800
1.000
1.200
1.400
F1
BATH 1
START 2
DRESS 5
TRAP 11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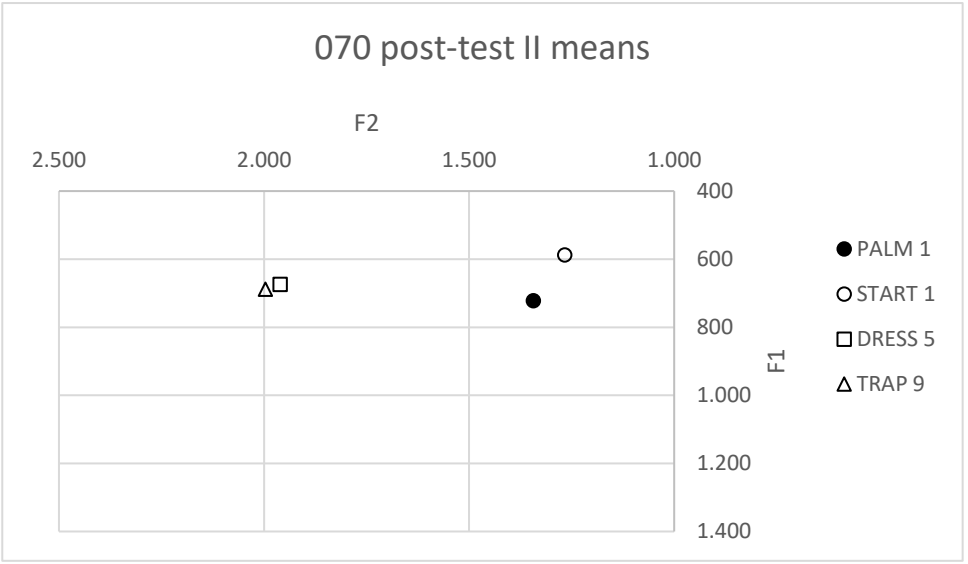
600
800
1.000
1.200
1.400
F1
START 2
DRESS 4
TRAP 10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PALM 1
START 1
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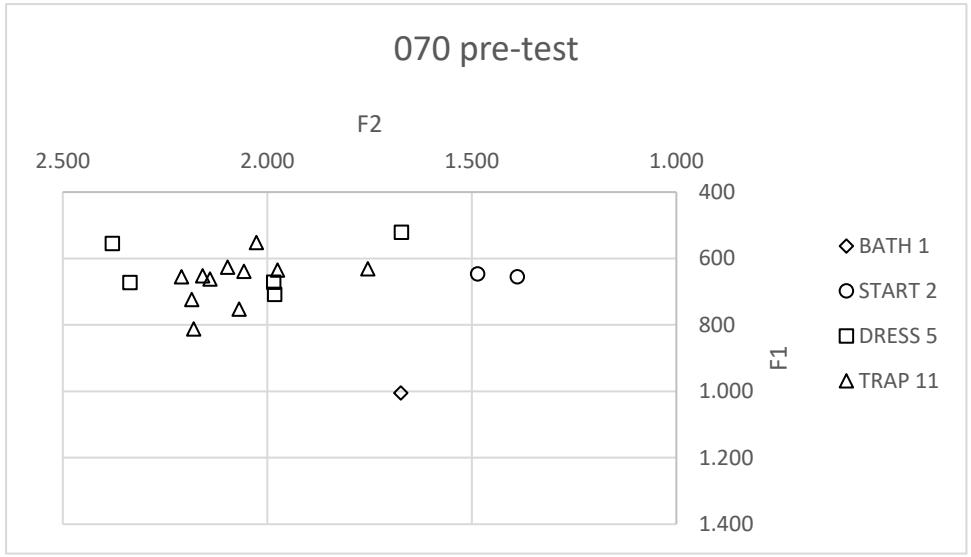
TRAP 9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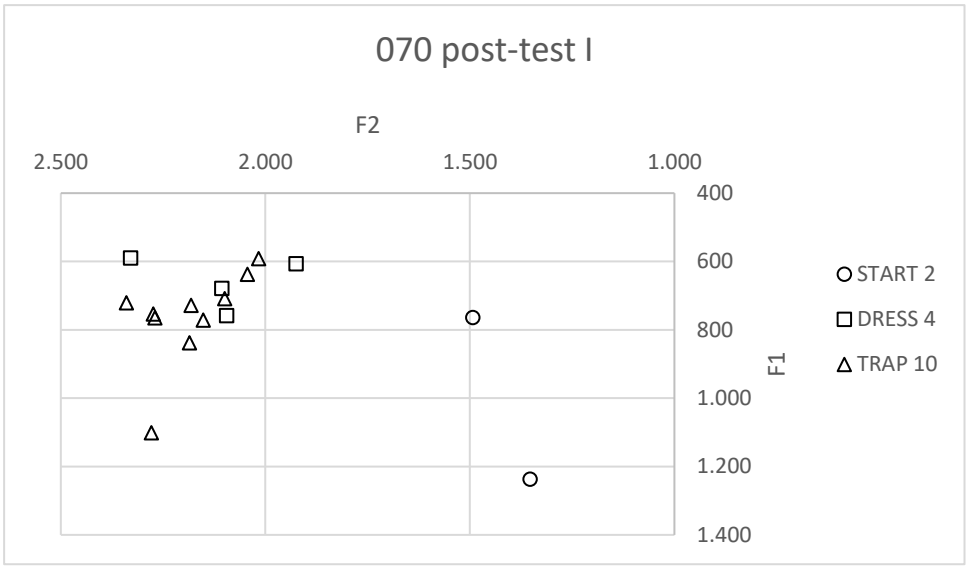
