

2024 Research Poster Competition

Competition Entries



Wearable-Based Monitoring and Stimulation for Focal Task-Specific Dystonia

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Supervisors: Prof. Luc Berthouze Dr. Temitayo Olugbade Dr. Simon Farmer

Background

Dystonia is a movement disorder, characterized by involuntary muscle contractions and possibly accompanied by tremors. Focal task specific dystonia, one type of dystonia that occurs in only one place of the body and is triggered by specific tasks, is a killer of the beloved careers of musicians, athletes, and writers. Currently the pathophysiology is unclear. Neurologist often use Botox injections as treatment but that can cause muscle weakness, which is bad news, especially for athletes.

Introduction

The diagnosis of dystonia is often based on measurements made in the clinic but if the symptoms do not occur during those measurements, it's difficult for the medical team to decide how to proceed. Using wearables is increasingly considered for personalized and continuous rather than episodic medicine. The incorporation of peripheral stimulation will enable targeted neural modulation to enhance motor control. A successful execution of this project holds the promise of enhancing quality of life and performance in precision tasks.

Aim: To develop a new intervention approach in daily life by wearable bracelet for individuals contending with focal task specific dystonia.

Objectives: 1) The development of a wearable device that integrates sensor technology and machine learning algorithms to detect dystonic symptoms; 2) The exploration of intervention methods grounded in peripheral stimulation by continuously monitoring muscle activities and movement patterns then offer real-time feedback to users.



Musicians

Symptoms of musician's dystonia often include abnormal finger or hand postures, involuntary muscle contractions, and unexpected movements such as tremors or spasms during playing an instrument.



Due to the abnormal curling of fingers toward the palm, previous work focused on measuring finger muscles, such as right extensor digitorum and flexor digitorum superficialis muscles. We will try to see if different movements can be distinguished and predicted by the forearm muscles. We might ask a musician to play a piece of music, capturing sEMG data in the process.

Athletes

Dystonia in athletes, or called yips, manifests itself as an inability to throw the ball accurately. Jerk, tremor, freezing cause interruptions in certain tasks, and accompanied by anxiety.



Taking golfers as an example, we will ask them to do putting, chipping and full swing, and at the same time collect sEMG data and IMU data from both forearms (Wrist flexor/extensor or pronator/supinator). Allowing us to understand the relationship between sEMG changes and specific movements or postures, and also explore the relation between sEMG and accelerometer data.

Writers

Writer's dystonia makes it difficult for writers to hold a pen or write for long periods of time and manifests as hand cramps and abnormal curling or stretching of the fingers.



In previous work, scientists found co-contraction signals in the antagonistic muscle pair of flexor and extensor carpi radialis muscles in writer's dystonia. We will ask the writer to first do image writing, then hold the pen with the thumb, index and middle finger stationary, and then copy a paragraph. In this process, sEMG and accelerometer signals are collected, and features are extracted for comparison with the data of healthy people copying the same paragraph.

Windowing

Preprocessing



sEMG+IMU

Stimulation

Machine learning classification (compare with healthy subjects)

a.



EDC4
FDS4

b.



EDC4
FDS4

Extract Features (ex. coherence)

