RGC Ref. No.:
UGC/FDS17/M04/18
(please insert ref. above)

**RESEARCH GRANTS COUNCIL**
**COMPETITIVE RESEARCH FUNDING SCHEMES FOR**
**THE LOCAL SELF-FINANCING DEGREE SECTOR**

**FACULTY DEVELOPMENT SCHEME (FDS)**

**Completion Report**
*(for completed projects only)*

***Submission Deadlines:***
1. *Auditor's report with unspent balance, if any: within **six** months of the approved project completion date.*
2. *Completion report: within **12** months of the approved project completion date.*

## Part A: The Project and Investigator(s)

### 1. Project Title

An investigation of semantic and associative encoding in schizophrenia using event-related potential.

### 2. Investigator(s) and Academic Department(s) / Unit(s) Involved

| Research Team | Name / Post | Unit / Department / Institution |
|---|---|---|
| Principal Investigator | Dr. KUO Michael Chih-chien, Assistant Professor | School of Medical and Health Sciences, Tung Wah College |
| Co-Investigator(s) | Prof. WU Jianhui, Professor | College of Psychology and Sociology, Shenzhen University |
| | Mr. WONG Lik-hang, Senior Clinical Associate | School of Medical and Health Sciences, Tung Wah College |
| | Dr. TSE Vincent Wai-shing, Associate Professor | School of Arts and Humanities, Tung Wah College |
| Others | N/A | N/A |

## 3. Project Duration

| | Original | Revised | Date of RGC / Institution Approval *(must be quoted)* |
|---|---|---|---|
| Project Start Date | 01/03/2019 | N/A | N/A |
| Project Completion Date | 28/02/2021 | 31/08/2021 | 8/12/2020 |
| Duration *(in month)* | 24 | 30 | 8/12/2020 |
| Deadline for Submission of Completion Report | 28/02/2022 | 31/8/2022 | N/A |

4.4 Please attach photo(s) of acknowledgement of RGC-funded facilities / equipment.


**Part B: The Final Report**

## 5. Project Objectives

5.1 Objectives as per original application

*1.* To investigate the neural mechanisms, especially the time dimension of cognitive processing revealed by subsequent memory effect (SME), associated with episodic encoding of semantic and associative strategies in people with and without schizophrenia (as revealed by ERP data for the baseline, semantic and associative strategy conditions).

*2.* To investigate the effect of semantic and associative encoding strategies on memory performance in people with schizophrenia (as shown by behavioural data – reaction time and accuracy).

*3.* To use correlation analysis to examine the relationships among SMEs, behavioural data and neuropsychological measures in people with and without schizophrenia.

5.2 Revised objectives

Date of approval from the RGC: N/A

Reasons for the change: N/A

*1.*

*2.*

*3. ....*

5.3 Realisation of the objectives

*(Maximum 1 page; please state how and to what extent the project objectives have been achieved; give reasons for under-achievements and outline attempts to overcome problems, if any)*

