The Differences in Cognitive Deficits Among Older Adult Patients with Schizophrenia, Schizoaffective Disorder, and Bipolar Disorder: The Results of a Chart Review Study From 1997 to 2017

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Research article

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Abstract

1. Background: literature indicated the patient with schizophrenia showed worse cognitive deficit than those with BD, however, little study was to examine the differences of cognitive deficits from clinical data and alternative measurement instruments. Moreover, the report of Cognitive Ability Screening Inventory and chart review were applied in this study.

2. Methods: This study reviewed the charts of 354 patients seen between 1997 and 2017, and each chart included diagnosis, sex, educational level, age, and two copies of Cognitive Ability Screening Inventory (CASI) reports. Each chart contained a diagnosis of SZ, SAD, or BD, and each patient was 55 years old or older. Descriptive analysis, one-way ANOVA, and the Chi-square test were used to analyze differences in demographic information and measurement variables at the first visit. A Generalized Estimation Equation (GEE) was used to examine the effects of time, group, and interactions. The significance level was set at 0.05.

3. Results: Overall CASI scores did not have any significant differences by group, time, or interaction, but the attention subscale, orientation subscale, and fluency subscale had interaction effects. Through GEE analysis, our results partially support the idea that patients with SZ have stable cognitive deficits in all cognitive domains, whereas patients with SAD and BD show fluctuations in cognitive deficits in several cognitive domains, including CASI total scores, orientation, fluency, long-term memory, and abstract thinking.

4. Conclusions: Based on the implications of our findings, more time-efficient cognitive assessments could be provided, and specific cognitive rehabilitation programs could be developed for older adults experiencing psychosis.

1. Background

The median lifetime prevalence of schizophrenia (SZ) from 1965 to 2002 was 0.4% (0.16–1.21%) (Saha et al. 2005). The overall prevalence of bipolar disorder (BD) was 1.8% (1.1–3.0%) (Van Meter et al. 2011). Both SZ and BD are severe mental illnesses, and evidence has indicated that SZ and BD share several risk factors. Some examples of shared etiology include the expression of t-DARPP-32, which integrates dopaminergic and glutaminergic signaling and is increased in patients with SZ and BD (Kunii et al. 2014). Exposure to specific infectious diseases (i.e., Candida albicans) could result in impaired cognitive function, due to a dysfunctional immune system (Severance et al. 2016), and neurodevelopmental impairments, such as deficits in myelination (Wolfgang et al. 2006).

In clinical practice, patients with BD display similar symptoms as patients with SZ, such as grandiose delusions or hallucinations. Therefore, it is important to differentiate BD from SZ. Classifications of cognitive deficits have been widely applied in the literature, such as in a review study concluding that patients with SZ and BD had deficits in general intelligence, executive function, and inhibition (Stefanopoulou et al. 2009). A case-control study was conducted to compare neuropsychological
functioning between patients with SZ (n = 106) or BD (n = 66) and healthy controls (n = 316), and the results showed that patients with SZ had comprehensively worse cognitive performance than healthy controls. Compared with healthy controls, the patients with BD did not show worse cognitive performance across all cognitive domains, with exceptions occurring for attention, word fluency, and recognition discrimination (Schretlen et al. 2007). Thus, patients with SZ may have more severe impairments in cognitive functioning than patients with BD (Krabbendam et al. 2005). The latest study not only found that patients with SZ showed poorer comprehensive cognitive performance and financial abilities than patients with major depressive disorder (MDD), BD, and healthy controls but also confirmed worse performances of patients with MDD and BD in working memory, verbal fluency, attention, and information processing compared with those of healthy controls (Huang et al. 2020).