(A) Normal subject



(B) Writers cramp with tremor

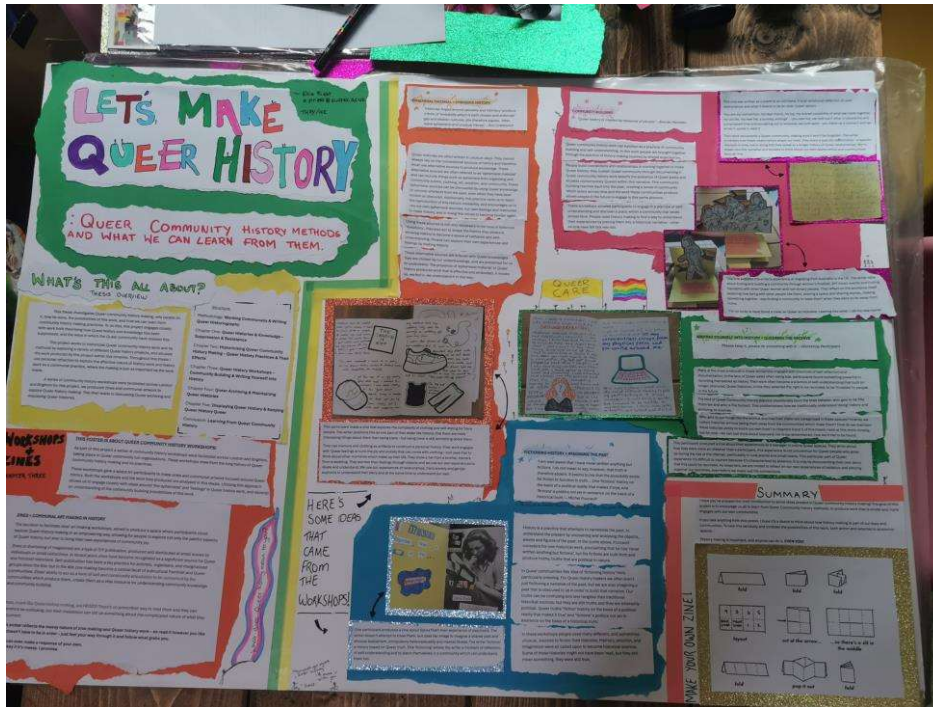


Our wearable bracelet collects surface electromyography and IMU posture signals from the forearm. We segment the data to windows for analysis after preprocessing. From Figure[2] we can see that the antagonist muscle pairs in the healthy group show alternating burst activity, while the dystonia group shows a loss of silent period. Then we extracted features (ex. coherence). In the healthy group, there is no significant peak between the antagonist muscle pairs, but in the writer's cramp group, there is an obvious peak at 12Hz[3]. Ultimately we close the loop by letting machine learning algorithms decide when to stimulate and which muscles to stimulate.

References

- 1 Gold Miner: <https://xiaozai.zol.com.cn/picture/39/388073.shtml> Musicians, Athletes, Writers: pixabay.com
- 2 Ross, M. H., Charness, N. E., Lee, D., & Loggiani, E. L. (1995). Does slow neuropathy predispose to focal dystonia? Muscle & Nerve: Official Journal of the American Association of Electrodiagnostic Medicine, 18(6), 606-611.
- 3 Farmer, S. F., Sheehan, G. L., Mayston, M. J., Rothwell, J. C., Marsden, C. D., Conway, B. A., ... & Stephens, J. A. (1998). Abnormal motor unit synchronization of antagonistic muscles underlies pathological co-contraction in upper limb dystonia. Brain: a journal of neurology, 121(5), 801-814.

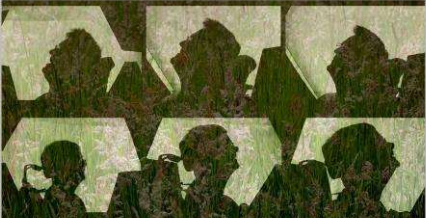
Wearable-Based Monitoring and Stimulation for Focal Task-Specific Dystonia - Muyun Cai (Engineering & Informatics)




Let's Make Queer History! : Queer community history methods and what we can learn from them - Ellie Priest (Media, Arts & Humanities)

Taking Nature to People
Can using art and design principles enhance the health benefits of nature-based interior architecture?

1. Introduction:
My PhD investigates incorporating multisensory nature simulations into interior architecture to enhance physical, mental and emotional well-being through nature-inspired spaces. By integrating art language into interior design, my aim is to maximise these health benefits.




I believe that the language and mechanics of art are intrinsically linked to the way the natural environment has shaped our evolution. If true, this suggests that it is reasonable to assume that an understanding of art is invaluable to how we approach nature-based design. My work is influenced by a lifetime of studying and creating art. It is also affected by a life-changing experience of stroke that dramatically presented me with an altered subjective experience that has, at times, been simultaneously terrifying and inspiring.