- Thirty-seven adults with schizophrenia and 32 healthy controls completed neuropsychological or related assessments. Thirty-five participants with schizophrenia and 20 participants in the control group also completed the behavioral and EEG parts of the study.
- First objective was to investigate the neural mechanisms, especially the time dimension of cognitive processing revealed by subsequent memory effect (SME), associated with episodic encoding of semantic and associative strategies in people with and without schizophrenia. Data were removed from analysis if behavioral performance was too poor (may indicate poor understanding of the tasks or lack of effort) or too noisy (containing too many artifacts). Approximately twenty participants in each group entered into the analysis. In both semantic and associative conditions, differences in EEG amplitudes appeared in the later components (i.e., P500 and late positive component) rather than the earlier components. This may indicate encoding deficits in schizophrenia has origins in working memory updates and elaborate processing. We intend to test robustness of the effects by performing additional analysis in the future.
- Second objective was to investigate the effect of semantic and associative encoding strategies on memory performance in people with schizophrenia. This objective was 100% achieved. Behavioural data included accuracy and reaction time of judging the category of Character pairs at encoding and deciding whether or not a Character pairs was seen before at retrieval. Data were analysed. Results showed that there were no differences in reaction times in any of the comparisons in different conditions. Control participants showed significant better accuracy in judging Character pairs at both encoding and retrieval phases, which corresponded well to results from neuropsychiatric assessments.
- Third objective was 95% achieved. Correlation analysis was used to explore the relationships of cognitive abilities, symptomatology, demographic factors, community living skills, and behavioral and EEG indicators. Participants with schizophrenia performed worse than the control group in verbal fluency, visual memory, immediate memory, delayed memory, and executive function tests. Significant level for correlation analysis was set at $<0.01$ to minimize multiple comparison errors. Significant moderate correlations between community living skills score and participants' years of education, positive symptoms, general psychopathology, and The Positive and Negative Syndrome Scale (PANSS) total score were identified. Years of education was significantly correlated with PANSS positive symptoms and total score. There was a trend correlation between years of educations and many neuropsychological assessments and behavioral data, although none reached a significant level. We intend to continue explore potential relationships between EEG data, cognition, and demographics factors by performing additional analysis in the future.

5.4 Summary of objectives addressed to date

| **Objectives** *(as per 5.1/5.2 above)* | **Addressed** *(please tick)* | **Percentage Achieved** *(please estimate)* |
|---|---|---|
| *1.* To investigate the neural mechanisms, especially the time dimension of cognitive processing revealed by subsequent memory effect (SME), associated with episodic encoding of semantic and associative strategies in people with and without schizophrenia (as revealed by ERP data for the baseline, semantic and associative strategy conditions). | √ | 90%<br>(Intend to test robustness of the effects by performing additional analysis in the future) |
| *2.* To investigate the effect of semantic and associative encoding strategies on memory performance in people with schizophrenia (as shown by behavioural data – reaction time and accuracy). | √ | 100% |
| *3.* To use correlation analysis to examine the relationships among SMEs, behavioural data and neuropsychological measures in people with and without schizophrenia. | √ | 95%<br>(intend to continue explore potential relationships between EEG data, cognition, and demographics factors by performing additional analysis in the future) |

## 6. Research Outcome

6.1 Major findings and research outcome
*(Maximum 1 page; please make reference to Part C where necessary)*

- Thirty-seven adults with schizophrenia and 32 matched healthy controls were recruited. Both groups completed the Verbal Fluency Test, subtests of Cognistat, and the Color Trail Test. Additional assessments (i.e., Chinese version of St. Louis Inventory of Community Living Skills – SLICLS-C and Positive and Negative Syndrome Scale – PANSS) were used to evaluate participants with schizophrenia.
- Participants with schizophrenia performed worse than the control group in verbal fluency, visual memory, immediate memory, delayed memory, and executive function tests. Correlation analysis was used to explore the relationships of cognitive abilities, symptomatology, demographic factors, community living skills, and behavioral and EEG indicators. Significant moderate correlations between SLICLS-C score and participants' years of education, positive symptoms, general psychopathology, and PANSS total score were identified. Years of education was significantly correlated with PANSS positive symptoms and total score. There was a trend correlation between years of educations and many cognitive tests and behavioral data, although none reached a significant level.
- Results from neuropsychiatric assessments indicated cognitive impairments are persistent in schizophrenia who are in remission and have been partially integrated back into the community. Cognitive deficits that people with schizophrenia experience might be stable over most of the course of the illness. Participants' years of education, positive symptoms, general psychopathology, and PANSS total score might be important moderating variables to include in future investigations related to predicting community living performance in schizophrenia.
- In neutral condition, there were no significant effects in reaction times of behavioral data. D prime measure was significantly higher in the control group, which corresponded to results from neuropsychological measures. EEG patterns were very similar between control and schizophrenia groups. Differences were found at N2 where control exhibited more positive-going waves in left inferior sites and P500 in frontal sites. Results indicated difference in identification of information and working memory updates and these differences may contribute to differences in memory performance shown in behavioral data.
- In the semantic condition, control judged character pairs more accurately at encoding. D prime measure was significantly higher in the control group, which corresponded to results from neuropsychological measures. Correctly identified trials had significantly shorter reaction times in the control group. Differences between groups were found in the P500 and late positive components. At P500, control exhibited a more frontal and right lateralized positive-going pattern. At late positive interval, control exhibited a more positive-going pattern in the left inferior frontocentral sites. Results indicated difference in working memory updates and elaborate processing between groups. These differences may contribute to differences in semantic memory performance shown in behavioral data.
- In the associative condition, control judged character pairs more accurately at encoding. D prime measure was also significantly higher in the control group when compared with the schizophrenia group. There were no differences in reaction times between groups. Differences between groups were found in the P500 and late positive components. At P500, control exhibited a more frontal and right lateralized positive-going pattern. At late positive interval, control exhibited a more positive-going pattern in the left inferior frontocentral sites. Similar to results in semantic condition, there appeared to be difference in working memory updates and elaborate processing between groups. These differences may contribute to differences in associative memory performance shown in behavioral data.

