How Physical Therapists Instruct Patients with Stroke: An Observational Study on Attentional Focus during Gait Rehabilitation after Stroke

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Abstract

Purpose: People without neurological impairments show superior motor learning when they focus on movement effects (external focus) rather than on movement execution itself (internal focus). Despite its potential for neurorehabilitation, it remains unclear to what extent external focus strategies are currently incorporated in rehabilitation post-stroke. Therefore, we observed how physical therapists use attentional focus when treating gait of rehabilitating patients with stroke.

Methods: Twenty physical therapist-patient couples from 6 rehabilitation centers participated. Per couple, one regular gait-training session was video-recorded. Therapists' statements were classified using a standardized scoring method to determine the relative proportion of internally and externally focused instructions/feedback. Also, we explored associations between therapists' use of external/internal focus strategies and patients' focus preference, length of stay, mobility, and cognition.

Results: Therapists' instructions were generally more external while feedback was more internal. Therapists used relatively more externally focused statements for patients with a longer length of stay (B=-.239, p=.013) and for patients who had a stronger internal focus preference (B=-.930, p=.035).

Conclusions: Physical therapists used more external focus instructions but more internally focused feedback. Also, they seem to adapt their attentional focus use to patients' focus preference and rehabilitation phase. Future research may determine how these factors influence the effectiveness of different attentional foci for motor learning post-stroke.

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1. Introduction

A significant challenge for physical therapists working in the field of stroke rehabilitation is to effectively communicate the desired movement execution to their patients. Considering that many patients with stroke exhibit reduced information processing capacity [1] - and particularly language impairments [2] - therapists need to use instructions that are sufficiently detailed to help the patient perform the motor skill appropriately, but that at the same time do not overly burden the patient's cognitive resources. One promising way to achieve this seems to use instructions that trigger an "external" focus of attention during moving: a focus on the intended effects of the movement [3]. Many studies in people without neurological impairments have shown that such external focus instructions result in superior motor learning compared to "internal" focus instructions – i.e., instructions that trigger the learner to focus on movement execution itself [3]. For example, elderly are better able to stabilize a balance board when they practiced this task with an external focus ('keep the balance board horizontal') as opposed to an internal focus ('keep your feet horizontal') [4]. Significantly, these findings seem due to an external focus being less cognitively demanding than an internal focus – hence resulting in more automatic, implicit motor control [5,6].

Notwithstanding its potential, the benefit of external focus instructions for motor learning after stroke has not been fully confirmed. The few available studies have solely focused on immediate performance effects, and with mixed results. That is, two studies found an external focus to immediately improve reaching and sitting balance of people with stroke [7,8], while two others found no overall differences between external and internal focus instructions for reaching [9] and leg-stepping performance [10]. Notably, the latter study even found a trend for superior dual-tasking with an internal focus [10]. Also, none of these

studies actually investigated the long-term effects of *learning* with different focus instructions.

While limited, the above findings do suggest that an external focus may not *always* be superior to an internal focus for *all* patients with stroke. This begs the question which factors then determine which attentional focus strategy works best for which patient (see also Collins, Carson, & Toner [11]). One approach to get more insight into this issue is to evaluate current clinical practice, and to assess how physical therapists themselves (be it deliberately or implicitly) use different attentional focus strategies during rehabilitation post-stroke. This will inform us how often internal and external focus strategies are already used within rehabilitation post-stroke, and also whether there are specific patient factors that influence therapists' use of either of these strategies – hence providing future experimental studies on this topic with more specific leads on factors that might modify the effect of attentional focus on motor learning after stroke.

Two earlier, relatively small, studies suggest that therapists predominantly rely on internally referenced instructions and feedback (>67%) during therapy aimed at arm and gait function [12,13]. Yet, it is unclear whether these findings are representative for rehabilitation practice as a whole, given that these studies concerned a small number of therapists [8] and were confined to the UK. Moreover, these studies did not investigate whether therapists' use of external and internal focus strategies is related to specific patient characteristics.

Therefore, we conducted an observational study among twenty therapist-patient couples from rehabilitation centres across the Netherlands. The main aim was to assess how often physical therapists use internal and external focus instructions and feedback when (re-)training gait with patients with stroke admitted for inpatient rehabilitative care. Further, we assessed whether the relative frequency with which therapists used external or internal focus

strategies was associated with patients' preferred focus, rehabilitation phase, and cognitive abilities. These factors were specifically chosen based on early experimental work. For instance, studies in non-neurologically impaired adults [14] and in persons with chronic stroke [10] suggest that motor performance is enhanced when the instructed focus matches the performer's preferred focus. Further, an internal focus has been implied to be more effective in early learning stages, when motor skill is less developed, while an external focus may be more effective later in learning [10]. Finally, due to its lower cognitive demands[3,5], an external focus may be more suitable for patients with cognitive impairments.

Based on earlier experimental work [12,13] we hypothesised that therapists would provide more internal focus than external focus instructions and feedback. In addition, we also expected that therapists would make relatively more use of internal focus cues for patients (1) with a more established internal focus preference; (2) in early rehabilitation phases – i.e., with less motor skill and shorter length of stay in rehabilitation; and (3) better cognition.

2. Materials and Methods

2.1. Participants

Physical therapists were recruited from six specialized rehabilitation centres in The Netherlands: Heliomare Rehabilitation in Wijk aan Zee, Military Rehabilitation Center in Doorn, Rijnlands Rehabilitation Center in Leiden, Sophia Rehabilitation in The Hague, Revant Rehabilitation in Breda/Goes, and Reade in Amsterdam. We aimed to include at least 2 therapists per centre and 20 therapists in total, to optimize generalizability of findings and cancel out local practice effects. Inclusion started in November 2014 and ended in September 2015.

Therapists were eligible for participation if they had at least 6 months of professional experience within stroke rehabilitation and had completed post-graduate neurorehabilitation education. Each therapist conveniently selected one patient with stroke whom he/she provided clinical (inpatient) rehabilitation therapy to improve gait (i.e., ranging from standing balance to walking stairs). Therapists were told not to select patients with receptive aphasia, but patients with expressive aphasia were eligible for participation. Therapists and patients were told the study aimed to examine (non-)verbal communication during post-stroke rehabilitation. The aim was deliberately left vague, to minimize the possibility that participants adjusted their behaviour in line with the study's aim. Full debriefing took place afterwards. Therapists and patients provided informed consent. The ethical committee of the VU University Amsterdam approved the study protocol.