Mark Ware PhD Informatics (images: Mark Ware)


2. Research questions:

- How can the language of art contribute to nature-based interior architecture design?
- Can my personal experiences of stroke aid in understanding the benefits of nature-based design?
- Can computer-generated 3D visualisations enhance the design process?
- Can a toolkit of nature-based design principles be developed for various settings including hospitals, prisons, workplaces, schools, care homes, and space habitats?



3. Progress so far:

- Development of a library featuring over 5,000 of my high-resolution nature photographs for research purposes.
- Development of five projects to demonstrate how an understanding of art can enhance nature-based interior architecture design.
- Development of host venues for public engagement and research activities, including cathedrals and shopping centres.



Supervisors: Dr Simon Bowes, Prof Hugo Critchley

Taking Nature to People

Can using art and design principles enhance the health benefits of nature-based interior architecture? - Mark Ware (Engineering & Informatics)

COST-EFFORT ANALYSIS OF BRUV AND eDNA IN MONITORING MARINE ECOLOGICAL COMMUNITIES

Alice J. Clark, Sophie R. Atkinson, Valentina Scarponi, Tim Cane, Nathan R. Gerald, Ian W. Hendy, Reuben Shipway, Mika Peck

INTRODUCTION

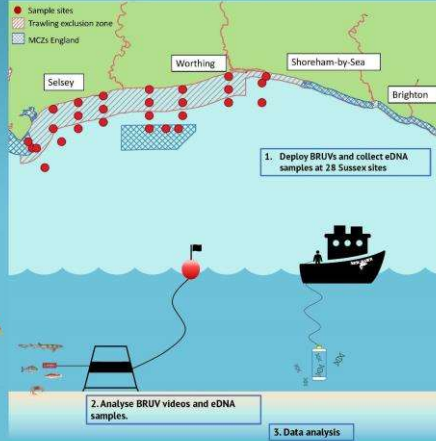
Ensuring that marine biomonitoring methods are cost-efficient and require minimal effort is crucial for effective environmental monitoring. In this study we compare the efficiency of species detection, the cost and the effort of two non-destructive sampling techniques: Baited Remote Underwater Video (BRUV) and environmental DNA (eDNA) metabarcoding to survey marine species. Comparisons were conducted along the Sussex coast upon the introduction of the Nearshore Trawling Byelaw.

Aims:

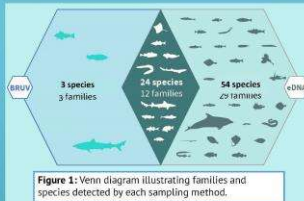
- 1) Compare species assemblage metrics obtained using BRUV and eDNA;
- 2) Investigate community composition detected by both methods and the factors driving it;
- 3) Compare the cost and effort required of both survey techniques for detecting the presence of marine vertebrate species.



METHODS & STUDY AREA



RESULTS

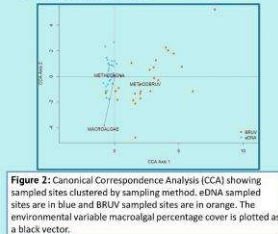


Species richness.

- eDNA detected 78 species, BRUV detected 27 species
- The two methods detected 24 species in common
- BRUV detected 3 species that eDNA missed, including critically endangered tope shark (*Galeorhinus galeus*)

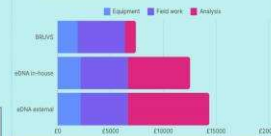
Community composition.

- The CCA revealed that the community detected was structured by macroalgal percentage cover ($\chi^2 = 0.25$, $F = 1.71$, $p = 0.008$) and sampling method ($\chi^2 = 0.34$, $F = 3.65$, $p = 0.001$).



Cost-effort analysis.

