Differentiated Measurements for Fatigue and Demotivation in Translation Process

Junyi Mao
sczs16@durham.ac.uk
Durham University, Durham, UK

Abstract
Fatigue is physical and mental weariness caused by prolonged continuity of work and would undermine work performance. In translation studies, although fatigue is a confounding factor previous experiments all try to control, its detection and measurement are largely ignored. To bridge this lacuna, this article recommends some subjective and objective approaches to measuring translation fatigue based on prior fatigue research. Meanwhile, as demotivation is believed to be an emotion that confounds its accurate measurements, a discussion on how to distinguish those two states is further conducted from theoretical and methodological perspectives. In doing so, this paper not only illuminates on how to measure two essential influencers of translation performance, but also offers some insights into the distinction of affective and physical states during translation process.

1 Introduction
With the flourish of experimental studies on translation process, translators’ cognitive and affective states at workplaces have gained increasing attention. However, compared with intense probes into the cognitive aspect of translation, how translators’ emotional states influence their translation performance remains largely underexplored. And one of essential reasons is the shortage of reliable instruments to record interested variables accurately and concurrently, especially when the ecological validity is considered. Even though, recent decades have witnessed a growing number of endeavours on translators’ emotion (Kitanovska-Kimovska & Cvetkoski, 2022; Lehr, 2014; Lehr & Hvelplund, 2020; Rojo & Caro, 2016), stress (details in Weng & Zheng, 2020) in particular, and motivation (Fan, 2012; Ghasem, 2019; Wu, 2019). Of note is that most experiments adopted subjective measurements (e.g., emotional or motivation scales) to investigate translators’ affective states, which somehow ignores the inevitable discrepancy between self-evaluation and actual moods. In this regard, Weng and Zheng’s (2020) combination of State-Trait Anxiety Inventory and biomarkers such as heart rate, blood pressure, skin conductance, and salivary cortisol is methodologically progressive. As there exist overlaps between biometrics used to measure different emotional and/or physical states, scholars have advocated the proper application of those techniques and meticulous interpretation of relevant data (Richter & Slade, 2017; Rojo & Korpal, 2020). In translation studies, Rojo and Korpal (2020) have elaborated on how to distinguish stress from other emotions when heart rate variability and skin conductance are employed as indicators. According to their review, no compelling evidence exists to support the assumption that discrete categories of emotions uniquely correspond to specific region(s) of brain, and the same applies to other biomarkers. Thus, the multiple explanations of same physiological indices are an obstacle to overcome before those cutting-edged devices are fully capitalised on. The story grows complexity when physical, cognitive, and emotional factors share one same indicator, of which pupil dilation is
an example. Though researchers have designed experiments conscientiously to eliminate common confounding variables such as fatigue, to what extent such manipulations are successful remains unknown. As fatigue is a universally concerned influencer in translation experiments, this article proposes some measurements for translation fatigue with reference to previous literature on fatigue theories and measurements. Afterwards, a comparison between demotivation and fatigue is conducted from the perspective of conceptualisation and measurement. In doing so, it suggests on how to distinguish two phenomenologically similar states in translation scenarios and offers some methodological insights into differentiating physical states from affective states.

2 Fatigue

2.1 Theoretical Definition of Fatigue

State fatigue is defined as “weariness or exhaustion from labour, exertion, or stress” in Merriam Webster dictionary, which denotes its physical and mental aspects. Theoretically speaking, fatigue can also function as a trait since certain people have stronger propensity to feel exhausted under the same workload. Comparatively, physical fatigue gains less theoretical interest than mental fatigue, for which diverse frameworks have been proposed. At first, mental fatigue is depicted as a psychobiological state caused by lengthy and uninterrupted periods of attention-demanding tasks and features a feeling of energy-depletion (Boksem & Tops, 2008). And its adverse impacts on cognitive and motor performances are believed to originate from an impairment in attention maintenance (Boksem et al., 2005), self-regulation (Lorist et al., 2005), response promptness and accuracy (Boksem et al., 2006), as well as efficiency of information identification and utilisation (Lorist et al., 2000). As its conception evolves, more emphasis was placed on its indication of inefficient energy management. According to Thorndike (1900), fatigue is indexed by the inability to do the right thing, rather than continue to work over sustained time. Likewise, Bartley and Chute (1947) believe the conflict between competing behavioural dispositions as the essence of fatigue. By this logic, fatigue is an adaptive state serving to maintain effective and systematic management of goals and meanwhile signifying one’s motivational control (details in Balkin & Wesensten, 2011). Also, theoretical attention has been paid to what determine the occurrence of mental fatigue. On a macro level, Grandjean (1968) posited that contextual elements, internal physical factors, and task features altogether accelerate the accumulation of fatigue, which can be alleviated by off-task or leisure activities. In comparison, microcosmic models explain cognitive fatigue through the lens of attention availability and utilisation. For instance, Kahneman’s (1973) model on attention allocation delineates the prerequisites for a task to be fatiguing. It postulates that individuals’ overall arousal during a task depends on the attentional resources available, whose distribution is a combined effect of one’s long-term task interest, state motivation, and regular evaluations on the goal-performance discrepancy. To modify Kahneman’s model, Hockey (1997) further included competence-related factors such as responses to challenges, capacity for sustained work, and tolerance of stress as well as perception-related element of task value (Hockey, 1997:80). In his viewpoint, when demands exceed efforts budgeted for the task, a downward revision of goals might be adopted to alleviate the discrepancy until a complete disengagement take places. Similarly, the integrated resource allocation model (Kanfer & Ackerman, 1989) surmised that the quantity of attention accessible for allocation is a joint function of one’s ability and willingness. Attention can be diverted to task effort, off-task thoughts and distractions, and self-regulation. And it is the self-perception of effort-performance, performance-utility, and effort-utility functions that determines how much attention one would commit to the given task (details in Ackerman, 2011:21-23). Taken together, those theories not only explicate the role of personal characteristics, time on task, and task features in determining the fatigue effect (Kanfer, 2011:197-198),
but also imply the interwoven relationship between motivation and fatigue in conditioning energy distribution and goal setting. It is such a functional overlap between demotivation and fatigue that legitimates the inclusion of motivational factors in some well-recognised fatigue scales (e.g., Åhsberg’s Occupational Fatigue Inventory).

