Dissecting the Mechanism of Fatigue: Tapping Speed, Rate of Perceived Efforts, and Fatigue Severity

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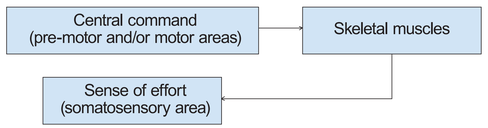
Introduction

Subjective fatigue in chronic illnesses may arise from different mechanisms. Fatigue may arise centrally, upstream from the motor cortex (M1), such as the supplementary motor area (SMA), from M1 due to GABA inhibitory interneurons, spinal cord Renshaw cells, to the neuromuscular junction, or from peripheral muscle. Rhythmic non-resistant movements are fundamental to daily activity.

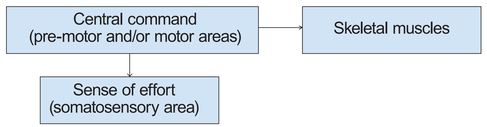
Methods and materials

This was an exploratory project designed to capture data on the performance of the FTT by patients diagnosed with CKD. The FACIT-F assessed subjective fatigue severity. Patients were asked to complete timed tapping tasks using their dominant hand's index finger. Tapping time frames were 15, 30, and 60 seconds. Tests were repeated twice with 60 seconds of rest between each task. The effort was assessed using the Borg Rating of Perceived Exertion scale after the tapping trials. Pearson correlation coefficients were calculated to assess the relationship between fatigue, perceived effort, and tapping rate. To further examine the data, data were stratified by history of neuropathy, dialysis, ECOG scores, and rate change. R2, the variance accounted for, was included as a measure of effect size.

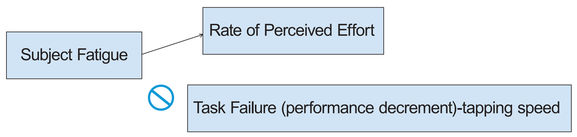
A. Afferent feedback model of perceived exertion



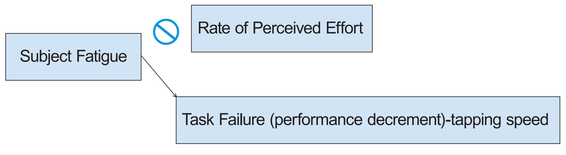
B. Corollary discharge model of perceived exertion



Cancer-Related Fatigue



Fatigue Associated with Renal Failure



Results

A total of 30 patients consented to participate in the study. They had an average age of 73, 53% were male, and 37% had a history of peripheral neuropathy. When looking at the difference in means, those with a rate decrease had a mean FACIT-F TOI score of 6.4 points higher than those with a rate increase, indicating more significant fatigue in those with a reduced tapping rate. Similarly, the Total FACIT-F Scores were 6.6 higher in those with a tapping rate decrease than those with a rate increase. Unlike cancer patients, there was no association with RPE suggesting that the location of fatigue is from the motor cortex to the muscle.

Summary		Cancer n 30		CKD n 30	
		Mean	SD	Mean	SD
Age		56.2	12	72.7	12.6
Gender, n (%)					
	Female	16	53.30%	14	46.70%
	Male	14	46.70%	16	53.30%
BFI score		4.1	2.1	2.7	2.51
Borg 10 score		2.6	1.9	3.3	2.85
Overall tapping speed (total taps/total seconds)		3.9	0.9	3.4	0.56

Cancer Tapping Speed and Fatigue Pearson's Correlation Coefficients	Overall Tapping Speed (total taps/total seconds)		Overall Tapping Speed (mean of trial taps/second)		Borg 10	
	ρ	p-value	ρ	p-value	r	p-value
BFI Mean Score	-0.075	0.6954	-0.082	0.6651	**0.513**	**0.0038**
BFI Median Score	-0.078	0.6807	-0.085	0.6537	**0.541**	**0.0020**
Fatigue Right Now	-0.191	0.3125	-0.194	0.3044	**0.440**	**0.0151**
Fatigue Usual Level	-0.248	0.1870	-0.261	0.1643	**0.517**	**0.0034**
Fatigue Worst Level	-0.189	0.3171	-0.206	0.2751	**0.342**	**0.0646**
Borg 10	-0.230	0.2212	-0.247	0.1891		
Age	**-0.364**	**0.0477**	**-0.381**	**0.0380**	0.096	0.6148

CKD Tapping Speed, BFI, FACIT-F and Borg 10 Pearson's Correlations Coefficients		r	p-value	r2	r	p-value
					Borg 10	
BFI Score	Taps/Second in Round 1 30-second trial	**-0.382**	**0.037**	**0.146**		
BFI Score					0.137	0.469
FACIT-F	PWB	**-0.441**	0.015	0.194	-0.237	0.208
	SWB	**-0.365**	0.047	0.133	-0.04	0.833
	FWB	**-0.753**	<.0001	0.567	0.085	0.657
	FS	**-0.669**	<.0001	0.448	0.153	0.42
	FACIT-F TOI	**-0.82**	<.0001	0.672	-0.153	0.42
	FACIT-G	**-0.82**	<.0001	0.672	-0.095	0.017
	Total FACIT-F Scores	**-0.89**	<.0001	0.792	-0.157	0.617

Discussion

The origins of fatigue, whether central or peripheral, can not be explained using a subjective fatigue questionnaire, gauging the RPE during the task, and the time-related deceleration of tapping speed over 30 seconds. We have found that cancer fatigue is associated with a rapid increase in RPE without a decrement in tapping speed over 30 seconds, suggesting the sight of origin in the SMA or upstream of M1 in cancer. In contrast, fatigue of chronic renal failure is associated with a decrement in 30-second tapping speed unassociated with the RPE, suggesting fatigue arising from sights at M1 or downstream from M1.

Conclusion

The neurophysiological causes of fatigue in cancer is pre-motor cortex whereas it arises from the motor cortex to muscle in those with fatigue from chronic renal failure.

References

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