2.2. Assessment of Therapist and Patient Characteristics

Demographic information was obtained both for therapists (age, gender, years of professional experience with patients with stroke) and patients (age, gender, education level [15], stroke characteristics, time since admission to rehabilitation centre). In addition, patients' motor abilities were scored with the Functional Ambulation Categories (FAC [16]) and Rivermead Mobility Index (RMI [17]), two recommended tests of functional mobility [18]. General cognitive functioning was assessed with the Montreal Cognitive Assessment (MoCA [19]). Patients' focus preference was assessed using a self-report instrument, the Movement-Specific Reinvestment Scale (MSRS [20,21]). Higher scores on the MSRS indicate that a patient is more strongly inclined to consciously monitor (Movement Self-Consciousness subscale; MS-C) and control (Conscious Motor Processing subscale; CMP) movements in daily life [20,22] and hence, suggest a stronger preference for an internal focus [10].

Finally, and always after observation of the therapy session, therapists also completed a custom-made questionnaire to determine whether they (1) were familiar with the concept of internal and external attentional focus; (2) generally preferred either of these two in daily practice; and (3) made deliberate choices for either attentional focus strategy in daily practice (see appendix 1). With regard to part (2) of the questionnaire, therapists were provided with five pairs of internal and external formulated statements that concerned 5 different aspects of gait. For each pair, they had to choose which option they *generally* preferred to use in daily practice. For example, for influencing "step width", therapists could choose between "try to walk with your feet in front of each other" (internal; 0 points) and "try to walk between the lines" (external; 1 point). In case a therapist had no clear preference, 0.5 point was scored. Scores could range from 0 (all internal) to 2.5 (no clear preference) to 5 (all external). The questionnaire was piloted with two physical therapists beforehand.

2.3. Procedure

First, the patient completed the MSRS and MoCA with the experimenter in a separate and quiet room. This also ensured that patients were familiarized with the experimenter and setting, and hence more at ease during the recording of the subsequent therapy session. The therapist was not present at this stage, and hence blind to the outcome of these tests.

Subsequently, for each therapist-patient couple, a regular one-to-one therapy session was recorded that focused on gait-related exercises (e.g., comprising exercises ranging from sit-to-stand transfers and standing balance to walking stairs). For this purpose, a digital camera was covertly positioned outside the participants' immediate line of sight, and therapists also wore a voice-recorder. The experimenter was present throughout the session, but did not interfere with the therapy in any way.

Afterwards, when the patient had left the room, the therapist rated the patient's score on the RMI, FAC, and MoCA (by judging patients' performance on each MoCA-item; see appendix 2 for this "MoCA-proxy" score form). This latter assessment thus provided us with information regarding therapists' perception of patients' cognition. Finally, therapists completed the questionnaire to determine their own preferred focus.

2.4. Data Analysis

All statements were transcribed verbatim. The content of these statements was analysed with a scoring system similar to the one used by Johnson et al. [13]. In short, statements were either labelled as instruction (i.e., description of how an action is to be performed), feedback (i.e., information pertaining to a previously executed movement, intended to improve future motor performance), or "other" (i.e., general talk, for instance about activities during the weekend). Instructional and feedback statements were further categorized as "internal", "external", "mixed", or "unfocused".

Reliability of scoring was ascertained as follows. First, two raters were instructed on the initial definitions of the scoring system. Subsequently, both raters independently scored ten randomly selected, 2-minute therapy fragments, blinded to each other's results. As sufficient agreement (Kappa = .60) could not be reached initially (Kappa = .49), differences between raters were discussed and definitions refined accordingly. Sufficient interrater agreement (Kappa = .64) was reached in a next round of testing, in which the raters independently scored five other randomly selected 2-minute therapy fragments. Having established its reliability, two raters each assessed half of the videos. Table 1 lists the final scoring method, including all scoring codes and accompanying definitions and examples.

***** TABLE 1 NEAR HERE *****

The following variables were reported for each therapy session:

- General therapy characteristics: therapy session duration, total number of statements, and the number of statements per minute;
- Nature of statements: the proportion of instructions, feedback, and "other" statements, expressed as a percentage of the total number of statements;
- Attentional focus content of instructions: the proportion of internal, external, mixed, and unfocused instructions, expressed as a percentage of the total number of instructions;
- Attentional focus content of feedback: the proportion of internal, external, mixed, and unfocused feedback, expressed as a percentage of the total number of feedback statements;

Finally, we used linear regression analyses to explore whether therapists' relative reliance on external or internal focus strategies was influenced by patients' internal focus preference, motor skill, time spent in rehabilitation, and cognition. To determine the degree to which each therapist made more use of external or of internal focus strategies we used the following formula:

$$Relative\ Focus\ Score = \frac{all\ instructions\&feedback\ with\ IF}{all\ instructions\&feedback\ with\ IF\ or\ EF}\ \text{x}\ 100\%$$

(IF = internal focus, EF = external focus). Thus, a score of 0% means that a therapist exclusively provided external focus statements, a score of 50% means that a therapist equally often used internal and external focus statements, whereas a therapist with a 100% score exclusively provided internal focus statements. Note that we combined instructions and feedback for this analysis.

For all analyses, alpha level was set at 0.05. We then used separate univariate linear regression analyses to explore the association between therapists' relative focus scores on the one hand, and patients' internal focus preference (MSRS-CMP & MSRS-MS-C), mobility (RMI), length of stay (i.e., the number of days since the admission to the rehabilitation center at the moment of the measurement), and cognition (MoCA & MoCA-proxy) on the other hand. Multivariate linear regression analysis was planned on those independent variables that showed a (near-)significant association ($p<.1$), to check whether these variables were uniquely associated with the outcome. The assumptions for regression analysis were verified, in that there was no multicollinearity (variance inflation factors < 1.7, tolerances > 0.6 [23,24]), and no homoscedasticity (as revealed by plotting the standardized residuals against the predicted values), and that errors were independent (Durbin-Watson = 1.951 > 1.270 [25]), and normally distributed (i.e., Kolmogorov-Smirnov test on residuals = .100, $p > .200$).

3. Results

3.1. Participants

In total, 24 therapists were approached for participation. One therapist declined, whereas three other therapists did not currently had a patient under treatment for gait retraining. Also, one patient was approached but did not want to be filmed. Thus, twenty physical therapists and twenty patients with stroke participated (figure 1). Therapist and patient characteristics are listed in table 2.

***** FIGURE 1 NEAR HERE *****

***** TABLE 2 NEAR HERE *****

3.2. Therapy Characteristics

Therapy duration ranged from 17.0 to 29.6 minutes (M = 22.7; SD = 3.6), with a total filmed therapy time of 451 minutes. During this time therapists made a grand total of 4821 statements ($M_{statements/session}$ = 241; SD = 60; range = 159-357), averaging out to 10.7 (SD = 2.3) statements per minute (range = 7.4-15.5).