BATH 1
START 2
DRESS 5
TRAP 11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800
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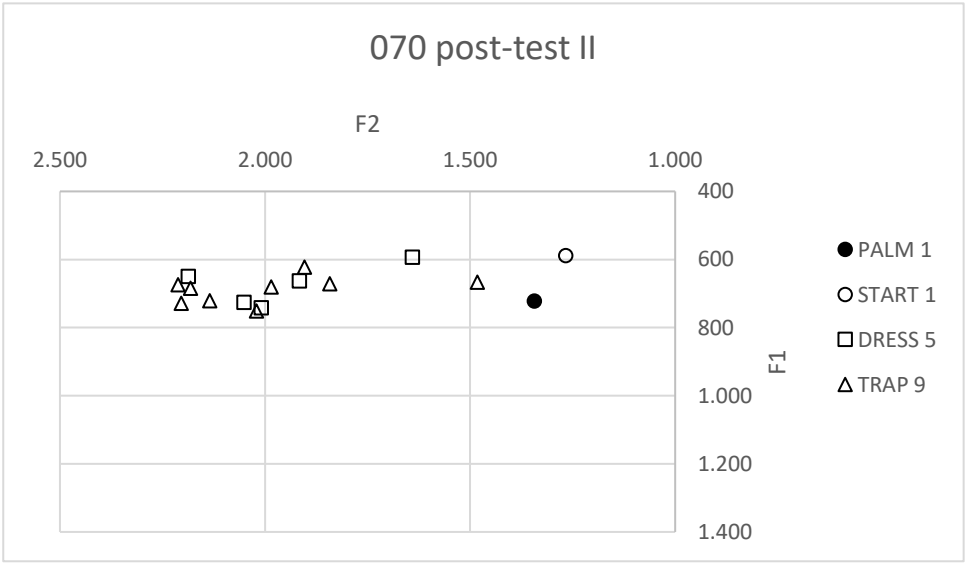
F1
START 2
DRESS 4
TRAP 10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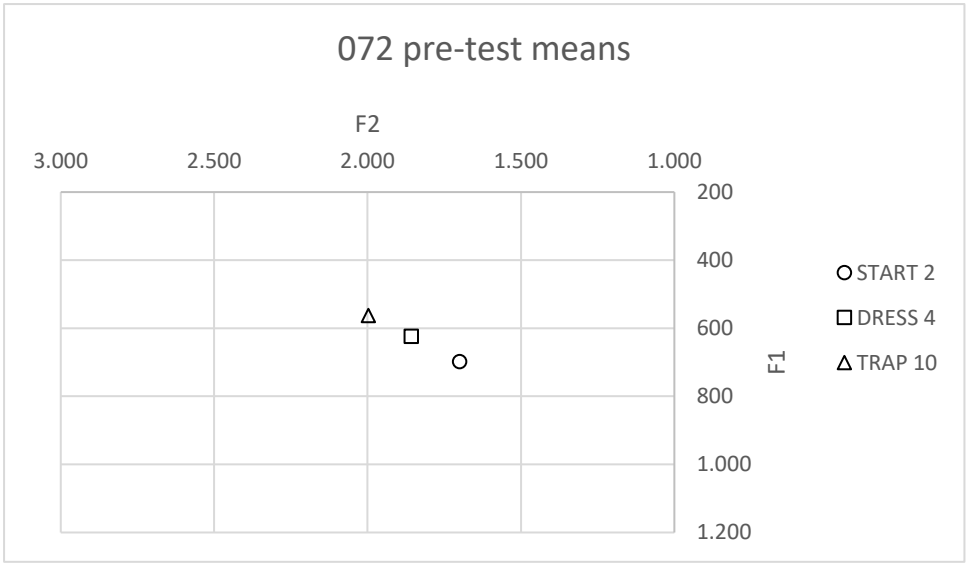
F1
PALM 1
START 1
DRESS 5
TRAP 9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400
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1.200