*6.2* Potential for further development of the research and the proposed course of action *(Maximum half a page)*

- Robustness of the effect especially in the behavioral and EEG data needs to be ascertained. One way to check for this is to perform a subgroup analysis in participants where results from all 3 conditions were usable and clean. Some participants had to be removed from analysis due to poor EEG recordings or poor behavioral performance, which may indicate lack of understanding or effort to the tasks. If the subgroup analysis yields similar results, we would have more confidence about our conclusions.
- More advanced analysis, such as source analysis, could also be conducted in the future. Suitable software will need to be acquired (e.g., Compumedics Neuroscan Curry) in order to perform the analysis more efficiently. Source analysis will allow us to identify and understand the neuro-substrates responsible in producing different EEG/ERP components/time windows in both groups, which should help us enrich and further explain the results.
- Future research, if continue to focus on semantic and associative encoding in schizophrenia, may consider fine-tuning the encoding tasks (e.g., making them more equivalent). In the present study, there was evidence that associative encoding task required more time to complete. Amount of processing time could be related to or affect memory performance, which made direct comparisons of behavioral or EEG data between tasks less appropriate.
- Encoding deficits in schizophrenia might be related to changes in working memory and decreased ability to enrich information to-be-remembered. To improve cognition in schizophrenia, interventions may consider addressing these aspects. Studies could be designed to investigate changes pre- and post- intervention.

## 7. Layman's Summary

*(Describe <u>in layman's language</u> the nature, significance and value of the research project, in no more than 200 words)*

The study investigated the effect of semantic and associative memory strategies on memory performance and examine the cognitive processes of memory formation in people with schizophrenia. Semantic strategies involve the processing of meaning or information that can be applied to a given context. Associative strategies involve processing relationships between at least two stimuli. Both semantic and associative strategies promote a deeper level of information processing and should improve memory performance. Results from cognitive assessments and behavioural tasks showed persistent nature of cognitive deficits in people of schizophrenia. People with schizophrenia could benefit from encoding strategies, though these strategies could not bring them to the same cognitive performance level as the healthy people. There has been limited studies that investigate memory formation processes in schizophrenia. Results from brain electrical activities indicated their memory deficits might be related to changes in working memory and decreased ability to enrich information to-be-remembered. To improve cognition in schizophrenia, interventions may consider addressing these two aspects.

## Part C: Research Output

### 8. Peer-Reviewed Journal Publication(s) Arising Directly From This Research Project

*(Please attach a copy of the publication and/or the letter of acceptance if not yet submitted in the previous progress report(s). All listed publications must acknowledge RGC's funding support by quoting the specific grant reference.)*