3.3. Nature of Statements (Instructions/Feedback/Other)

Figure 2 details the nature and attentional focus content of statements for each therapist-patient couple, while figure 3 shows the overall group results. Although results varied considerably across therapists, on average they provided more feedback (M = 37%) than instructions (M = 30%). Approximately one-third of all statements were labelled as "other". These statements often concerned social talk (e.g., about the patients' weekend, family matters, etcetera), general statements about the overarching goal of the therapy session (e.g., "Today you will practice making transfers"; Therapist-patient couple 16), and also more general conversation about the patient's progression and rehabilitation goals (e.g., "The main goal when you are back home is to practice walking with the walker in- and outside your house with the neighbour present"; Therapist-patient couple 15). These "other" statements were not further analysed.

3.4. Attentional Focus Content of Instructions and Feedback

Taking a closer look at the attentional focus content of instruction and feedback revealed that therapists' instructions were more often externally focused: on average 19% of all instructions were internal while 30% were external. The subsequent feedback on performance was more often internally focused. Of all feedback statements, 20% had an internal focus, while 14% had an external focus. A typical example is an exercise in which a patient was instructed to "walk around the cones without knocking them over" (external

focus), but subsequently received feedback that the "… right foot has difficulty turning inward" (internal focus; Therapist-patient couple 10). Mixed focus statements were infrequently used, both for instructions (4.5%) and feedback (2.3%). Finally, many instructions (46.8%) had no specific focus: i.e., "Start!" or "Go!". Similarly, the high frequency of unfocused feedback statements (64.4%) was due to the large number of motivational statements provided by the therapists. That is, 27.6% of all feedback statements was motivational in nature, such as 'Well done' (Therapist-patient couple 11).

***** FIGURES 2&3 NEAR HERE *****

3.5. Relation Between Therapists' Attentional Focus Use and Patient Characteristics

Independent linear regression analyses revealed that patients' length of stay in the rehabilitation centre (R^2 = 0.296, B = -0.264, p = 0.013) and MSRS-CMP scores (R^2 = 0.222, B = -1.066, p = 0.036) were independently and negatively associated with therapists' relative focus scores. These associations were maintained when a subsequent multivariate linear regression analysis was run on both these factors (R^2 = 0.462, F(2,17) = 7.30, p = 0.005; $B_{\text{lengthofstay}}$ = -0.239, p = 0.013; $B_{\text{MSRS-CMP}}$ = -0.930, p = 0.035). This indicates that therapists gave relatively more externally focused (and fewer internally focused) statements to patients who had spent more time in rehabilitation and who reported a stronger preference for an internal focus. These findings are illustrated by figure 4 in which the association between attentional focus and length of stay/MSRS-CMP scores is shown separately for instructions and feedback (panels A-D).

As discussed earlier, in our sample instructions were more often externally focused, and feedback more often internally focused. Therefore, the results noted above might simply reflect that patients with stronger internal focus preferences and/or longer length of stay received more instructions and less feedback (rather than more externally focused instructions

and feedback). As can be seen in figure 4 (panels E-F), this was not the case: the relative proportion of instructions and feedback was similar regardless of patients' length of stay or focus preference. Notably, though, an incidental finding was that therapists gave fewer instructions/feedback and made more "other" statements to patients with higher MSRS-CMP scores (r = .50, p = .03).

No independent associations were found between therapists' predominant focus scores and patient′s MSRS-MS-C, RMI, MoCA, and MoCA/proxy scores (*p's*>.5). Worthy of note, therapists' MoCA-proxy scores did show high agreement with the MoCA scores obtained by the experimenter (ICC = .83).

***** FIGURE 4 NEAR HERE *****

3.6. Questionnaire Results

One therapist could not complete the questionnaire after the therapy session, and failed to respond to follow-up emails. All therapists who did complete the questionnaire (N=19) indicated they were familiar with the concept of internal and external focus of attention. Further, fourteen therapists preferred an external focus in daily practice (i.e., > 2.5 points on the 5-item questionnaire), three did not have a clear preference (score = 2.5), and two preferred an internal focus (score < 2.5). Finally, sixteen therapists stated that they made deliberate choices in their use of external and internal focus strategies in daily practice. Twelve therapists indicated they took patients' cognitive abilities into account, by using more external cues for patients with more severe cognitive impairments. Other factors that were mentioned more than once were patients' rehabilitation phase/motor skill (N=7), learning style (N=6), and body awareness (N=3). More specifically, therapists reported that they made more use of external focus cues in later learning phases, that they tried to tune in to patients' "learning style" (i.e., by finding out which focus works best for which patient, mostly by trial and error), and that they generally preferred to use more internal focus cues for patients with impaired body awareness.

4. Discussion

This study aimed to determine with what frequency physical therapists use internal and external focus instructions and feedback when retraining gait of inpatient individuals with stroke. In addition, we explored whether a patient's internal focus preference, rehabilitation phase, motor skill, and cognition were related to how often therapists used a particular focus strategy. Contrary to our hypothesis, therapists used a balanced mix of external and internal focus strategies, using relatively more externally focused instructions and more internally focused feedback. In addition, therapists made less use of internal focus cues and more of external ones for patients with a stronger internal focus preference and longer length of stay.

The current study's unexpected findings nuance earlier reports that patients with stroke almost exclusively receive internal focus instructions *and* feedback from their therapists [12,13]. It seems unlikely that differences in scoring underlie the considerably higher proportion of external statements in the current study, since our methodology was highly similar to that of the previous studies [12,13]. A more plausible explanation is therapists' preferred focus. In the current study, fourteen out of nineteen therapists indicated that they generally preferred external focus strategies in daily practice. By contrast, in the study of Durham et al. [12] six out of eight therapists preferred a mixed or internal focus strategy. The more pronounced external focus preferences among the current study's therapists may in part be due to the fact that the concept of external/internal focus of attention has received much attention since these previous investigations. Relatedly, our cohort consisted of experienced (M = 13.3 ± 10.3 years) physical therapists specialized in stroke rehabilitation, who regularly participate in neurorehabilitation courses and conferences in which topics such as internal/external focus learning are discussed. Combined, this likely made our cohort more inclined to use an external focus than the therapists in the studies of Durham et al. [12] and Johnson et al. [13] whom were somewhat less experienced ($M_{Durham\ et}$

al. = 6.7 ± 3.0 years; $M_{Johnson\ et\ al.}$ = 7.1 ± 3.5 years). Finally, another factor that may explain the difference in results is that fact that the NDT/Bobath method is widely practiced in the UK, while in The Netherlands the emphasis is now on "… direct learning of the actual intended functional skill." [26]. Arguably, the Bobath approach seems more likely to require an internal focus approach, as it is more directly concerned with achieving a prescribed, desired movement pattern.