- BRUV surveys are more affordable than eDNA
- eDNA has lower cost per species detected (£180 external analysis, £160 in-house analysis, £275 BRUV)
- Conducting eDNA analysis externally requires the least amount of effort (time) for lead researchers



Discussion

- Using both methods in conjunction provides a more complete view of biodiversity
- BRUV data supplements eDNA monitoring by providing life-history traits and habitat complexity
- These results will serve as a baseline of the marine community in Sussex Bay allowing future biodiversity monitoring projects to understand the community structure as the ecosystem recovers
- Although this study was regional, the findings presented have relevance to marine biodiversity and conservation programs around the globe.



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Cost-effort analysis of BRUV and eDNA in monitoring marine ecological communities - Alice Clark (Life Sciences)

THE IMPACT OF SCHOOL TRANSITIONS ON CHILDREN'S APPEARANCE-BASED COMPARISONS AND BODY IMAGE

Joshua Francis: joshua.francis@sussex.ac.uk



STUDY BACKGROUND

To investigate early risk factors for body image dissatisfaction that surrounds social changes during childhood, especially school transitions.

- According to cross-sectional research, children as young as 5-7 years old develop body image dissatisfaction (Dohnt & Tiggemann, 2005).
- Body image dissatisfaction has been prevalent within samples of young people: 40-60% (Skemp et al., 2006; Latiff et al., 2017).
- Children's Body image is a result of sociocultural factors (Jung & Peterson, 2007).
- Primary-secondary transition is one of the biggest social moments (Pratt & George, 2005), and impacts wellbeing (Symonds & Galton, 2014) and identity (Christiaens et al., 2021).

METHODOLOGY

A longitudinal quantitative study measuring changes surrounding school transition.

- Data collection: two pre-transition and post-transition data collection timepoint.
- Sample: year 5, 6 and 7 (ages 8-13).
- Sample size aim: 850-1050.
- Potential follow-ups in two successive years.

MATERIALS

An 81-item self-report questionnaire containing the following measures:

- Demographic questions: age, siblings, gender, and ethnicity.
- We adapted the Physical Appearance Comparison Scale 3 (Schaefer & Thompson, 2018).
- Self-Perception Profile for Children: body image items (8-13; Harter, 2012)
- The Psychological Sense of School Membership Scale (Gooderow, 1993).
- The Family Affluence Scale III (Hartley et al, 2016).
- The Revised Child Anxiety and Depression Scale (Ebesutani, 2012).

I1 When I see friends or people I know on social media, like Instagram or Snapchat, or Be Real I _____ compare how I look to the people I see.

Never	Do not Often	Sometimes	Often	Always
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Example of an item from our adapted appearance-based comparison scale.

PROGRESS

- Ethical approval from the University of Sussex & Sussex Council.
- Attended Youth PPI cafes to ensure that the study is understandable, and identify any potential risks to young people.
- Currently engaging with schools and parents to gain consent for gather young people to take part.

PREDICTIONS

- Year 6s will increase in upward appearance comparisons as they move from being oldest to the youngest cohort in a school.
- Year 5s will make more downward appearance comparisons as they become the eldest cohort.
- Year 7s will increase in downward comparisons as a new younger cohort joins the school.
- School belonging will be a protective factor.
- Young People who report higher in anxiety, depression, and upward comparisons will report more negative body image.

WHAT NEXT?

- Start data collection within schools.
- Investigate risk factors such as: gender dysphoria, sexuality & adverse life conditions.
- Conduct a Draw and Tell focus group study on experiences of school transitions with year 7s.
- Conduct a reflective journal study with secondary school leavers. (For an opportunity for a peer-led intervention).



RESEARCHERS

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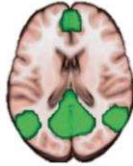
The Impact of School Transitions on Children's Appearance-Based Comparisons and Body Image - Joshua Francis (Psychology)

Introduction

The Default Mode Network (DMN) is typically active during rest, introspection, or when retrieving episodic memory and entails the dorsal medial prefrontal cortex, the medial lateral parietal, and the posterior cingulate cortex^{1,2}.