Schizoaffective disorder (SAD) can also be compared with SZ and BD in all domains of cognitive performance. SAD is a spectrum of diagnoses, ranging from affective disorder with psychosis to schizophrenia. Patients with SAD can display intermediate symptoms between mood disorders and SZ (Kempf et al. 2005). Compared with patients with BD and SZ, patients with SAD show moderate deficits in cognition, despite impairments in all cognitive domains among the three groups. Patients with SZ had a more severe deficit than the other two groups, while patients with BD showed better performance than patients with SZ and SAD (Chen et al. 2018). However, a cross-sectional study assessed executive function and memory among healthy controls, those with BD, those with SAD, and those with SZ, and the results showed only significant differences between those with psychoses and healthy controls. No significant differences in cognitive performance were found among those with BD, SAD, and SZ (Amann et al. 2012). The results of the review article also indicated that the differences in cognitive deficits were not enough to differentiate among the three groups due to a small effect size and heterogeneity in the characteristics of participants (Bora et al. 2009).

To the best of our knowledge, few studies have been concerned with the effect of aging on cognitive deficit among the patients with mental illness. Most participants in past studies have been adults (Fiszdon et al. 2007; Kaneda et al. 2009). For example, a cross-sectional study assessing the neuropsychological performance of participants with SZ and that of healthy participants ranging in age from middle adulthood to older adulthood found that older healthy participants showed superior neuropsychological performance than younger patients with SZ (aged 40–49 years). Additionally, the effect of aging on cognitive performance is significant in those with SZ (Loewenstein et al. 2012). Another study assessed older adult patients with SZ (including SAD), BD, and MDD in terms of social skills, behavioral problems, self-care skills, and community living skills, showing that older adult patients with SZ exhibited worse functioning than other groups across all domains (Bartels et al. 1997). However, the cross-sectional study design may not fully reflect the effects of age on these populations.

Although the above study did not directly assess cognitive performance in patients with SZ and BD, and SAD was not assessed independently from SZ, the results partially support the hypothesis that aging may play an important role in the cognition deficits in patients with schizophrenia. An imaging study
revealed that the average apparent brain age in patients with SZ was 6–8 years greater than their chronological age, but there was no difference seen in patients with BD (Shahab et al. 2019).

Due to limited physical ability and limited sustained attention in these patients, brief assessments should be considered. In this study, the Cognitive Ability Screening Instrument (CASI) was used. The CASI has been widely utilized to examine the extent of cognitive degeneration. In the CASI, ten subscales of cognitive performances are assessed, including attention, concentration, orientation, short-term memory, long-term memory, language abilities, visual construction, fluency, abstraction, and judgment. The CASI takes 15–20 minutes to administer (Teng et al. 1994). Although the CASI is sensitive to cognitive performance in dementia (Lin et al. 2002), the literature has indicated that the CASI can also be used as a measure of cognitive function in populations without dementia (Mccurry et al. 1999). A cross-sectional study investigating the cognitive deficits of chronic SZ patients argued that the CASI was useful for providing a comprehensive profile determining the level of cognitive function (Sherrell et al. 1999).

Chart review studies can collect clinical data on a large scale and remain close to practical situations. The chart review method has several advantages, such as its inexpensive cost and ease of access in situations when there is a long latencies between onset and full-brown disorder. The nine steps of the chart review method include conception (research formulation and clinical scan), literature review, proposal development, data abstraction, development of protocols and guidelines for abstraction, sampling, ethics, and pilot studies (Gearing et al. 2006).23

Here, the present study adopts another short-form measurements to assess the differences in cognition among older adult patients with SZ, SAD, and BD through chart reviews.

2. Methods

2.1. Procedures and participants

A retrospective chart review was conducted. Three hundred and fifty-four charts from patients diagnosed with either SZ (n = 291; including residual, paranoid, and unspecific types), SAD (n = 53), or BD (n = 10) were reviewed. All patients were the inpatients or outpatients of a mental health hospital from 1997 to 2017. All reviewed charts included a clear diagnosis, two copies of Cognitive Ability Screening Inventory (CASI) reports, and a patient 55 years old or older. This study was approved by the Yuli Hospital Institute Review Board (YLH-IRB-10702).