Another novel finding of the current study is that therapists' use of instructions and feedback was influenced by specific patient characteristics, namely their focus preference and length of stay. With regard to the former, therapists gave relatively more external focus (and fewer internal focus) cues to patients with a stronger internal focus preference. In addition, these patients also received fewer instructions and less feedback. At first glance, this apparent mismatch between the preferred focus of the patient and the provided focus of the therapist might seem to point at a misjudgement of the therapist. However, combined these findings could also be explained as an attempt of therapists to discourage such "internal focusers" from over-focusing on their movement execution, by giving them less movement-specific and more externally referenced information. Thus, in some cases therapists apparently deviated from their self-reported strategy of tuning in to their patients' preferred focus. This finding provides a specific lead for future research: should therapists adapt to patients' focus habits, or should they prevent patients from relying too much on conscious control? While some recent studies suggest that it may be best to align instructions with an individual's focus preference [10,15], it has also been argued that a too strong internal focus preference can prevent patients from successfully re-automating motor control [27]. For these patients, using a (non-matching) external focus approach might be preferred. More research is needed to delineate the optimal use of attentional focus in relation to patients' own preferences.

Therapists' relative use of attentional focus was also influenced by the time that patients had spent in inpatient rehabilitation. Patients with a longer length of stay heard more external focus statements, and proportionally fewer internally referenced cues. As our study did not involve a longitudinal observation, we must be careful with interpreting this finding. Still, one gets the impression that therapists use an "internal-then-external" strategy in the course of rehabilitation. This idea is supported by the fact that therapists themselves stated they relied more on external focus strategies in later learning stages. Such an internal-then-external strategy fits classical views on motor learning, which hold that conscious motor control (i.e., an internal focus) is essential for early learning, while strategies that promote more automatic processing (i.e., an external focus [5]) become more effective as learning unfolds [28]. The little experimental evidence available seems to provide some initial support for such an approach. One study found that reaching performance of individuals with stroke was optimized when a similar internal-then-external-focus strategy was used [7], while another recent study suggests that patients with less motor skill show better leg-stepping performance with internal focus than with external focus instructions[10]. Notice, though, that these early findings are purely based on immediate performance effects rather than long term changes as a consequence of learning. In any event, future studies into the overall effects of different focus strategies on motor learning post-stroke may also want to investigate the optimal schedule (both within and across learning sessions) in which attentional focus strategies should be used during motor relearning post-stroke.

Apart from patients' length of stay and focus preferences, no other patient characteristics were associated with the relative frequency with which therapists used external and internal focus instructions/feedback. Especially notable is the absence of such an association with patients' cognitive abilities, considering that most therapists indicated this to be an important factor when choosing for an internal or external focus strategy. Although

therapists were able to accurately gauge their patients' cognition (their MoCA-proxy scores highly agreed with those obtained by the experimenter), their use of attentional focus strategies did not seem to be influenced by this knowledge in the current study. It might be that such an association would have been more easily detected if we had observed each therapist with a range of different patients, rather than with one single patient only. Also, the limited statistical power of this study warrants some caution when interpreting lack of statistically significant associations.

A limitation of the current study are that we only observed therapists for one session, and did not incorporate a longitudinal assessment of therapist-patient couples. This may have compromised the reproducibility of our findings. On the other hand, we tried to maximize reliability by observing therapists in a sufficiently long regular therapy session, and with a patient they had already had under treatment. An inherent, yet significant limitation of the current study's observational design is that the mere act of observation may have altered the therapists' and patients' behaviour. This possibility cannot be ruled out, even though we took several precautions to prevent this from happening – i.e., we did not reveal the specific study goal to the participants until after the study was completed, covertly positioned the camera out of sight, and familiarised participants with the experimenter and setting beforehand. Thirdly, the questionnaire we used to determine therapists' preference for/familiarity with internal and external focus of attention had not been officially validated. Fourthly, the use of the MoCA could have resulted in an underestimation of cognitive functioning of the three aphasic patients in our study. A final limitation is the possible presence of selection bias. That is, we studied a relatively small sample of twenty therapists, who selected the patient with which they were observed themselves. Yet, we aimed to minimize this bias by including therapists from 6 different specialized inpatient rehabilitation centres in the Netherlands (out of the 18 existing ones), and including multiple therapists per centre. Also, our patient sample seemed

fairly representative for the stroke population as a whole, as they varied considerably in terms of their motor and cognitive abilities.

5. Conclusions

Physical therapists use a mix of relatively more external focus instructions and relatively more internal focus feedback during gait rehabilitation post-stroke. Furthermore, therapists seem to adapt their use of attentional focus strategy to the rehabilitation phase and focus preference of their patients. Future studies may want to specifically test the optimal order in which external and internal focus strategies should be used, and how their use can best be adapted to the individual patient's focus preferences and rehabilitation phase.

6. Declaration of Interest Statement

The authors report no conflicts of interest.

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Appendix 1. Questionnaire on therapists' familiarity with, preference for, and use of external and internal focus of attention.

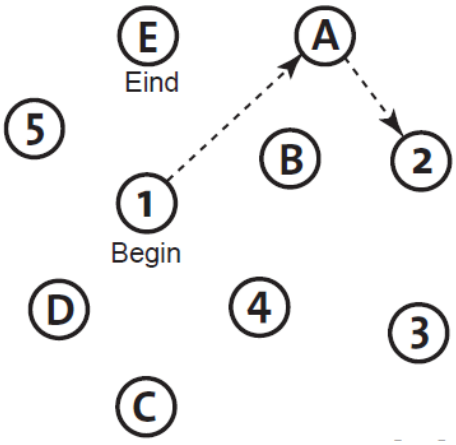
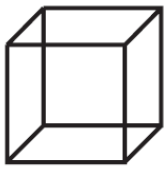
Instruction: Below are 5 pairs of statements that patients may hear when retraining gait. One statement is internally referenced, and one statement is externally referenced. External statements refer to the outcome or goal of the movement, while internal statements refer to the body and movement execution itself. Please indicate for each pair statements the one that you would **generally prefer** to use in **daily practice** when treating people with stroke. There are no wrong or right answers.