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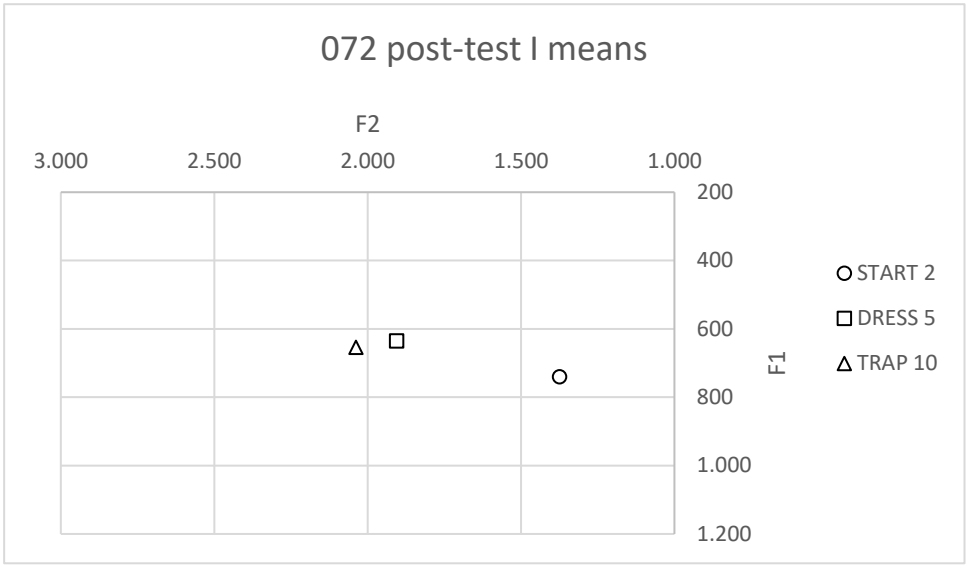
START 2
DRESS 4
TRAP 10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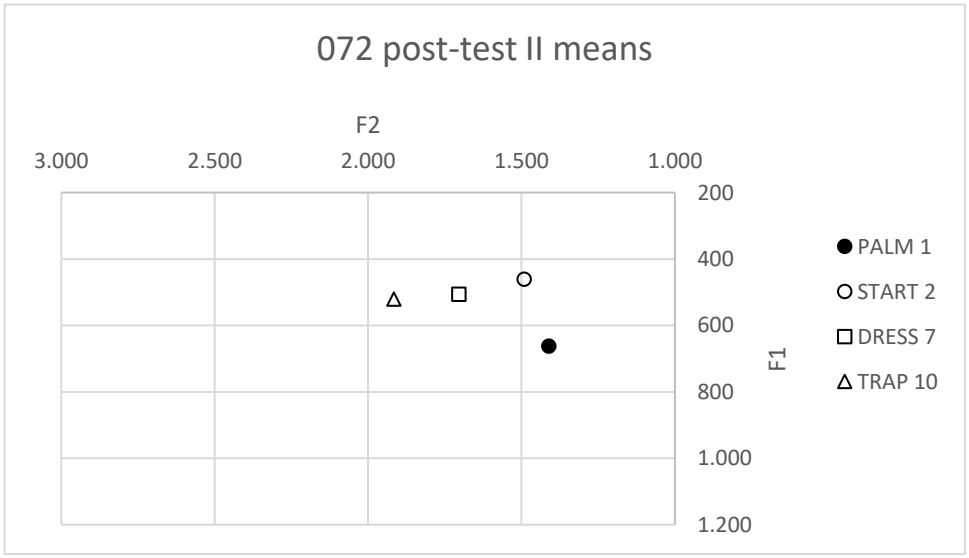
START 2
DRESS 5
TRAP 10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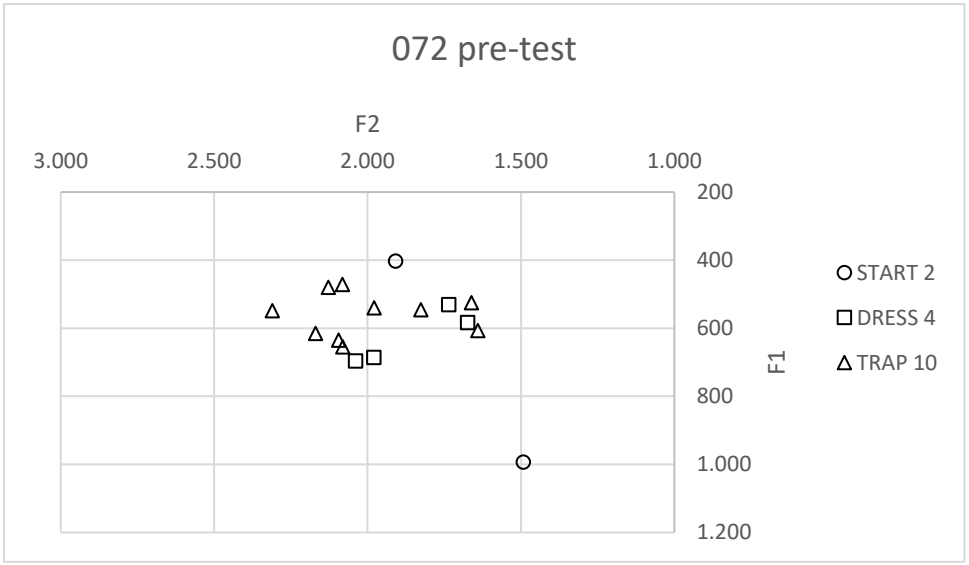
F1
PALM 1
START 2
DRESS 7
TRAP 10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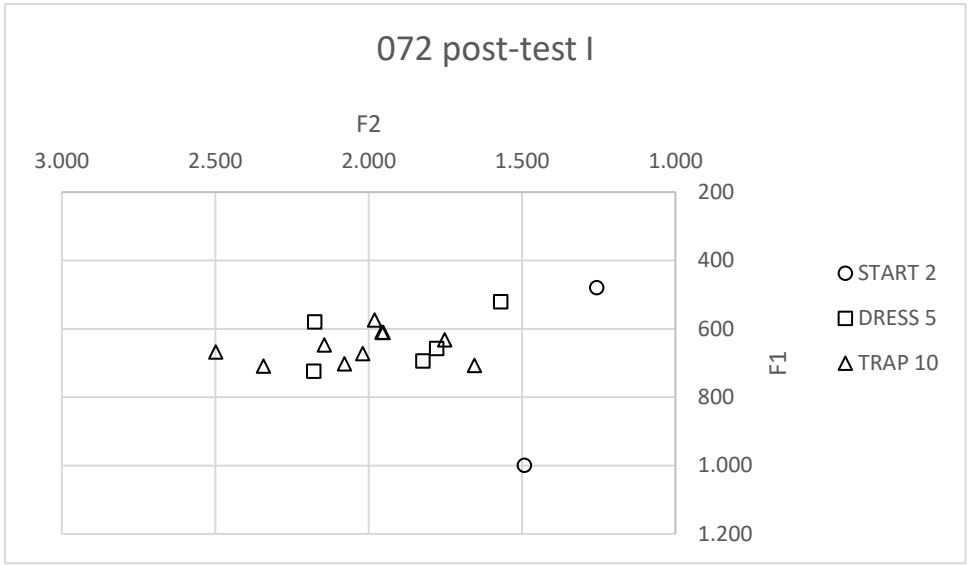
START 2
DRESS 4
TRAP 10