In practice, apart from measurements of fatigue targeting clinic populations, various self-report and observational indicators for chronic and state fatigues have been developed and implemented in cognitive and physical tasks. The following part introduces typical measurements of fatigue for healthy people and examines their applicability in translation studies.

2.2 Measurement of Fatigue

Subjective Measurement of Fatigue

For nonclinical populations, subjective measurements of fatigue consist of task-specific scales, general scales, and measures of related constructions (details in Ackerman, 2011:24). The first type focuses on one single dimension of subjective fatigue (e.g., stress-state measures in Matthews & Desmond, 2002). The second kind is more diversified with a distinction between short-term and long-term fatigue (e.g., Occupational Fatigue Inventory; Åhsberg, 2000) as well as trait (e.g., Modified Fatigue Impact Scale; Larson, 2013; Fatigue Severity Scale; Krupp, 1989) and state fatigue (e.g., Visual Analog Scale of Fatigue; Lee et al., 1991). Most of those inventories incorporate physical, psychosocial, and cognitive aspects of fatigue and measure the fatigue intensity on a Likert-based scale. In the last case, fatigue is assessed as a component of its highly relevant variables ranging from the activity level (Brooket et al., 1979), moods (Mcnair et al., 1971), activation–deactivation (Thayer, 1978), to tiredness (Montgomery, 1983). When implemented, different scales are often combined, and a comparison of pre-task and post-task data reveals the fatigue caused by a lengthy and attention-demanding task. For instance, when Trejo et al. (2005) examined cognitive fatigue in a continuous mental arithmetic task, both Activation Deactivation Adjective Checklist and Visual Analogue Mood Scale were administered. As evidence on individualised influences (e.g., personality) over self-rated fatigue accrues, meticulous scholars began to enclose personality tests into their instruments. A case in point is Ackerman and Kanfer’s (2009) investigation on how the temporal length of SAT test impacts self-rated cognitive fatigue, which shows that differences in neuroticism accounted for the variance in pre-test and post-test cognitive fatigue. However inclusive current fatigue scales are, subjective data is criticised for being unidentical to real-time states, not to mention the concurrent influence of individual differences. In this sense, objective measurements serve as a healthy supplement.

Objective Measurement of Fatigue

Performance as a Fatigue Indicator: Although a decrement in performance after a long-period task execution is accepted as one objective marker of fatigue (Hockey, 2011:171), the validity of such a proposition depends on the satisfaction of following requirements: 1). for a between-group comparison, participants’ task specific competency and differences in fatigue proneness and regulation should be considered as confounding factors; for a within-subject comparison, task difficulty should be controlled at a comparable level. 2). time-on-task is key to distinguishing fatigue effects from those of others (e.g., unfamiliarity with experimental setting-up) when task difficulty is within one’s competency. Fatigue normally occurs at the later stage of a lengthy and continuous task, which means underperformance at the onset is nonattributable to fatigue unless a taxing task is deliberately assigned beforehand. 3). the task must be intrinsically enjoyable and attention-demanding so that confounders of amotivation or boredom can be eliminated. Even though, extensive evidence has shown that direct effects of fatigue on task performance can be unnoticeable (Ackerman, 2011:14-15), which according to Compensatory Control Model (Hockey, 1997), may result from self-regulation and cogni-
tive control. From this perspective, performance may not be an effective and reliable index of translation fatigue as self-reports and physiological markers do.