Gait parameter	External	Internal	My preference:
Step length	Try to step over the cones	Try to extend your leg more when taking a step	External Internal No preference
Foot clearance	Try not to shuffle during walking	Try to lift your knee properly during walking	External Internal No preference
Standing balance	Place your feet outward	Align your feet with your shoulders	External Internal No preference
Weight bearing transport	Feel the ground "rolling through"	Transfer your weight from your heel to your toes	External Internal No preference
Step width	Try to walk between the lines	Try to walk with your feet in front of each other	External Internal No preference

B. Were you familiar with this distinction between internal and external focus of attention before this experiment?	Yes / No
C. In daily practice, do you feel that you make conscious choices in your use of internal and external focus of attention instructions and feedback?	Yes / No
D. If so, could you specify any reasons/factors that prompt you to use an internal or external focus? (e.g., in terms of patient characteristics, type of exercise, rehabilitation phase, etcetera)	

Appendix 2. MoCA –proxy score form

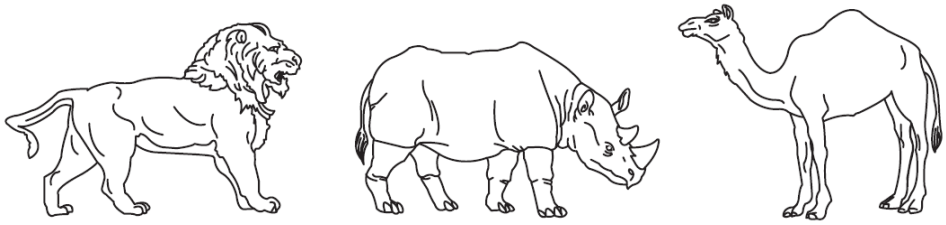
Your patient has completed the following cognitive test. We would like you to estimate for each task if your patient would be able to perform that task correctly. You may try each task by yourself to aid your assessment.

Task	**Is your patient able to do this?**
1. Visuo-constructive skills The patient needs to alternately connect numbers and letters, starting from "1" and stopping at "E" (as in the example below). Can the patient do this without making 1 error?  	Yes / No
2. Cube; the patient needs to copy the cube  Does the patients' copy fulfil all four drawing criteria?: Three-dimensional All lines are present No extra lines are drawn Lines are relatively parallel and equal lengths	Yes / No
3. Drawing a clock The patient is asked to draw a clock with the arrows indicating 10 past 11. Is the patient able to draw a clock that: - Is round	Yes / No

<table>
<tr><td>

- Has all the numbers (1-12) at the right position
- Has a large arrow that points to (slightly past) 11, and a small arrow that points to the 2

</td><td>Yes / No
Yes / No</td></tr>
<tr><td>

4. Naming
Is your patient able to name these animals?


</td><td>All of them
2 out of 3
1 out of 3
None of them</td></tr>
<tr><td>

5. Memory

	Face	Velvet	Church	Daisy	Red
1st trial					
2nd trial					

I read the list of words. The patient has to remember them for now and for later.

- Is the patient able to repeat them after one trial?
- and after two trials?
(No points are given for this task)

</td><td>1st trial Yes / No
2nd trial Yes / No</td></tr>
<tr><td>

6. Attention
- Is the patient able to repeat a list of 5 digits in forward order?
- Is the patient able to repeat a list of 3 digits in backward order?

</td><td>Yes / No
Yes / No</td></tr>
<tr><td>

7. Sustained attention

- Is your patient able to tap with his/her hand at each letter a while I read the list of letters, without tapping at other letters?
- If not, would your patient make more than one mistake?

F B A C M N A A J K L B A F A K D E A A A J A M O F A A B

</td><td>Yes / No

Yes / No</td></tr>
<tr><td>

8. Serial subtraction

- Is your patient able to count by subtracting seven from 100, and then, keep subtracting seven from the answer until 65? (thus, doing five subtractions in series)

</td><td>Yes / No</td></tr>
</table>

- If not, how many mistakes would your patient make?	Number of mistakes (0-5):
9. Sentence repetition Is your patient able to exactly repeat after me: - 'I only know that John is the one to help today' - 'The cat always hid under the couch when dogs were in the room'	 Yes / No Yes / No
10. Fluency - Is your patient able to name at least 11 words that start with the letter F (the letter D in Dutch) in one minute time? Any kind of word is ok, except for names of people or places (like Bob or Boston), numbers, or words that begin with the same sound but have a different suffix, for example, love, lover, loving. It is easiest to try this task for yourself in order to be able to estimate your patients ability.	 Yes / No
11. Abstraction - Is your patient able to understand that an orange and a banana are alike in the way that they are both fruit? (this is an example, and hence not scored) - Would your patient be able to tell how a train and bicycle are alike (means of transportation, travelling, taking trips in both) ? - Would your patient now how a watch and a ruler are alike (measuring instruments)?	 Yes / No Yes / No Yes / No
12. Memory - Delayed recall How many of the earlier learned words would your patient be able to remember at this point? (face, velvet, church, daisy, red)	4-5 2-3 1 0
11. Orientation Is your patient able to tell the year, month, exact date, day of the week, name of this place and which city this is. If not, how many incorrect answers would he/she give?	All correct Number of incorrect answers (0-6):

Tables.

Table 1. Scoring system to classify nature (instructions/feedback/other) and attentional focus content of therapists' verbal statements.

Category	Scoring code	Definition	Example
INSTRUCTION	**I-in** - *internal focus - verbal*	Instruction to focus attention to movement execution (and body) itself	"Press your heel against your toes while walking"
	I-ex - *external focus - verbal*	Instruction to focus attention to the movement goal/movement effects	"Walk the line"
	I-ex-a - *external focus, auditory*	Instruction to focus attention on auditory cues relevant to performance	"Synchronize your steps with the beat"
	I-ex-v - *external focus - visual*	Instruction to focus attention on visual cues relevant to performance	"Step toward the target that lights up"
	I-mix - *mixed focus*	Instruction that conveys both externally and internally referenced information	"Press your heel against the toes when walking the line"
	I-un - *unfocused*	Instruction that does not trigger a specific focus	"Go!"
	I-dem - *demonstration*	Demonstration of desired movement by therapist	[Therapist demonstrates walking the line]
	I-think - *'think about'*	Instruction that prompts reflection	"Think what you should do next"
FEEDBACK	**F-in** - *internal focus - verbal*	Feedback triggering a focus on movement execution (and body) itself	"Your heel did not touch your toes"
	F-ex - *external focus - verbal*	Feedback triggering a focus on the movement goal/movement effects	"You stepped next to the line there"
	F-ex-a - *external focus - auditory*	Auditory cues aimed to support/guide motor performance	"Hop, step, hop, step, hop, step"
	F-ex-v - *external focus - visual*	Visual cues aimed to support/guide motor performance	Stepping on projected stepping stones
	F-mix - *mixed focus*	Feedback that conveys both external and internal focused information	"You walked the line perfectly, your heel pressing against your toes"
	F-un - *unfocused*	Feedback that does not trigger a specific focus	"This is difficult, isn't it?"

	F-dem - *demonstration*	Demonstration of previous movement by therapist	[Demonstration of patient stepping next to the line]
	F-quan - *quantified feedback*	Quantitative information about previous motor performance	"Walking here took you 20 seconds"
	F-facil - *manual facilitation*	Any tactile or manual facilitation during moving	[Therapist supports patient standing up]
	F-mot - *motivational feedback*	Feedback aimed to motivate/stimulate	"Well done"
OTHER	**O** - *general talk*	General talk on weather, last weekend's football, etc.	"How are you feeling today?"