2.2. Measurements

2.2.1. Demographic information and diagnosis

The chart included the diagnosis, age, gender, educational level, and at least received twice for CASI assessments. Each patient was diagnosed by a senior psychiatrist based on the criteria of Schizophrenia,
2.2.2. Cognitive Ability Screening Inventory (CASI)

The CASI has been widely applied to assess cognitive performance. Twenty-five items assess nine domains of cognition, including attention, orientation, long-term memory, short-term memory, mental manipulation, language, visual construction, fluency, abstraction, and judgment. The total score is out of 100, and lower scores show poorer cognition performance. It takes 15–20 minutes to complete the CASI (Teng et al. 1994). The sensitivity and specificity of a cut-off score of ≤ 86 are 96.5% and 92%, respectively (Mccurry et al. 1999).

2.3. Statistics

Descriptive analysis, one-way ANOVA, Scheffe's method (post-hoc test), and the Chi-square test were used to present the distribution of demographic information and to differentiate the cognitive deficits among patients with SZ, SAD, and BD. The charts provided follow-up data; therefore, a Generalized Estimating Equation (GEE) was used to assess longitudinal data when the data were not normally distributed (Lee, 2019). The significance level was set at 0.05.

3. Results

3.1. Demographic distribution

Table 1 shows the demographic data for the three groups of participants. Among the three groups, there were no significant differences in gender ($\chi^2 = 1.670$, df = 2, $p > 0.05$), educational level ($\chi^2 = 9.230$, df = 8, $p > 0.05$), or age ($F_{2,350} = 1.36$, $p > 0.05$).
Table 1

The distributions of measured variables among three groups

|                  | SZ      | SAD     | BD      | $\chi^2/F$ | P value |
|------------------|---------|---------|---------|------------|---------|
| Age              | 63.33(6.45) | 61.85(5.66) | 64.10(4.15) | 1.36       | 0.26    |
| Gender           | 115(39.5%) | 16(30.2%)  | 4(40%)  | 1.67       | 0.43    |
| Female           | 176(60.5%) | 37(69.8%)  | 6(60%)  |            |         |
| Male             |         |         |         |            |         |
| Educational level| 15(5.5%)  | 0 (0%)  | 0(0%)  | 9.29       | 0.32    |
| none             | 69(25.4%) | 9(17%)  | 3(33.3%) |            |         |
| Elementary       | 59(21.7%) | 13(24.5%) | 3(33.3%) |            |         |
| Junior high school| 96(35.3%) | 26(39.1%) | 3(33.3%) |            |         |
| Senior high school| 33(12.1%)  | 5(9.4%)  | 0(0%)  |            |         |
| College above    |         |         |         |            |         |
| CASI a           | 25.93(34.51) | 25.01(36.54) | 31.62(41.08) | 0.15       | 0.86    |
| Attention a      | 5.78(2.22)  | 6.37(1.92)  | 7.25(0.957) | 1.42       | 0.25    |
| Orientation a    | 11.38(6.1)  | 13.47(5.61) | 15.25(1.89) | 1.7        | 0.19    |
| Mental a         | 5.74(3.63)  | 6.68(3.65)  | 7(3.16)  | 0.75       | 0.47    |
| Short memory a   | 5.95(3.89)  | 6.58(4.40)  | 7.25(2.22) | 0.39       | 0.68    |
| Long memory a    | 7.31(3.38)  | 7.84(3.2)   | 9.50(1)  | 1.01       | 0.37    |
| Visual a         | 7.41(3.20)  | 7.84(3.17)  | 8.50(1.73) | 0.36       | 0.71    |
| Fluency a        | 4.67(3.02)  | 6(2.73)    | 8.50(1.00) | 4.62       | 0.01*   |
| Language a       | 7.28(2.66)  | 7.39(2.51)  | 9.05(0.74) | 0.89       | 0.41    |
| Abstraction a    | 5.36(3.26)  | 6.26(2.45)  | 6.75(3.1) | 0.97       | 0.38    |

SZ: schizophrenia; SAD: Schizoaffective disorder; BD: Bipolar disorder; Mental: Mental manipulation; Short memory: short-term memory; Long memory: long-term memory; Visual: Visual construction; Abstraction: Abstraction and Judgment. *: p < 0.05; **: p < 0.001; CASI = total scores of Cognitive Ability Screening Inventory; a: the scores of subscale of CASI in first visit.