**Physiological Markers as Fatigue Indicators:** Prior experiments resorting to biomarkers cover varied cognitive and physical tasks, among which literature on drivers’ fatigue has established a systematic measurement mechanism. In Ani et al.’s (2020) review of detecting systems for driving fatigue, extant approaches were summarised as behavioural, psychophysical, and biomechanical based. As to behaviours observable by naked eyes, yawning, eye closure or blinking, and changed head or sitting positions can manifest the appearance of fatigue. To capture more subtle changes of physiological signals precisely, electrocardiogram (ECG), electromyogram (EMG), electrooculogram (EOG), electroencephalogram (EEG) and eye trackers have been applied. As far as ecological validity and operational simplicity is concerned, eye trackers seemingly outperform neuro-imaging detectors. And eye-related indicators in service range from eye closure, blink, saccades, fixation, to pupil dilation. Of note is that most research co-used different indices to represent the multi-facets of fatigue. Considering translators’ normal work environments, indices of practical value are enumerated in Table 1 along with cautions on their application.

| Fatigue type               | Author & task situation | Tools                        | Variables and signs of fatigue                                         | Measurement and analysis, findings                             | Applicability in translation |
|---------------------------|-------------------------|------------------------------|--------------------------------------------------------------------------|-----------------------------------------------------------------|-----------------------------|
| Muscular fatigue          | Rahayu et al., 2016     | Grip pressure measurement System | Decrease in hand grips pressure force                                 | Electromyogram was put on the skin surface of interested muscles, and compare data from the first and the last 15-min sessions | Applicable                   |
|                           |                         |                              |                                                                          |                                                                  |                             |
|                           | Zhang et al., 2014      | EMG                          | Higher average EMG response indicates higher level of fatigue           | Electromyogram was put on the skin surface of interested muscles, and compare data from the first and the last 15-min sessions | Applicable                   |
|                           |                         |                              |                                                                          |                                                                  |                             |
| Muscular visual fatigue   | Jia et al., 2020        | portable EEG cap             | Increase in α & β frequency band and a decrease in / frequency band      | Electrodes were placed on the upper eyelid                     | Applicable                   |
|                           |                         |                              |                                                                          |                                                                  |                             |
|                           | Zhang et al., 2014      | EEG                          | Self-developed algorithm                                                | Electrodes were placed on 03 and 04                            | Applicable                   |
| Cognitiva/mental fatigue  | Punamwar et al., 2015  | wearable functional near-infrared spectroscopy (fNIRS) & EEG amplifier | Three different weighting factors applied to the index (β + α)/β         | Electrodes were placed on 7 standard locations with a reference electrode on the tip of the nose | Applicable                   |
|                           |                         |                              |                                                                          |                                                                  |                             |
|                           | Amma et al., 2012       | EEG (Ag/AgCl electrodes)     | An increase in Theta and Alpha frequencies                              | Electrodes were placed on 7 standard locations with a reference electrode on the tip of the nose | Applicable                   |
|                           |                         |                              |                                                                          |                                                                  |                             |
|                           | Peng et al., 2022       | wearable functional near-infrared spectroscopy (fNIRS)                   | Functional connectivity strength, characteristics of brain functional network, and time-domain characteristics of blood oxygen | From low to moderate fatigue, the network connectivity overall decreased, especially between regions of PPC and FEF, PPC and PMC. From moderate to severe fatigue, the network connectivity generally increased, and there is a relatively compact connectivity remained between left PPC and other regions, especially between PPC and FEF | Applicable but lacking compelling evidence |
|                           |                         |                              |                                                                          |                                                                  |                             |
|                           | Shin et al., 2010       | smart phone system           | The concentration of salivation cortisol/ low level indicates fatigue   | smoking was collected at the end of each test (5-min practice and three 15-min driving tests) | Applicable but requiring the control of confounding factors (stress) |
|                           |                         |                              |                                                                          |                                                                  |                             |
|                           | Qiao et al., 2016       | eye tracker                  | Increased blink duration & frequency, delay of lid opening               | Standardized                                                    | Applicable                   |
|                           |                         |                              |                                                                          |                                                                  |                             |
|                           | Zhu et al., 2004        | portable EEG cap             | Increased rate of eye closure and average eye closure speed              | Standardized                                                    | Applicable                   |