NB: Note that in some cases two codes could be assigned to one statement/action of the therapist. For example, when the demonstration of walking over a line is accompanied by the instruction to "walk the line" this is scored as "I-ex-dem" (external instruction with demonstration). The scoring system was modified from: Johnson, L., Burridge, J.H. & Demain, S.H. (2013). Internal and external focus of attention during gait re-education: an observational study of physical therapist practice in stroke rehabilitation. *Physical Therapy, (93)*, 957–966.

Table 2. Characteristics of therapist-patient couples.

Therapist-Patient Couple	Therapist			Patient														
	Gender (m/f)	Age [years]	Experience (years)*	Gender (m/f)	Aphasia (yes/no)	Age [years]	Education (0-7)	MoCA [0-30]	MoCA-proxy [0-30]**	FAC [0-5]	RMI [0-15]	Ambulation Aid***	MSRS-CMP [5-30]	MSRS-MS-C [5-30]	Stroke type	Lesion location	Days since admission	Days since stroke
1	f	45	17	m	no	73	4	21	20	4	6	yes	25	10	In	L-Ct	60	65
2	m	37	7	m	yes	56	5	8	2	3	7	yes	19	16	In	L-Ct	106	125
3	m	31	4	f	no	68	5	22	24.5	5	14	yes	27	11	In	L-Ct	45	54
4	f	35	9	m	no	62	3	23	14.5	2	6	yes	28	25	In	R-Ct	22	60
5	f	30	9	m	no	60	5	24	22	3	8	yes	27	18	In	R-Ct	126	136
6	f	50	22	f	no	56	3	16	10	4	9	yes	26	12	In	L-Pons	59	70
7	f	28	5	m	no	40	6	29	28.5	5	14	no	24	17	In	Bi-Ct	27	46
8	f	51	28	m	no	75	6	27	27.5	5	14	yes	26	20	In	R-Ct	75	85
9	m	45	18	m	no	70	6	28	25.5	4	13	no	29	22	In	L-Ct	27	30
10	m	29	6	f	no	56	3	16	17	2	4	yes	26	20	He	L-Sub	104	115
11	f	33	9	m	no	73	5	20	18	3	7	yes	24	18	He	L-Sub	79	87
12	m	54	18	m	no	70	6	24	23.5	0	1	yes	18	16	He	L-CB	50	97
13	f	34	7	f	yes	68	3	12	19.5	2	5	yes	13	9	In	L-Ct	10	57
14	m	56	33	m	no	62	4	24	23.5	4	11	yes	28	15	In	L-Ct	32	****

15	m	33	7	m	no	69	2	23	22	4	10	yes	30	15	He	R-Sub /L-Ct	74	83
16	f	32	7	f	no	68	3	25	25.5	2	3	yes	12	6	In	R-Ct	29	43
17	f	40	16	m	no	67	4	21	24.5	3	7	yes	30	25	In	L-Ct	30	39
18	f	61	38	m	no	60	4	26	18.5	3	5	yes	16	8	In	R-Ct	57	75
19	f	27	2	m	yes	69	2	4	7	4	10	yes	13	17	In	L-Ct	76	95
20	f	31	4	f	no	44	4	28	24.5	1	6	yes	9	28	In	R-Ct	44	61
Mean		39.1	13.3			63.3		21.1	19.9		8.0		22.5	16.4			56.6	74.9
SD		10.2	10.0			9.1		6.6	6.8		3.7		6.5	5.8			30.5	28.6
Median							4			3								
Range							2-6			0-5								

* Number of years therapist has been working with people with stroke.

** For the memory-item of the MoCA-proxy, therapists had to indicate the number of words they thought the patient would be able to recall correctly, choosing from 0, 1, 2-3, and 4-5 words. As patients scored one point per correctly recalled word, this resulted in non-rounded MoCA-proxy scores in some cases.

*** I.e., this could refer to any ambulation aid (ankle-foot orthosis, walking cane, rollator, etcetera).

****For one patient, the exact stroke date was unknown.

NB: Bi = bilateral; CB = cerebellum; Ct = cortex; FAC=Functional Ambulation Categories; He = haemorrhage; In = Infarction; R = right hemisphere; L = left hemisphere; MoCA = Montreal Cognitive Assessment; MoCA-proxy = therapists' judgment of patients' performance on MoCA; MSRS-CMP = Movement-Specific Reinvestment Scale, conscious motor processing subscale; MSRS-MSC = Movement-Specific Reinvestment Scale, Movement Self-Consciousness subscale; RMI = Rivermead Mobility Index; SD = standard deviation; Sub = subcortex;

Figure legends

Figure 1. Flowchart of inclusion of therapists and patients with stroke.

Figure 2. Nature (panel A) and attentional focus content (panel B) of statements of each physical therapist. The upper panel (A) shows the total number of instructions, feedback, and other statements. The lower panel (B) depicts what percentage of all instructions (left bar for each therapist-patient couple) and all feedback (right bar for each therapist-patient couple) was external, internal, mixed, or unfocused.

Figure 3. Average percentages of instruction, feedback and other statement types (left panel), and average percentages of attentional focus content (right panel) of physical therapists' instruction and feedback.

Figure 4. Associations between the nature and content of therapists' statements and patients' length of stay and MSRS-CMP scores. Panels A-D depict the relation between the percentages internal and external instructions and feedback on the one hand and patients' length of stay (panels A&C) and MSRS-CMP scores (panels B&D) on the other hand. Panels E-F show the relation between the percentage instructions, feedback, and other statements and patients' length of stay (panel E) and MSRS-CMP scores (panel F). NB: The regression analyses were based on the therapists' relative focus scores (i.e., the relative proportion of external vs. internal statements*100%). In this figure we show the underlying proportions of external/internal focus instructions and feedback for illustrative purposes.