DMN connectivity can be influenced by factors, such as sleep, stress, or occupation³.

Pilot data of the 4DW has been shown to improve sleep and decrease stress. Therefore, changing to a 4DW could alter DMN connectivity, possibly by decreasing stress and improving sleep.



How does a 4-day working week influence DMN connectivity?

How do the results differ depending on the mask used?

Methods

Participants

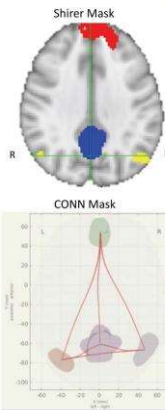
35 full time employees (age 20-50; mean 35.5; 60% male) working 5-days per week with no no eligibility limitations (business sectors, or prior (mental) health diagnoses) were recruited.

Data Collection

With no loss of pay, participants switched to a 4-day week for 12 weeks. Resting state data was collected at week 1 and week 12.

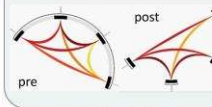
Analysis

After preprocessing the data, two the Shirer (2012) and CONN masks were applied to do Region of interest (ROI) to ROI analysis to observe whether there was a difference in DMN connectivity pre-prepared to post-4DW trial. There were analysed using functional connectivity and graph theory.

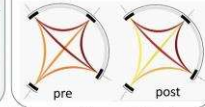


Results

Shirer



CONN

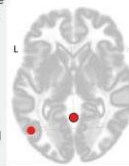


There was significant DMN connectivity in the pre and the post 4DW trial with both masks.

Shirer

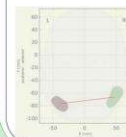
While the Shirer mask showed significantly higher connectivity between the left lateral parietal and the posterior cingulate cortex in the post-4DW trial, other graph theory measures did not yield significant, yet indicative results of stronger connectivity in the post 4DW trial. The functional connectivity measures did not show significant differences between the trials with the Shirer Mask.

Significant results in betweenness centrality with a FDR corrected p-value of 0.0367.



	T	Uncorrected p-value
Global Efficiency	-1.87	0.070
Local Efficiency	2.03	0.051
Betweenness centrality (total network)	-2.61	0.013

CONN



When applying the CONN Mask, the functional connectivity was significantly increased in the post 4DW trial between the left and right lateral parietal. The Graph theory results were not significant when applying the CONN ROIs.

Discussion

DMN connectivity was stronger post 4DW trial using both masks. However, the results differed depending on which mask was used.

These changes in connectivity could possibly be explained by the improved sleep and decreased stress resulting from the 4DW.

Further analysis, such as ICA, and increasing the sample size will be done in the future.

References

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- 3) Hoare, R. J., Smith, E. B., Manders, B. N., Green, S. M., Sabatini, J. M., Goldstein-Peterson, A. N., & Volkow, M. P. (2017). The sleep-deprived human brain. *Nature Reviews Neuroscience*, 20(7), 404-418. <https://doi.org/10.1038/nrn.2017.50>

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US UNIVERSITY OF SUSSEX
Grass height measurement, biodiversity estimation, and livestock grazing consumption by drone images
 Jinjin Wang, supervisor: Bao Kha Nguyen

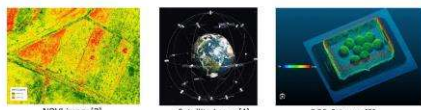
Conventional grass quality monitoring methods

Conventional grass quality monitoring methods include using a ruler, rising plate meter to measure the grass height. Quadrats are used to estimate grass biodiversity. These methods are all labour-intensive, time-consuming, and limited in specific areas.