---

*Proceedings of the 15th Biennial Conference of the Association for Machine Translation in the Americas, Orlando, USA, September 12-16, 2022. Workshop 1: Empirical Translation Process Research*
Translation can induce both muscular and cognitive fatigue. For the former, thin, and high-resolution sensors or EMG electrodes can be placed on the skin surfaces where translators exercise continuous forces such as thenar to detect physical fatigue caused by typing. Meanwhile, cameras and EOG can be combined to document changes in translators’ facial expressions (e.g., face lagging) and eye movements (increased eye blink frequency and duration, and decreased eyelid muscle activities indicate visual fatigue), which serve as indicators of facial muscular fatigue. As to cognitive fatigue, attention decrement and drowsiness can be monitored by portable EEG cap (fatigue is indexed by an increase in theta and alpha frequency band and a decrease in beta frequency band), fMRI (indicated by changes in network connectivity between different brain regions), or eye trackers (a decrease in pupil size, eye closure speed, or an increase in the percentage of eye closure and saccades). However, it merits notice that when applying aforesaid biomarkers, confounding factors must be considered in the experimental design. For instance, when using pupil size as an indicator of fatigue, environmental (e.g., light, noise), task (e.g., time pressure), textual (e.g., difficulty and emotionality of source texts) and personal (e.g., health condition, medication and coffee consumption) factors should be controlled for a between-period comparison as evidence shows that pupil dilation is sensitive to those elements (Hvelplund & Lehr, 2021). Moreover, to ensure those physiological changes result from fatigue, time on task is essential. The duration of previous experiments ranged from 30 minutes to 8 hours depending on the task workload. And one study conducted in the similar scenario to translation (Rasyad et al., 2020) indicated fatigue due to computer-based work normally occurs after 30-40 minutes. In this sense, translators’ fatigue may appear after a similar length of screen-based translation. Researchers interested in this topic should set their studies at a reasonably long time to detect its effect and meanwhile consider individualised factors such as fatigue proneness.

Compared with scales, physiological data collected by those devices have the merits of reflecting the unconscious aspect of fatigue and accurately recording online states. Nevertheless, its flaws are also obvious. Multiple sources of one physiological signal means that it can be hard to make a confident interpretation of changes in interested variables. As fatigue shares some cognitive, physiological and behavioural indicators with demotivation, the following section will discuss how to differentiate fatigue from demotivation based on their conceptual and measurement differences.

### 3 Definition of (De)motivation and its Measurement

Motivation is a topic of interdisciplinary discussion for which multitudes of theories and models (e.g., self-determination theory, motivational intensity theory) have been established to explicate its operating mechanism. Some treat motivation as a trait which exercises long-term effects on work and learning performance (Deci & Ryan, 1985), while others regarded it as a state that

| Cognitive/mental fatigue | Munoz-de-Escalona et al., 2020 aircraft tasks | Reduced pupil size | baseline correction of pupil size | Applicable if confounding factors (e.g., task difficulty, emotionality of source texts) are controlled |
|--------------------------|---------------------------------------------|------------------|----------------------------------|--------------------------------------------------------------------------------------------------|
|                          | Rasyad et al., 2020 1-hour computer-based work | Saccades, eye blink frequency and duration | Fatigue occurs from 30-40 min; microsleep from 40-50 min; eye blink variables are more sensitive than saccades | Only applicable in extremely lengthy or taxing tasks |
| General fatigue          | Zhu & Ji, 2004 Test of Attention             | Facial expression detector | lagging facial muscles, expressionless, and frequent yawning | multi-scale and multi-orientation Gabor wavelets are used to represent and detect facial features |
|                          | Zhang et al., 2014 2h simulated driving      | Human observation | signs of boredom, anxiety, agitation, restlessness, or grimaces; yawns and dozes | Only applicable in extremely lengthy or taxing tasks |

Table 1: Physiological Indicators of Fatigue in Previous Literature.
have direct influences over task effort and outcomes (Brehm & Self, 1989). To illustrate how motivation as a trait and a state play their role in cognitive and physical activities, emphasis have been placed on its measurement.

Theoretically speaking, trait motivation composes of intrinsic and extrinsic motivations, which stem from the satisfaction of competence, relatedness, autonomy, and external rewards or regulations (Deci & Ryan, 1985). Contrarily, a failure to meet those requirements entails amotivation/demotivation. Though relatively steady, trait motivation can be domain specific as one’s motivation to work is no equivalence of that to learning or entertainments. Moreover, trait motivation is so implicit that its measurement largely relies on established scales. In translation studies, a typical example is interpreter trainers’ learning (de)motivation scale (Wu, 2016). In comparison, state motivation is temporary and task-specific, whose intensity is believed to have detectable cognitive, behavioural and physiological outcomes (Blaise et al., 2021; Derbali & Frasson, 2010; Neigel et al., 2019). Defined strictly, state motivation is regulated by the biological structure of Basal Ganglia and its intensity can shift even within one single task (Wasserman & Wasserman, 2020). In practice, state motivation is always interchangeably used with task motivation and operates as a multi-component structure (de Brabander & Martens, 2014). As such, the more prudent measurement is a combination of self-report and biometric data. Regarding self-report data, factors such as self-efficacy, autonomy, task meaning, utility, enjoyment, and difficulty, as well as output satisfaction are theoretically presumed as reflections of task motivation (Kormos & Wilby, 2019). As to biomarkers, motivational intensity theory (Brehm & Self, 1989) proposes task effort as an indicator of task motivation which can be measured by sympathetic system responses in systolic blood pressure and pre-ejection period. Ideally, task motivation would increase as tasks get more complicated if task accomplishment is possible and justified. And enhanced motivation is indicated by a higher level of systolic blood pressure and shorter pre-ejection period. By contrast, when task difficulty exceeds one’s competence, a sense of demotivation would entail a sharp decline in task effort, thus lowering systolic blood pressure and lengthening pre-ejection period. Empirical evidence from varied cognitive and physical tasks have lent adequate validity to those assumptions (Guido et al., 2012). Although SBP and PEP are most suitable measures of motivational intensity from a biological angle, alternative indices such as diastolic blood pressure, heart rate, pupil size and skin conductance are also utilised in many experiments in case one indicator may be insensitive to certain stimuli. Of note is that current practice measures task motivation holistically and focuses on differences in selected parameters between pre-task and during-task conditions rather than subperiods in one lengthy task. Specifically, task motivation is calculated as the mean level of biological data over the whole task deducted by baseline data collected at the resting condition.