072 post-test I
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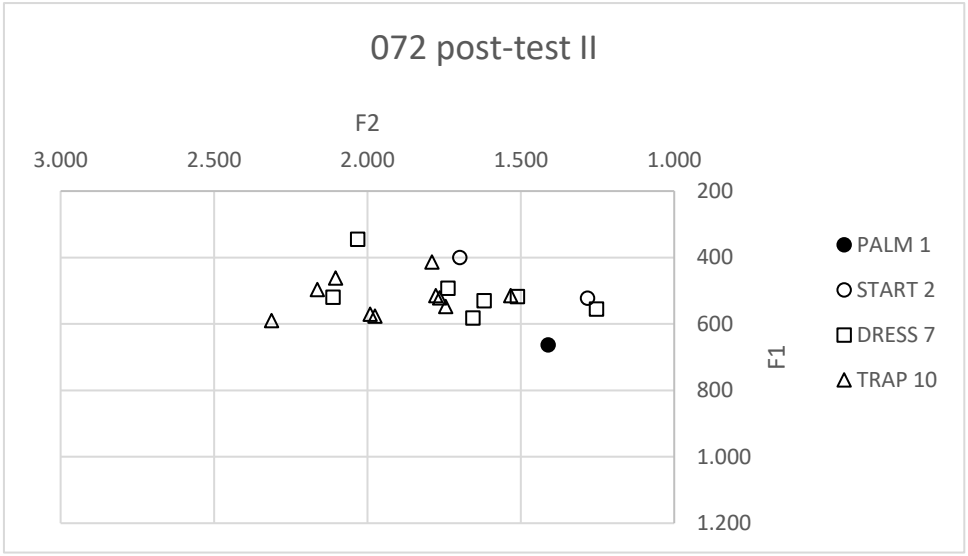
START 2
DRESS 5
TRAP 10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F2
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200
400
600
800
1.000
1.200
F1
PALM 1
START 2
DRESS 7
TRAP 10