Additionally, the scores of the CASI subscales at visit 1 (received CASI assessment at first time) among the three groups showed no significant differences, except for fluency ($F_{2,141}=4.62$, p < 0.05). After the post-hoc test, we found that the SZ group showed worse performance in fluency than the BD group.
(mean difference=-3.831, p = 0.04), but there was no significant difference between the SZ and SAD groups (mean difference=-1.33, p = 0.19).

3.2. GEE data

Table 2 shows the changes in the overall CASI and subscales among the three groups between visit 1 (received CASI assessment at first time) and visit 2 (received CASI assessment at the second time). Although the overall cognitive performance of the three groups showed significant changes over time, there was no significant effect for the interaction of time and group. Figures 1 and 2 show the trends for all variables at visit 1 and visit 2 among the three groups.
Table 2
Longitudinal measures among three groups

|       | SZ   | S.D  | SAD  | S.D  | BD   | S.D  |
|-------|------|------|------|------|------|------|
|       | Mean | S.D  | Mean | S.D  | Mean | S.D  |
| CASI  |      |      |      |      |      |      |
| Visit 1| 25.95| 2.05 | 25.10| 5.01 | 31.62| 12.32|
| Visit 2| 31.72| 2.19 | 45.39| 5.99 | 40.80| 11.10|
| Attention |      |      |      |      |      |      |
| Visit 1 | 5.88 | 0.17 | 6.38 | 0.36 | 7.29 | 0.3  |
| Visit 2 | 5.96 | 0.17 | 6.80 | 0.24 | 6.61 | 0.3  |
| Orientation |      |      |      |      |      |      |
| Visit 1 | 11.68| 0.49 | 13.36| 1.05 | 16.13| 1.23 |
| Visit 2 | 12.12| 0.48 | 13.54| 0.9  | 13.21| 1    |
| Mental |      |      |      |      |      |      |
| Visit 1 | 5.72 | 0.28 | 6.86 | 0.67 | 5.62 | 1.50 |
| Visit 2 | 6.02 | 0.27 | 6.57 | 0.56 | 5.82 | 1.27 |
| Short memory |      |      |      |      |      |      |
| Visit 1 | 5.85 | 0.33 | 6.48 | 0.88 | 7.86 | 1.15 |
| Visit 2 | 6.65 | 0.32 | 6.75 | 0.6  | 7.68 | 1.17 |
| Long memory |      |      |      |      |      |      |
| Visit 1 | 7.36 | 0.29 | 7.13 | 0.96 | 9.27 | 0.49 |
| Visit 2 | 7.83 | 0.24 | 12.01| 3.29 | 7.36 | 1.38 |
| Visual |      |      |      |      |      |      |
| Visit 1 | 7.52 | 0.25 | 7.86 | 0.64 | 7.52 | 0.5  |
| Visit 2 | 7.56 | 0.26 | 7.97 | 0.45 | 7.56 | 0.91 |
| Fluency |      |      |      |      |      |      |
| Visit 1 | 4.67 | 3.02 | 5.95 | 2.70 | 8.50 | 1.00 |
| Visit 2 | 5.42 | 2.85 | 6.00 | 2.72 | 5.00 | 2.10 |