More recently, EEG has also been applied to record motivational states (Gergelyfi et al., 2015) since changes of band power in the prefrontal cortex proved to be modulated by emotion and motivation (Spielberg et al., 2008). Specifically, approach motivation leads to more activations in the left hemisphere whereas withdrawal motivation activates the right hemisphere more (Gollan et al., 2014, Horan et al., 2014). And more motivating tasks produce greater magnitude EEG alpha and beta band power in the left prefrontal cortex (Sammler et al., 2007). With the growing application of EEG, channels corresponding to attention, emotion, motivation, and fatigue were further identified. Moreover, using residual-to-residual CNN algorithm, beta waves proved to outperform alpha waves in the accurate predication of motivation for game-playing (Chattopadhyay et al., 2021).
Thus largely self-determined. However, concerning their measurements, the boundary becomes
tal state out of personal control, while the latter is more related to one’s willingness and are
cynthesis and intrinsic motivations.
In theory, demotivation and fatigue is easily distinguishable. The former is a physical and men-
tal state out of personal control, while the latter is more related to one’s willingness and are
thus largely self-determined. However, concerning their measurements, the boundary becomes

| Motivation type | Author(s), date & instruments | Application scenario | Instruments & indications | Measurement features & precautions when applied |
|-----------------|------------------------------|----------------------|--------------------------|-----------------------------------------------|
| Trait motivation| Wu, 2016 Interpretation learning motivation scale | Motivation for learning interpretation | Motivation and demotivation | Theory-based and data-driven scale. Require administration immediately before or after the investigated period as participants’ responses can vary noticeably across time |
|                 | Cai & Dong, 2017 Interpretation learning motivation scale | Attitudes to learning environment, teachers and translation, interest in translation, willingness to translate | Immune, instrumental motive, achievement goal, extended effort | |
|                 | Wu, 2015 Translation learning motivation scale | Motivation for learning translation | Modified motivation scale with no distinction between intrinsic and extrinsic motivations | |
|                 | Amabile et al., 1994 Work preference inventory | Professionals’ work motivation or students learning motivation | Immune (challenge & enjoyment) and extrinsic (outward & compensation) motivations | Weakly applicable; require modifications to make the scale more relevant to translation work, scale validation in different cultures has generated different subdimensions (Ocal et al., 2019) |
| State motivation| Carver & White, 1994 BIS/BAS scale | Simple cognitive tasks | Approach: reward responsiveness, drive, and fun seeking; & Avoidance motiva: lower score indicates low motivation | |
|                 | Task-specific motivation scale (e.g., Martin, 2012)/ English Writing Motivation and Engagement Scale | (L2) writing task | Self-belief, anxiety, task value, learning focus, persistence, uncertain control, task management, disengagement, planning, failure avoidance and self-sabotage | Have been validated and applied in different cultures; validation of this scale in different contexts has led to different subdimensions (Maack & Ebesutani, 2018) |
|                 | Heart-rate-related variables (e.g., pre-creation period) | Simple cognitive and physical tasks | Difference in indicators between the resting and the operating states: a reduced difference indicates declined motivation | Situational but subjective, for whose implementation individual differences should be considered |

Table 2: Applied/applicable motivation measurements for translation activities

As shown in Table 2, in translation studies, previous investigators have adopted theories and models in the learning domain to develop their scales and confined their targets on language learners. However, as professional translators’ motivation has been found to shape their performance (Lehr, 2014), trait and state motivation measurements dedicated to translation are in urgent demand if further exploration of the underlying mechanism were conducted. In this sense, pre-existing generic scales (e.g., work preference inventory, BAS/BIS scale), though not directly applicable, lay the foundation for translation scholars to build their measurement toolkits. Take WPI as an example, the general expression that “I love translating problems completely new to me” can be situationalised by adding “translation” before “problems”. Moreover, as exploratory factor analysis in previous studies on employers’ motivation has generated structures different from the original ones, it is essential to validate the modified scales with adequate sample size before their implementation. Regarding state motivation, psychological metrics (e.g., blood pressure, heart rate variables, skin conductance) widely applied in other cognitive tasks are worthy of consideration if confounding factors (e.g., emotional valence of source texts) were meticulously controlled. Another two cautions are: 1) when the attentional and emotional aspects of translation are concurrently examined, eye-movement indicators such as pupil size may not be a rigorous biomarker; 2) in practice, some biomarkers may not be so sensitive to motivational alteration, for which a combined use of indexes are recommended.