Analysis of dental fricatives

Teachers' dental fricatives

Teacher	word	phoneme	voiced	voiceless
A	the	th	1	0
A	the	th	1	0
A	mouth	th	0	1
A	mouse	th	0	1
A	with	th	1	0
A	mouse	s	0	1
A	the	th	1	0
A	the	th	1	0
A	teeth	th	0	1
A	house	th	0	1
A	the	z	1	0
A	the	z	1	0
A	bath	th	0	1
A	there	th	1	0
A	Thursday	th th ("Thurth	0	2
A	the	th	1	0
A	there	th	1	0
A	father	th	1	0
A	mother	th	1	0
A	the	z	1	0
A	the	th	1	0
A	three	s	0	1
A	thirteen	th	0	1
A	there	th	1	0
A	the	th	1	0
A	thank	th	0	1

Teacher A = 23 tokens

th = 22

s = 1

z = 3

hypercorrection (?) = 3

Teacher	word	phoneme	Voiced?
B	mouth	th	no
B	bathroom	th	no
B	father	th	yes
B	mother	th	yes
B	brother	th	yes
B	teeth	th	no
B	month	th	no
B	Thursday	th	no
B	three	th	no
B	thirteen	th	no
B	the	th	yes
B	that	th	yes
B	this	th	yes

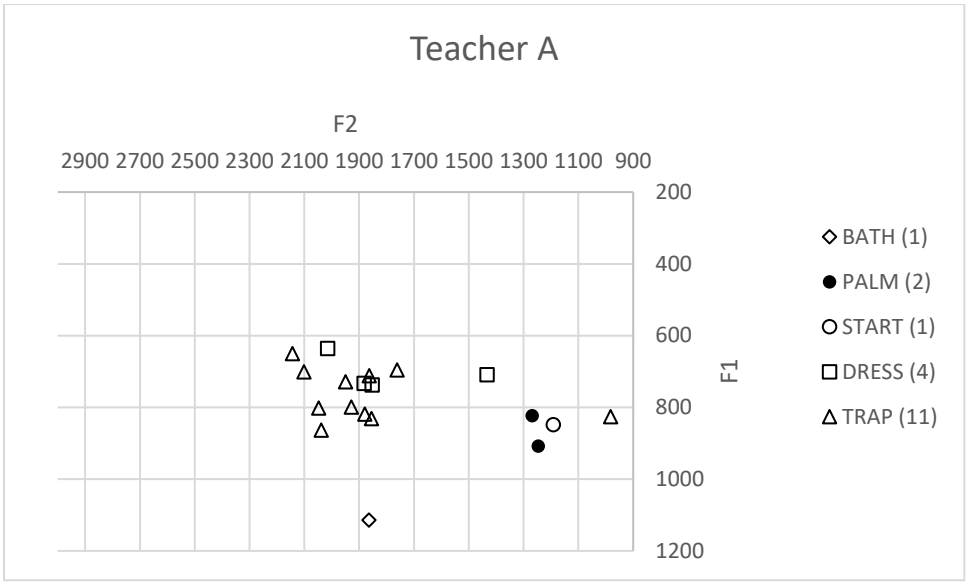
Teacher B = 13 "th"