Mental: Mental manipulation; Short memory: short-term memory; Long memory: long-term memory; Visual: Visual construction; Abstraction: Abstraction and Judgment
|                           | SZ     | SAD    | BD     |
|---------------------------|--------|--------|--------|
| **Language**              | 7.47   | 0.20   | 7.43   |
|                           | 7.49   | 0.20   | 7.79   |
| **Visit 1**               | 0.38   | 9.17   | 0.48   |
|                           | 9.14   | 0.15   |        |
| **Visit 2**               |        |        |        |
| **Abstraction**           | 5.6    | 0.26   | 5.96   |
|                           | 5.8    | 0.25   | 6.5    |
| **Visit 1**               | 0.57   | 6.16   | 0.58   |
|                           | 6.40   | 0.95   |        |
| **Visit 2**               |        |        |        |

Mental: Mental manipulation; Short memory: short-term memory; Long memory: long-term memory; Visual: Visual construction; Abstraction: Abstraction and Judgment

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**Table 3**

The results of post hoc test for interaction effects among three groups

|                           | SZ     | SAD     | BD     |
|---------------------------|--------|---------|--------|
| **Attention**             |        |         |        |
|                           | < ASD at visit 2 (p = 0.002) | < BD at visit 1 (p = 0.05) |
|                           | < BD at visit 1 (p = 0.000)  | < BD at visit 2 (p = 0.039) |
| **Visit 1**               |        |         |        |
|                           | < ASD at visit 2 (p = 0.004) | < BD at visit 1 (p = 0.008) |
|                           | < BD at visit 1 (p = 0.000)  | < BD at visit 1 (p = 0.000) |
| **Orientation**           |        |         |        |
|                           | < BD at visit 1 (p = 0.000)  |        |
| **Fluency**               |        |         |        |
|                           | < BD at visit 1 (p = 0.000)  | < BD at visit 1 (p = 0.019) |
|                           | < BD at visit 1 (p = 0.000)  | < BD at visit 1 (p = 0.001) |
|                           | < BD at visit 1 (p = 0.000)  | < BD at visit 1 (p = 0.000) |

SZ: schizophrenia; SAD: Schizoaffective disorder; BD: Bipolar disorder
Further analysis showed that the interaction of time by group with the attention subscale, orientation subscale, and fluency subscale had significant effects. The language subscale only had a main effect on group but not on time or interaction. Short-term memory, long-term memory, visual construction, abstraction and judgment, or mental manipulation did not have any main effects on group, time, or interaction.

3.2.1. The differences in CASI scores among the three groups at visit 1 and visit 2

The results of the GEE analysis found a main effect of time (Wald $\chi^2 = 5.22$, df = 1, $p = 0.02$), especially for visit 2 ($\beta = 5.77$, $p = 0.04$). Group did not have a main effect (Wald $\chi^2 = 2.13$, df = 2, $p = 0.34$), and the interaction between group and time had no significance (Wald $\chi^2 = 5.43$, df = 2, $p = 0.07$).

3.2.2. The differences in the attention subscale among the three groups at visit 1 and visit 2

The results of the GEE analysis found a main effect of group (Wald $\chi^2 = 13.52$, df = 2, $p = 0.001$), especially for the BD group ($\beta = 1.41$, $p = 0.00$). However, time did not have a main effect (Wald $\chi^2 = 0.16$, df = 1, $p = 0.69$).

The interaction effect between time and group was significant (Wald $\chi^2 = 8.99$, df = 2, $p = 0.01$), especially for the BD group at visit 2 ($\beta = -0.77$, $p = 0.02$).

The scores on the attention subscale of the BD group at visit 2 were significantly lower than those of the BD group at visit 1 (mean difference = -0.68, $p = 0.01$) but also significantly higher than SZ group at visit 1 (mean difference = 0.73, $p = 0.07$).

The scores on the attention subscale for the BD group at visit 1 was significantly higher than the scores of the SZ group at visit 1 (mean difference = 1.41, $p = 0.00$) and at visit 1 (mean difference = 1.33, $p = 0.00$). Additionally, the attention subscale scores of the BD group at visit 1 were marginally higher than the scores of the SAD group at visit 1 (mean difference = 0.92, $p = 0.05$). The scores on the attention subscale for the SZ group at visit 2 were significantly lower than those of the SAD group at visit 2 (mean difference = -0.84, $p = 0.04$).