| **The Latest Status of Publications** | | | | **Author(s)** *(denote the corresponding author with an asterisk*)* | **Title and Journal / Book** *(with the volume, pages and other necessary publishing details specified)* | **Submitted to RGC** *(indicate the year ending of the relevant progress report)* | **Attached to this Report** *(Yes or No)* | **Acknowledged the Support of RGC** *(Yes or No)* | **Accessible from the Institutional Repository** *(Yes or No)* |
|---|---|---|---|---|---|---|---|---|---|
| **Year of Publication** | **Year of Acceptance** *(For paper accepted but not yet published)* | **Under Review** | **Under Preparation** *(optional)* | | | | | | |
| | 2022 | | | Sin, W.Y., Wong, W.N., Lo, Y.T.M., Tse, U.T.E., Wong, H.W.H., Tung, K.Y.E., Fung, A.D.M, Kuo, M.C.C.* | Title: Cognition, Symptomatology, and Community Living Skills in Schizophrenia<br><br>Journal: Current Psychiatry Research and Reviews. | No | Yes [Appendix 1] | Yes | Yes (after publication) |
| | | | √ | Kuo, M.C.C.* | Semantic Encoding in Schizophrenia: An event-related potential study | No | No | Yes | Yes (after publication) |
| | | | √ | Kuo, M.C.C.* | Associative Encoding in Schizophrenia: An event-related potential study | No | No | Yes | Yes (after publication) |

**9. Recognized International Conference(s) In Which Paper(s) Related To This Research Project Was / Were Delivered**
*(Please attach a copy of each conference abstract)*

| **Month / Year / Place** | **Title** | **Conference Name** | **Submitted to RGC** *(indicate the year ending of the relevant progress report)* | **Attached to this Report** *(Yes or No)* | **Acknowledged the Support of RGC** *(Yes or No)* | **Accessible from the Institutional Repository** *(Yes or No)* |
|---|---|---|---|---|---|---|
| July/ 2019/ Japan | An investigation of semantic and associative encoding in schizophrenia | The 5th International Conference on Education, Psychology and Social Studies, Sapporo, Japan | 2019 | Yes [Appendix 2] | Yes | Yes |
| July/ 2020/ Virtual | Cognition, positive and negative symptoms, and community living skills in schizophrenia | 2020 FENS Virtual Forum | 2020 | Yes [Appendix 3] | Yes | Yes |

**10. Whether Research Experience And New Knowledge Has Been Transferred / Has Contributed To Teaching And Learning**
*(Please elaborate)*

Research experience and knowledge generated have been shared in the research methods and capstone project courses. Plans to transfer this experience and knowledge to other relevant parts within a course (e.g., Pathophysiology) are in place.

**11. Student(s) Trained**
*(Please attach a copy of the title page of the thesis)*

| **Name** | **Degree Registered for** | **Date of Registration** | **Date of Thesis Submission / Graduation** |
|---|---|---|---|
| [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] | [redacted] |

## 12. Other Impact

*(e.g. award of patents or prizes, collaboration with other research institutions, technology transfer, teaching enhancement, etc.)*

1. Students' *Capstone Project* has been incorporated with this FDS project. The experience provided these students opportunities to interact with people with schizophrenia and improved their clinical skills. They also developed important research skills in the areas of occupational therapy, psychiatry and neuroscience.

2. Two editorial articles were published based on this project before the commencement of the study. Kuo, M.C.C. (2018). Electrophysiological investigation of episodic encoding in schizophrenia. International Clinical Neuroscience Journal, 5, 1-2.

Kuo, M.C.C. (2018). Event-related potential investigation of the mechanisms of memory encoding in Schizophrenia. Archives of Neuroscience, 5, e64776.

## 13. Statistics on Research Outputs

| | **Peer-reviewed Journal Publications** | **Conference Papers** | **Scholarly Books, Monographs and Chapters** | **Patents Awarded** | **Other Research Outputs (please specify)** | |
|---|---|---|---|---|---|---|
| **No. of outputs arising directly from this research project** | 3 (1 accepted, 2 under preparation) | 2 | 0 | 0 | Type | No. |
| | | | | | Editorial | 2 |

## 14. Public Access Of Completion Report

*(Please specify the information, if any, that cannot be provided for public access and give the reasons.)*

| **Information that Cannot Be Provided for Public Access** | **Reasons** |
|---|---|
| N/A | N/A |