Figures

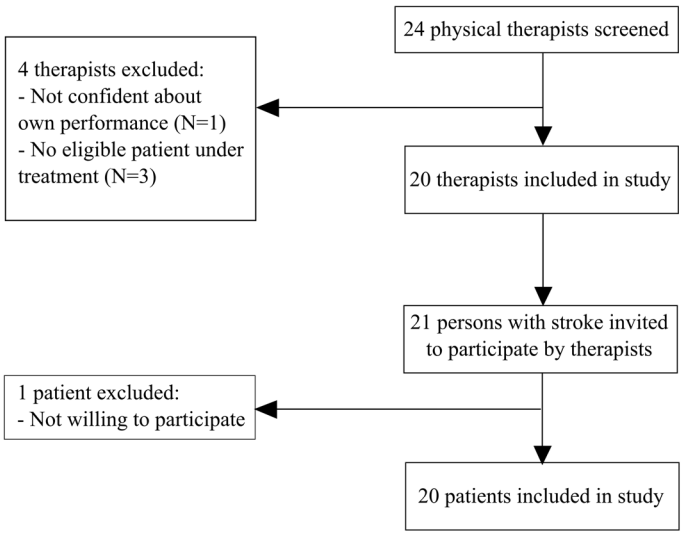


Figure 1

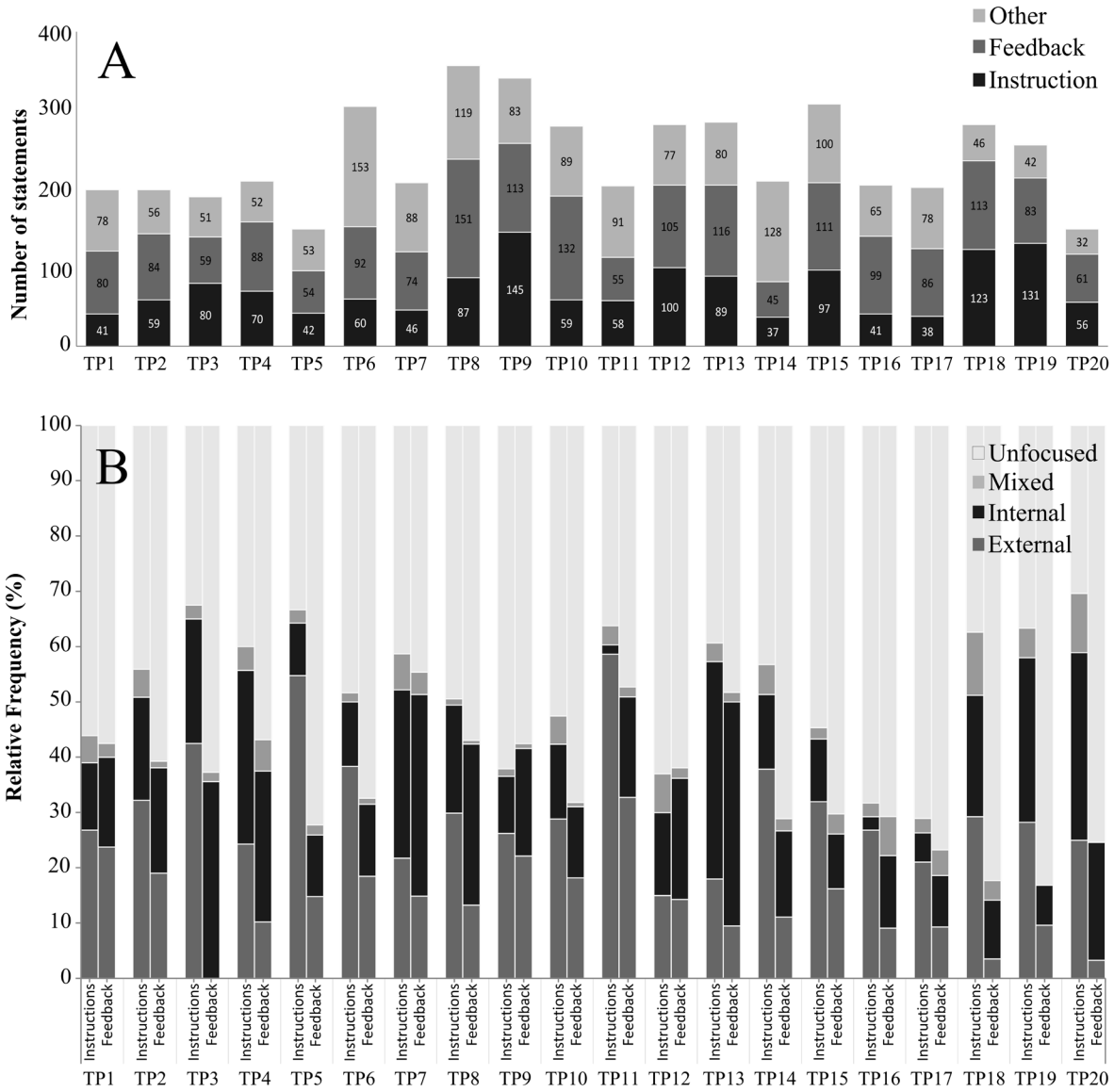
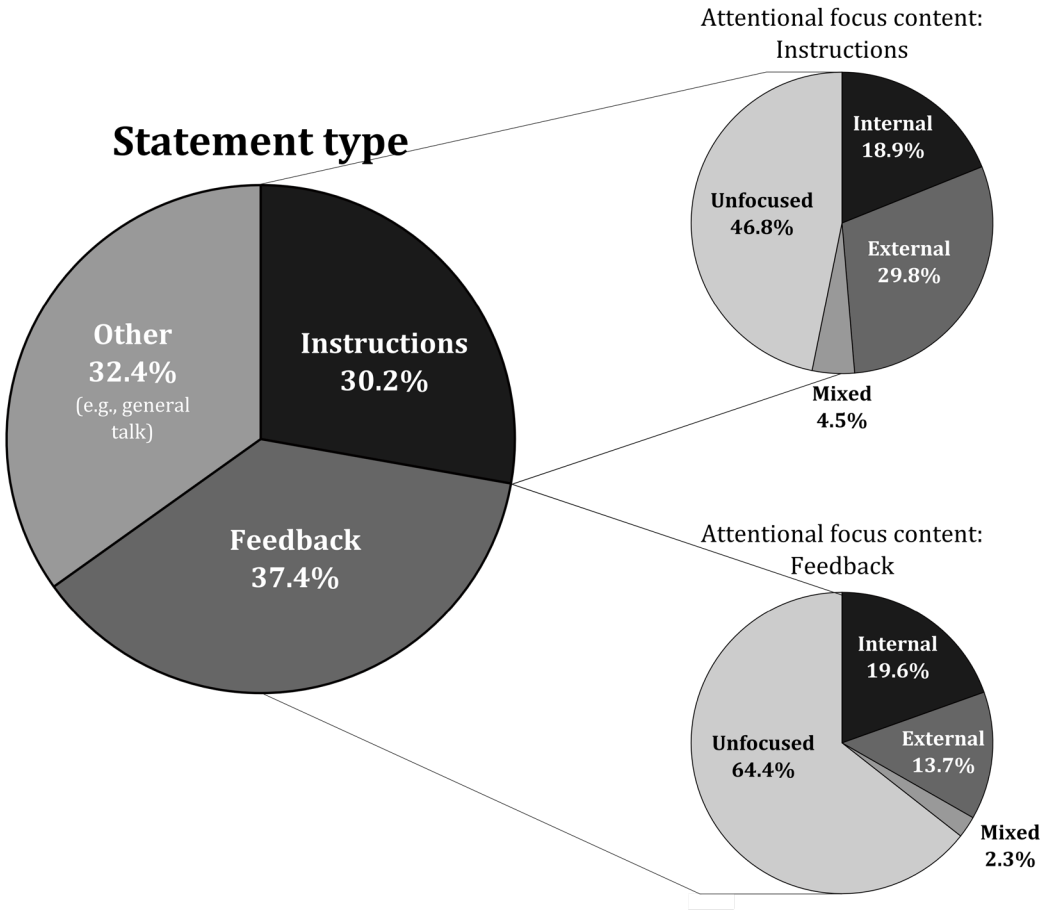
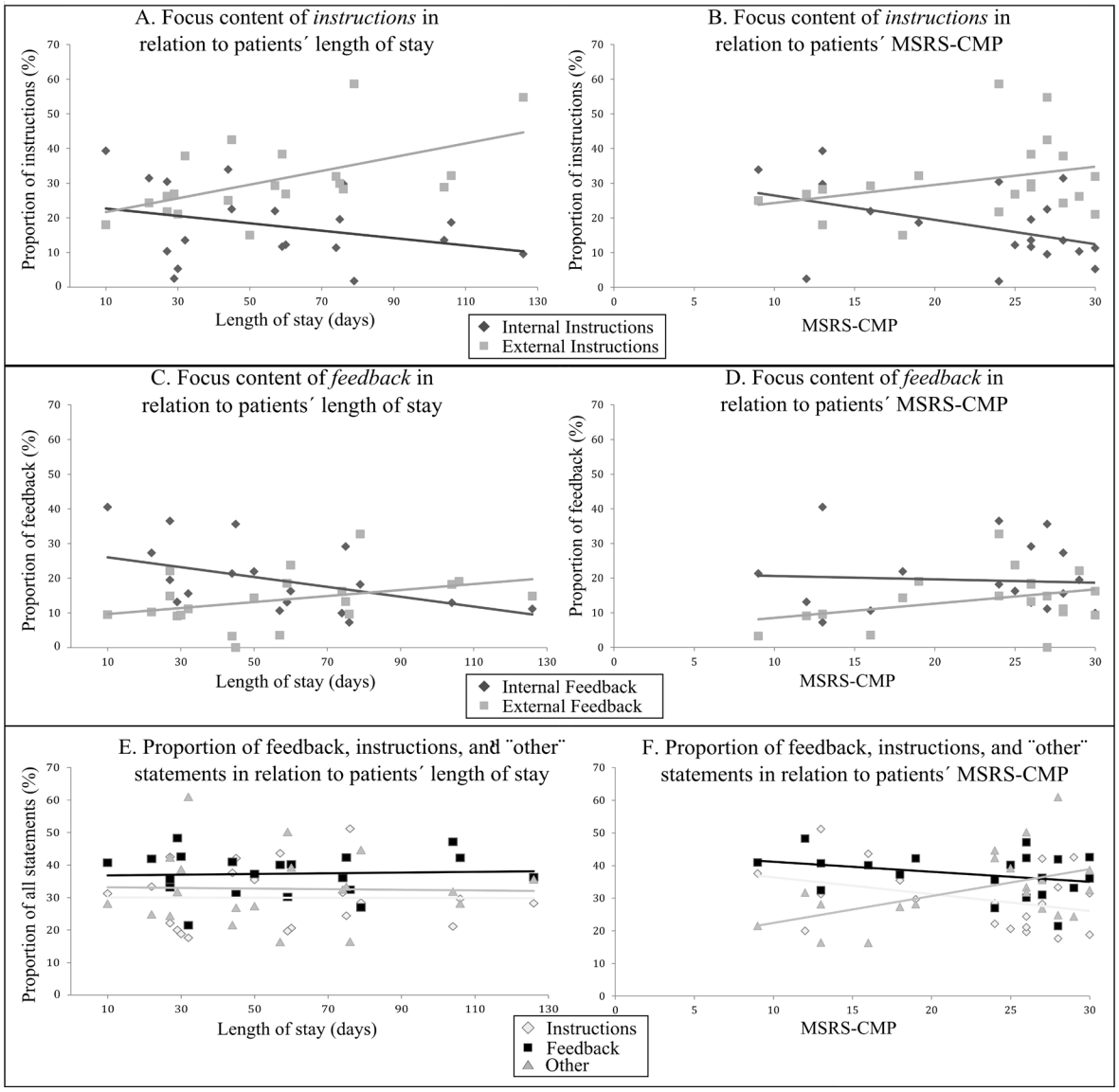