th = 13

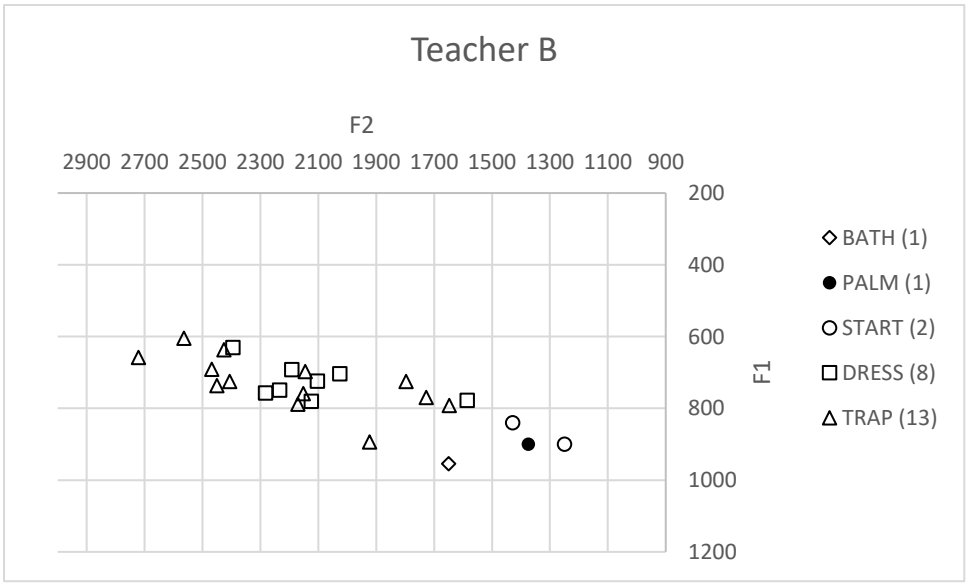
s = 0

Analysis of TRAP

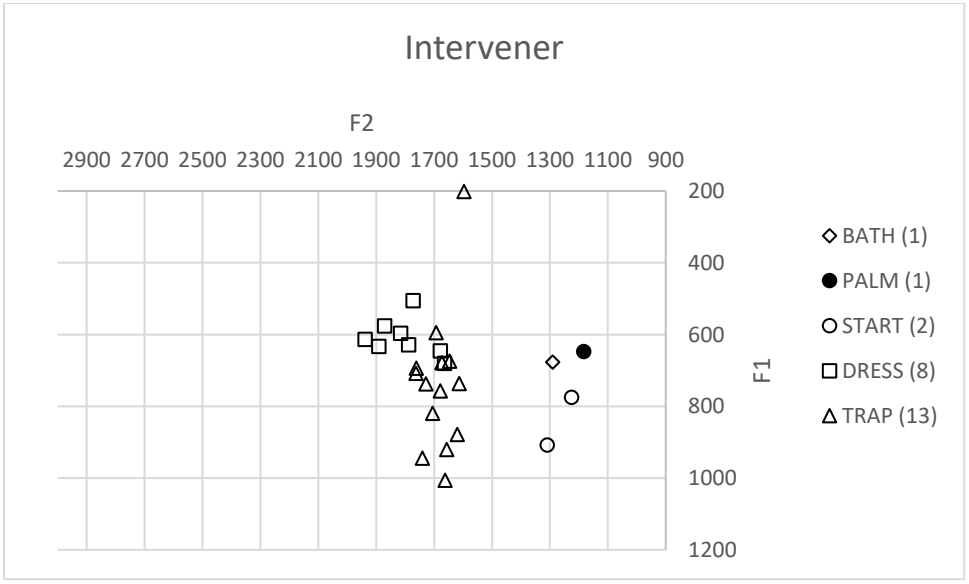
Teachers and researcher vowel plots



Euclidean distance = 95, 39



Euclidean distance = 82,17



Euclidean distance = 177, 3

Erklärung über die selbstständige Verfassung der Arbeit

Hiermit erkläre ich gemäß §12 der Promotionsordnung:

a. Dass die vorgelegte Arbeit selbständig und ohne Benutzung anderer als der in der Arbeit angegebenen Hilfsmittel angefertigt wurde;

b. Dass die Arbeit bisher weder im In- noch Ausland in gleicher oder ähnlicher Form einer anderen Prüfungsbehörde vorgelegt wurde;

c. ob bereits früher oder gleichzeitig ein Promotionsverfahren bei einer anderen Hochschule oder bei einer anderen Fakultät beantragt wurde, gegebenenfalls nebst vollständigen Angaben über dessen Ausgang.

Borchen, 24.04.2023

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Charlotte Anna Hahn