3.2.3. The differences on the orientation subscale among the three groups at visit 1 and visit 2

The results of the GEE analysis found a main effect of group (Wald $\chi^2 = 7.764$, df = 2, $p = 0.02$), especially for the BD group ($\beta = 4.45$, $p = 0.00$). The effect of time was not significant (Wald $\chi^2 = 2.99$, df = 1, $p = 0.05$).
0.08).

The interaction effect between time and group was significant (Wald $\chi^2 = 10.295$, df = 2, $p = 0.01$), especially for the BD group at visit 2 ($\beta = -3.36$, $p = 0.00$).

The post-hoc test showed that the scores on the orientation subscale of the BD group at visit 2 were significantly lower than the scores of the BD group at visit 1 (mean difference = -2.92, $p = 0.00$). The scores on the orientation subscale of the BD group at visit 1 were significantly higher than the scores recorded for the SZ group at visit 1 (mean difference = 4.45, $p = 0.00$) and visit 2 (mean difference = 4.02, $p = 0.00$).

Additionally, the scores on the orientation subscale for the BD group at visit 1 were marginally higher than the scores for the SAD group at visit 1 (mean difference = 2.78, $p = 0.056$) and visit 2 (mean difference = 2.59, $p = 0.054$), respectively.

### 3.2.4. The differences on the fluency subscale among the three groups at visit 1 and visit 2

The results of the GEE analysis found a main effect of group (Wald $\chi^2 = 6.86$, df = 2, $p = 0.03$), especially for the BD group ($\beta = 3.23$, $p = 0.000$). Time also had a main effect (Wald $\chi^2 = 11.90$, df = 1, $p = 0.00$). The effect of interaction between time and group was significant (Wald $\chi^2 = 47.01$, df = 2, $p = 0.00$), especially for the BD group at visit 2 ($\beta = -3.6$, $p = 0.00$).

The post-hoc test showed that the scores on the fluency subscale for the BD group at visit 2 were significantly lower than at visit 1 (mean difference = -3.13, $p = 0.00$).

Additionally, the scores on the fluency subscale for the BD group at visit 1 were significantly higher than the scores for fluency for the SAD group at visit 1 (mean difference = 2.39, $p = 0.00$) and visit 2 (mean difference = 2.00, $p = 0.02$) and the scores on the fluency subscale for the SZ group at visit 1 (mean difference = 3.23, $p = 0.000$) and visit 2 (mean difference = 2.76, $p = 0.000$).

### 3.2.5. The differences on the language subscale among the three groups at visit 1 and visit 2

The results of the GEE analysis found a main effect of group (Wald $\chi^2 = 43.31$, df = 2, $p = 0.00$), especially on the BD group ($\beta = 1.698$, $p = 0.000$). Time (Wald $\chi^2 = 0.37$, df = 1, $p = 0.54$) and interaction between time and group (Wald $\chi^2 = 0.69$, df = 2, $p = 0.71$) did not have main effects.

### 3.2.6. The differences on the abstraction and judgment subscale among the three groups at visit 1 and visit 2
The results of the GEE analysis found no significant main effect for time (Wald $\chi^2 = 0.68$, df = 1, p = 0.41) or group (Wald $\chi^2 = 1.19$, df = 2, p = 0.55), and the interaction between group and time also had no significance (Wald $\chi^2 = 0.25$, df = 2, p = 0.88).

3.2.7. The differences on the visual construction subscale among the three groups at visit 1 and visit 2

The results of the GEE analysis found no significant main effect for time (Wald $\chi^2 = 2.28$, df = 1, p = 0.13) or group (Wald $\chi^2 = 0.64$, df = 2, p = 0.73), and the interaction between group and time also had no significance (Wald $\chi^2 = 4.51$, df = 2, p = 0.11).