4 How to Differentiate Fatigue and Demotivation in Translation

In theory, demotivation and fatigue is easily distinguishable. The former is a physical and men-
tal state out of personal control, while the latter is more related to one’s willingness and are
thus largely self-determined. However, concerning their measurements, the boundary becomes
less clear-cut. Not only fatigue can be a source of demotivation, but also demotivation and fatigue share some cognitive (less focused) and behavioural (underperformance) signals. The theoretical premise that the amount of deliberate effort, efficiency of attention allocation and information processing can index one’s motivation fails to discriminate demotivation from fatigue which could lead to same outcomes, albeit at an unconscious level. In this regard, the employment of traditional scales, though at the risk of inaccuracy and latency, seems more helpful in differentiating physical states from emotional states than biomarkers of attention and effort.

However, a perusal of theoretical and biological underpinnings for their measurements sheds more lights. First, fatigue is an exhausting state due to protracted work, which means long time-on-task is a requisite to its occurrence. Differently, lack of motivation can happen at any stage of task performance, either because of one’s unwilling to take the task (in the very beginning), a growing understanding of task difficulty (in the middle of task) or gradually getting bored. Second, as one subdimension of fatigue, muscle fatigue has physical features undetectable in the case of demotivation. Biologically speaking, human beings are unlikely to control their muscles in a conscious way, especially in cognitive tasks where skeletal muscle does not play a noted role. In this sense, biometers for measuring muscle fatigue such as EMG and EOG are effective in distinguishing fatigue from demotivation. Third, as far as the mental aspect of both states is concerned, bio-signals of drowsiness (e.g., increased activities in Alpha band power) are peculiar to fatigue as motivation is more self-controlled and operates consciously in most of time. Meanwhile, neuroscience scholars have mapped out some brain regions correspond to motivation and fatigue respectively (Chattopadhyay et al., 2021), which paves the way for applying EEG to tell fatigue from demotivation that may occur at the similar stage. Finally, physiological indices of parasympathetic and sympathetic activities are also useful. Based on motivational intensity theory, demotivation is associated with decreased arousal in sympathetic activities (indicated by lower SBP and longer PEP), which has gained ample empirical supports. Contrarily, fatigue was discovered to be linked to increased sympathetic arousal (Tran et al., 2009) and decreased parasympathetic nervous activities (Lee et al., 2021). Hence, the opposite reflections of those two states in the autonomic nervous system speaks to the applicability of heart rate and blood pressure related parameters for their distinction. Actually, Gergelyi et al. (2015) have employed a series of neural, autonomic, psychometric, and behavioural signatures to dissociate effects on working memory performance of mental fatigue (measured by ECG, eye blink, and Multidimensional Fatigue Inventory) from that of motivation (measured by EEG, pupil diameter, skin conductance response, and self-rated task interest, efficacy, effort, and value). And their results showed participants’ subjective feeling of fatigue is positively related to their eye blink rate and heart rate variability. While reward-induced EEG, pupillometric and skin conductance signal changes (indexes of motivation) did not correlate with subjective and objective indices of mental fatigue. Tentative as their findings are, this research nevertheless indicates the differentiable manifestations of amotivation and fatigue.

5 Conclusion

In summary, although fatigue is a confounding factor that previous translation experiments all try to control, no objective or subjective approaches have been adopted to detect its occurrence. To bridge this gap, this article, based on the fatigue literature, proposed some methods for monitoring and measuring translators’ fatigue, which cover self-report scales and various physiological biomarkers. To avoid the impacts of emotional states that share similar cognitive and behavioural consequences with fatigue on its accurate measurement, demotivation was taken as an example to illustrate how to distinguish affective and physical states in translation activities. In doing so, this paper not only illuminates on the measurement of two essential influencers of translation performance, but also cautions on the meticulous employment of biomarkers in
translation studies. For future experimenters with an eye on translation (de)motivation and fatigue, it is advised to incorporate objective and subjective measures for the sake of data triangulation. Specifically, PEP and S/DBP, heart rate and skin conductance can be useful indicators of (de)motivation. While muscular activities (in face or body) recorded by EMG, EOG or cameras can help detect translation fatigue. Meanwhile, a combination of biomarkers serves as a safeguard to potential “insensitivity” issue. On the other hand, when scales or self-reports are employed, their relevance to translation tasks, translation (if not phrased in participants’ mother tongue) and validation (for both newly developed and established scales) are things to consider.
References

Ackerman, P. L. (2011). 100 Years Without Resting. In Cognitive Fatigue: Multidisciplinary Perspectives on Current Research and Future Applications, pages 11–44. American Psychological Association.

Ackerman, P. L., & Kanfer, R. (2009). Test length and cognitive fatigue: An empirical examination of effects on performance and test-taker reactions. Journal of Experimental Psychology. Applied, 15(2):163–181.

Åhsberg, E. (2000). Dimensions of fatigue in different working populations. Scandinavian Journal of Psychology, 41(3), 231–241.