Grass height measurement

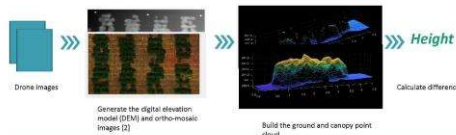
- **Vegetation indices (VIs):** estimating vegetation conditions by analyzing the reflectance or radiation in spectral bands. However, VIs have a statistical relation with grass on the early growth period and would decrease in the late stages.
- **Three-dimensional (3D) point cloud:** rebuild the virtual grassland environment to monitor grass height. Hand-held LIDAR (Light Detection and Ranging) scanner, Satellite radar data, LIDAR in UAV platforms are used to build the point cloud. However, they are limited in coverage and field of view, frequency and resolution, integration and price. Hand-held RGB-Depth (RGB-D) camera is also used to get depth data, but few research studies reported the mission for vegetation height monitoring using RGB-D in UAV.



- **Structure from Motion (SfM) algorithm** is a machine vision technology to build 3D model from 2D images. In a study conducted by Obanawa et al.[1], drone images and Lidar all present good results in grass height measurement.



Grass height normally method using SfM from UAV images



However, it is challenging to generate ground point cloud as in nature grassland where perennial grass persist throughout the year.

Machine learning methods

- Handle large-scale data
- Uncover hidden correlations
- Combined with remote sensing data have been used in monitoring pasture farm such as above ground biomass, nutrition estimation.

References:
 [1] Obanawa H., Yoshitoki R., Okazaki N., et al. Satellite LIDAR-based method for improvement of grass height measurement accuracy: comparison with SfM method[J]. Sensors, 2020, 20(17): 4885.
 [2] Xu B., Li C., Paterson A.H. Multi-objective machine learning neural networks for cotton plant phenotyping[J]. Plant and Soil, 2020, 2020: 1-15.
 [3] <https://www.youtube.com/watch?v=21andjwamrl4&list=PL6n3c-ve4t0m3k0>
 [4] https://www.researchgate.net/publication/353208687_Deep_learning_based_monitoring_of_3D-vegetation-height-and-ground-normal
 [5] https://www.researchgate.net/publication/353208687_Deep_learning_based_monitoring_of_3D-vegetation-height-and-ground-normal

Proposed method for Grass height measurement

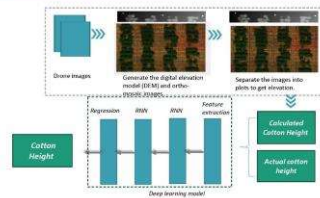


Table 1. MSE represents Mean Squared Error, RMSE represents root mean square error. Reference Calculated represents the reference method[2] calculate cotton height from the difference between canopy and ground elevation. Reference with GCTs represents the reference methods add the ground control targets calibration based on Reference Calculated.

	Reference Calculated	Reference with GCTs	Linear regression	Proposed
MSE	0.08579	0.0422	Train: 0.0288 Test: 0.0288	Train: 0.02846 Test: 0.02584
RMSE	0.2939	0.2054	Train: 0.1680 Test: 0.1594	Train: 0.1687 Test: 0.1582

Biodiversity estimation

Biodiversity are presented in Species Richness, Species Diversity, Species Evenness. The Shannon diversity index and Shannon evenness index are used to represent the species diversity and evenness.

The Shannon Diversity Index (H'):

$$H' = - \sum_{i=1}^S P_i \cdot \log_2(P_i) \quad (3)$$

The Shannon Evenness Index (E'):

$$E' = \frac{H'}{\log_2(S)} \quad (4)$$

where S is the total number of species, and P_i is the proportion of individuals belonging to species i , H' is the Shannon Diversity Index.

- Semantic segmentation method in Deep learning

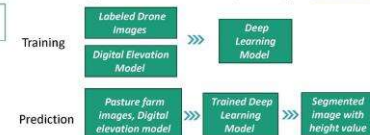


Livestock grazing consumption

Normally, the height of vegetation is classified as either grazed or "ungrazed" after grazing to measure the consumption. However, livestock often display selective eating behavior, consuming certain species while ignoring others. So, monitoring changes both on grass height and pasture biodiversity are equally important.



- Semantic segmentation method in Deep learning



- Each pixel of the image has the capability to predict grass height and species.

Grass height measurement, biodiversity estimation, and livestock grazing consumption by drone images - Jinjin Wang (Engineering & Informatics)