3.2.8. The differences on the mental manipulation subscale among the three groups at visit 1 and visit 2

The results of the GEE analysis found no significant main effect for time (Wald $\chi^2 = 0.02$, df = 1, p = 0.89) or group (Wald $\chi^2 = 1.89$, df = 2, p = 0.39), and the interaction between group and time also had no significance (Wald $\chi^2 = 1.31$, df = 2, p = 0.52).

3.2.9. The differences on the long-term memory subscale among the three groups at visit 1 and visit 2

The results of the GEE analysis found no significant main effect for time (Wald $\chi^2 = 0.69$, df = 1, p = 0.41) or group (Wald $\chi^2 = 2.53$, df = 2, p = 0.28), and the interaction between group and time also had no significance (Wald $\chi^2 = 4.9$, df = 2, p = 0.09).

3.2.10. The differences on the short-term memory subscale among the three groups at visit 1 and visit 2

The results of the GEE analysis found no significant main effect for time (Wald $\chi^2 = 0.32$, df = 1, p = 0.57) or group (Wald $\chi^2 = 2.50$, df = 2, p = 0.29), and the interaction between group and time also had no significance (Wald $\chi^2 = 0.81$, df = 2, p = 0.67).

4. Discussion

This study used the CASI to assess cognitive performance among older adult patients with SZ, SAD, and BD to determine differences in the cognitive deficits of the three groups. We found that the CASI scores among the three groups changed over time, but no interactions were found. Three subscales (attention,
orientation, and fluency) showed significant interaction effects. Only the language subscale had a main effect for groups, but the residual of the subscale did not show any significant findings for group, time, or interaction.

Our results found overall cognitive performance among older adult patients with SZ, SAD, and BD to be lower than the healthy norm (educational level ≥ 6 years; cut-off scores = 67/68) (Lin et al. 2002) and found that cognitive performance among the three groups could increase significantly over time. This result also partially confirmed the findings of an imaging study that indicated that patients on the SZ spectrum appeared to have non-progressive symptoms, despite accelerated aging (Shahab et al. 2019). However, our result showed no significant interaction between group and time. In other words, the cognitive decline among the three groups over time could be similar. Our findings are supported by a three-year follow-up study on patients with BD and SZ (Balanzá-Martínez et al. 2005). While this study focused on participants who were 55 years or older, in future studies the age of enrollment could be earlier than 55 years to investigate the process of cognitive decline.

While we could not find significant differences in cognition deficits at visit 1 among the three groups, the patients with BD showed a significant decrease at visit 2, compared with patients with SZ and SAD. This finding was partially consistent with the results from a study in a long-term care setting where higher subscale scores were found in patients with BD than in patients with SZ. Based on our findings, patients with SZ and SAD showed relatively stable attention performance compared with patients with BD. Further studies could extend the number of visits analyzed from the charts to determine the process of changes among the three groups.

Patients with BD showed significantly higher orientation subscale scores at visit 1 than patients with SZ and SAD, although the patients with BD at visit 1 showed a more significant drop in this score than other groups at visit 2. Orientation in time and space is related to motivation and engagement in daily activities (Cooper et al. 2015); therefore, people with poor orientation may not function as well in social situation. Bartels, Mueser, and Miles found that older adult patients with SZ and SAD showed worse self-care skills and living skills (Bartels et al. 1997). One possible explanation for a drop in orientation scores for the BD group is the effect of acute symptoms. Most older adults with SZ or SAD suffer from negative symptoms rather than positive symptoms, but BD patients can display psychotic symptoms when in an acute state. Therefore, the patients with BD may not have been as well-oriented in time and space as patients with SZ or SAD. Experimental or longitudinal studies to confirm this result could be conducted in the future.