Ani, M. F., Kamat, S., & Fukumi, M. (2020). Development of Decision Support System via Ergonomics Approach for Driving Fatigue Detection. Journal of Social Science and Technical Education, 1:60–72.

Antons, J.-N., Schleicher, R., Arndt, S., Moeller, S., & Curio, G. (2012). Too Tired for Calling? A Physiological Measure of Fatigue Caused by Bandwidth Limitations. 2012 Fourth International Workshop on Quality of Multimedia Experience, 63–67.

Amabile, T. M., Hill, K. G., Hennessey, B. A., & Tighe, E. M. (1994). The Work Preference Inventory: Assessing intrinsic and extrinsic motivational orientations. Journal of Personality and Social Psychology, 66(5):950-967.

Balkin, T. J., & Wesensten, N. J. (2011). Differentiation of Sleepiness and Mental Fatigue Effects. In Cognitive Fatigue: Multidisciplinary Perspectives on Current Research and Future Applications, pages 47–66. American Psychological Association.

Blaise, M., Marksteiner, T., Krispenz, A., & Bertrams, A. (2021). Measuring Motivation for Cognitive Effort as State. Frontiers in Psychology, 12: 785094.

Brehm, J. W., & Self, E. A. (1989). The intensity of motivation. Annual Review of Psychology, 40:109-131.

Carver, C. S., & White, T. L. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: The BIS/BAS Scales. Journal of Personality and Social Psychology, 67(2): 319-333.

de Brabander, C. J., & Martens, R. L. (2014). Towards a unified theory of task-specific motivation. Educational Research Review, 11: 27-44.

Deci, E. L., & Ryan, R. M. (1985). Intrinsic Motivation and Self-Determination in Human Behavior. Springer.

Deci, E. L., & Ryan, R. M. (2013). Intrinsic Motivation and Self-Determination in Human Behavior. Springer Science & Business Media.

Derbali, L., & Frasson, C. (2010). Prediction of Players Motivational States Using Electrophysiological Measures during Serious Game Play. 2010
Fan, D. (2012). *The Development of Expertise in Interpreting through Self-Regulated Learning for Trainee Interpreters [PhD Thesis]*. University of Newcastle.

Ghasem, M. (2019). Developing and validating involvement in translation scale and its relationship with translation ability. *Forum*, 17(2):225-248.

Guido, H. E., Gendolla, R. A. W., & Michael, R. (2012). Effort Intensity: Some Insights From the Cardiovascular System. In *The Oxford Handbook of Human Motivation*, page 420-440. Oxford University Press, Inc.

Hockey, G. R. (1997). Compensatory control in the regulation of human performance under stress and high workload; a cognitive-energetical framework. *Biological Psychology*, 45(1–3):73-93.

Hockey, G. R. J. (2011). A Motivational Control Theory of Cognitive Fatigue. In *Cognitive Fatigue: Multidisciplinary Perspectives on Current Research and Future Applications*, pages 168-188. American Psychological Association.

Jing, D., Liu, D., Zhang, S., & Guo, Z. (2020). Fatigue driving detection method based on EEG analysis in low-voltage and hypoxia plateau environment. *International Journal of Transportation Science*, 9(4):366-376.

Kanfer, R. (2011). Determinants and Consequences of Subjective Cognitive Fatigue. In *Cognitive Fatigue: Multidisciplinary Perspectives on Current Research and Future Applications*, pages 189-208. American Psychological Association.

Kitanovska-Kimovska, S., & Cvetkoski, V. (2022). The Effect of Emotions on Translation Performance. *Research in Language*, 19:169-186.

Kormos, J. & Wilby, J. (2019). Task Motivation. In *The Palgrave handbook of motivation for language learning*, pages 267-286. Palgrave Macmillan.

Lee, K. F. A., Gan, W.-S., & Christopoulos, G. (2021). Biomarker-Informed Machine Learning Model of Cognitive Fatigue from a Heart Rate Response Perspective. *Sensors*, 21(11):3843.

Lehr, C. (2014). *The influence of emotion on language performance: Study of a neglected determinant of decision-making in professional translators [PhD Thesis]*. Univ. Genève.

Lehr, C., & Hvelplund, K. T. (2020). Emotional experts: Influences of emotion on the allocation of cognitive resources during translation. *Multilingual Mediated Communication and Cognition*, 44-68.

Maack, D. J., & Ebesutani, C. (2018). A re-examination of the BIS/BAS scales: Evidence for BIS and BAS as unidimensional scales. *International Journal of Methods in Psychiatric Research*, 27(2):e1612.

Martin, A. (2012). Motivation and engagement: Conceptual, operational,
and empirical clarity. In *Handbook of research on student engagement*, pages 303-311. Springer.

Muñoz-de-Escalona, E., Cañas, J. J., & Noriega, P. (2020). Inconsistencies between mental fatigue measures under compensatory control theories. *Psicológica Journal*, 41(2):103-126.