A
Other
Feedback
Instruction
Number of statements
400
300
200
100
0
TP1 TP2 TP3 TP4 TP5 TP6 TP7 TP8 TP9 TP10 TP11 TP12 TP13 TP14 TP15 TP16 TP17 TP18 TP19 TP20
78 80 41
56 84 59
51 59 80
52 88 70
53 54 42
153 92 60
88 74 46
119 151 87
83 113 145
89 132 59
91 55 58
77 105 100
80 116 89
128 45 37
100 111 97
65 99 41
78 86 38
46 113 123
42 83 131
32 61 56
B
Unfocused
Mixed
Internal
External
Relative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
Instructions
Feedback
TP1 TP2 TP3 TP4 TP5 TP6 TP7 TP8 TP9 TP10 TP11 TP12 TP13 TP14 TP15 TP16 TP17 TP18 TP19 TP20

Figure 2


Statement type
Other
32.4%
(e.g., general
talk)
Instructions
30.2%
Feedback
37.4%
Attentional focus content:
Instructions
Internal
18.9%
External
29.8%
Mixed
4.5%
Unfocused
46.8%
Attentional focus content:
Feedback
Internal
19.6%
External
13.7%
Mixed
2.3%
Unfocused
64.4%

1

2 **Figure 3**


A. Focus content of *instructions* in relation to patients´ length of stay
Proportion of instructions (%)
Length of stay (days)
B. Focus content of *instructions* in relation to patients´ MSRS-CMP
Proportion of instructions (%)
MSRS-CMP
Internal Instructions
External Instructions
C. Focus content of *feedback* in relation to patients´ length of stay
Proportion of feedback (%)
Length of stay (days)
D. Focus content of *feedback* in relation to patients´ MSRS-CMP
Proportion of feedback (%)
MSRS-CMP
Internal Feedback
External Feedback
E. Proportion of feedback, instructions, and ¨other¨ statements in relation to patients´ length of stay
Proportion of all statements (%)
Length of stay (days)
F. Proportion of feedback, instructions, and ¨other¨ statements in relation to patients´ MSRS-CMP
MSRS-CMP
Instructions
Feedback
Other

1

2 **Figure 4**