Neigel, A. R., Claypoole, V. L., & Szalma, J. L. (2019). Effects of state motivation in overload and underload vigilance task scenarios. *Acta Psychologica*, 197:106-114.

Ocal, F., Akdol, B., & Arikboga, F. S. (2019). The Work Preference Inventory: Motivation Factors of Banking Sector Employees. *Siyasal Journal of Political Sciences*, 28(2):257-280.

Peng, Y., Li, C., Chen, Q., Zhu, Y., & Sun, L. (2022). Functional Connectivity Analysis and Detection of Mental Fatigue Induced by Different Tasks Using Functional Near-Infrared Spectroscopy. *Frontiers in Neuroscience*, 15:771056.

Punsawad, Y., Aempedchr, S., Wongsawat, Y., & Parnichkun, M. (2015). Weighted-Frequency Index for EEG-based Mental Fatigue Alarm System. *International Journal of Applied Biomedical Engineering*, 4(1):36-41.

Qiao, Y., Zeng, K., Xu, L., & Yin, X. (2016). A smartphone-based driver fatigue detection using fusion of multiple real-time facial features. *2016 13th IEEE Annual Consumer Communications & Networking Conference*, 230-235.

Rahayu, S., Ani, M. F., & Fa’iz, M. (2016). A comparison study for the road condition with hand grip force and muscle fatigue. *Malaysian Journal of Public Health Medicine*, 1:7-13.

Rasyad, M., Muslim, E., & Pradana, A. A. (2020). Measurement of Fatigue Eye on Computer Users with Method of Eye Tracking. In *Recent Progress on: Mechanical, Infrastructure and Industrial Engineering* (Vol. 2227, p. 040026). Amer Inst Physics.

Richter, M., & Slade, K. (2017). Interpretation of physiological indicators of motivation: Caveats and recommendations. *International Journal of Psychophysiology*, 119:4-10.

Rojo, A., & Caro, M. R. (2016). Can emotion stir translation skill? Defining the impact of positive and negative emotions on translation performance. In *Re-embedding Translation Process Research*, pages 107-130. John Benjamins.

Rojo, A. M., & Korpal, P. (2020). Through your skin to your heart and brain: A critical evaluation of physiological methods in Cognitive Translation and Interpreting Studies. *Linguística Antverpiensia, New Series – Themes in Translation Studies*, 19:191-217.

Sammler, D., Grigutsch, M., Fritz, T., & Koelsch, S. (2007). Music and emotion: Electrophysiological correlates of the processing of pleasant and unpleasant music. *Psychophysiology*, 44(2):293-304.
Shin, J., Kim, S., Yoon, T., Joo, C., & Jung, H.-I. (2019). Smart Fatigue Phone: Real-time estimation of driver fatigue using smartphone-based cortisol detection. *Biosensors and Bioelectronics*, 136:106-111.

Spielberg, J. M., Stewart, J. L., Levin, R. L., Miller, G. A., & Heller, W. (2008). Prefrontal Cortex, Emotion, and Approach/Withdrawal Motivation. *Social and Personality Psychology Compass*, 2(1):135-153.

Tran, Y., Wijesuriya, N., Tarvainen, M., Karjalainen, P., & Craig, A. (2009). The Relationship Between Spectral Changes in Heart Rate Variability and Fatigue. *Journal of Psychology*, 23:143-151.

Trejo, L. J., Kochavi, R., Kubitz, K., Montgomery, L. D., Rosipal, R., & Matthews, B. (2005). Measures and models for predicting cognitive fatigue. In *Biomonitoring for Physiological and Cognitive Performance During Military Operations*, pages 105-115. Spie-Int Soc Optical Engineering.

Wasserman, T., & Wasserman, L. (2020). Motivation: State, Trait, or Both. In *Motivation, Effort, and the Neural Network Model*, pages 93-101. Springer International Publishing.

Weng, Y., & Zheng, B. (2020). A multi-methodological approach to studying time-pressure in written translation: Manipulation and measurement. *Linguistica Antverpiensia New Series-Themes in Translation Studies*, 19:218-236.

Wu, G. (2019). A study on the motivation and its effects in translation learning among English majors. *Foreign Language Education*, 40(2):66-70.

Wu, Z. (2016). Towards understanding interpreter trainees’ (de)motivation: An exploratory study. *Translation and Interpreting: The International Journal of Translation and Interpreting Research*, 8:13-25.

Zhang, C., Wang, H., & Fu, R. (2014). Automated Detection of Driver Fatigue Based on Entropy and Complexity Measures. *Intelligent Transportation Systems. IEEE Transactions*, 15:168-177.

Zhu, Z., & Ji, Q. (2004). Real time and non-intrusive driver fatigue monitoring. *Proceedings. The 7th International IEEE Conference on Intelligent Transportation Systems*, 657-662.

Zhang, J., Xu, J. W., & Wang, W. C. (2004). Construct research on work motivation of Chinese employees. In *Management Sciences and Global Strategies in the 21st Century*, pages 1876-1881. Macao Univ Science Technology.