We found that patients with SZ showed worse fluency than patients with SAD and BD at visit 1. At the second visit, patients with BD not only had poorer fluency than at visit 1, but these measures were also poorer than the fluency scores of patients with SAD and SZ at visit 2. A possible explanation lies in the heterogeneity of psychotic symptoms. According to the results of an fMRI study, first-episode SZ and psychotic BD patients showed disruptions in information processing (Baker et al. 2014). Older adult patients with SZ may more frequently experience negative symptoms relative to patients with BD. Therefore, patients with BD showed more severe disruption in thoughts (i.e., flights of ideas, talkative,
incoherence, etc.) when psychotic symptoms were recurrent than patients with SZ. Further studies could examine the degree of changes in fluency with first-episode SZ, chronically residual SZ, and BD.

Our results revealed that patients with SZ showed poorer language expression than the other two groups. In accordance with our findings, a review article found that compared with patients with SZ, patients with BD displayed better verbal fluency (Bortolato et al. 2015). The literature has indicated that patients with SZ can frequently experience negative symptoms (Hafner et al. 1999); avolition-apathy and diminished expression are two such clusters of symptoms (Strauss et al. 2013). These negative symptoms are related to verbal expression (Howanitz et al. 2000); thus, patients with SZ could display worse scores in language expression than the other two groups. Further studies could focus on developing more effective interventions for improving verbal expression skills in populations of patients with SZ.

Although significance was not found in the effects of time, group, or interaction on long-term or short-term memory among the three groups, our results revealed that the deficits in memory were relatively stable for patients with SZ, while patients with SAD and BD showed fluctuating tendencies in memory. In part, this result is consistent with a literature review that argued that patients with SAD could show improvements in memory (Madre et al. 2016). The heterogeneity of the illness course could influence memory performance for patients with SAD, and according to neuropsychological and fMRI findings, improvement of memory can occur in manic remission but not in depressive remission (Madre et al. 2014). However, we did not collect more detailed data on the chief complaints in visit 1 and visit 2 in this study. Patients with SZ, SAD manic phase, SAD depressive phase, SAD remission, and BD could be recruited for memory assessment in future studies.

Although we did not confirm a significant difference in visual construction among the three groups, the present study found that patients with SAD had slightly higher visual construction scores than patients with SZ and BD. Additionally, patients with SZ showed a similar performance on the visual construction subscale as patients with BD. Our findings are consistent with a review article’s conclusion that patients with BD showed similar neuropsychological deficits to patients with SZ (Rumana et al. 2003). According to the study of Bodapati, Jenkins, Sharma, and Rosen, anhedonia, along with visual memory, could be a factor differentiating patients with SAD from patients with BD (Bodapati et al. 2019). However, our current study did not code the level of negative symptoms or depressive mood in our participants. Further studies could focus on the visual performance of different subgroups to confirm varying neuropsychological profiles among the three groups.

Despite no significant findings of the effects of time, group, and interaction among the three groups on the abstraction and judgment subscale, we found the scores on the abstraction and judgment subscale for patients with SAD at visit 2 to be relatively higher than the scores of patients with SZ and BD. Additionally, we found that patients with BD at visit 1 showed higher abstraction and judgment performance than patients with SZ and SAD. Our finding is partially consistent with the results of a review article that indicated that patients with SZ, SAD, and BD showed similar performance in insight and inflexible abstract thinking (Shad et al. 2006); our study also preliminarily found that patients with SAD
could show relative improvements in abstract thinking. Future endeavors could involve conducting longitudinal or case-control studies to examine the differences in abstract thinking.

5. Conclusions

This study examined cognitive function among older adults with SZ, SAD, and BD to determine specific cognitive deficit profiles. Through GEE analysis, our results partially support the idea that patients with SZ have stable cognitive deficits in all cognitive domains, whereas patients with SAD and BD have fluctuating cognitive deficits in several cognitive domains, including the CASI total scores, orientation, fluency, long-term memory, and abstract thinking. The smaller sample size for patients with BD and SAD and the fixed intervals of assessment (i.e., 12 months or 24 months, etc.) limit the possible extent of generalization. However, the strengths of this study include the examination of cognitive performance in older adult patients with SZ, SAD, and BD and the chart review study design. Based on the implications of our findings, time-effective cognitive assessments could be provided and specific cognitive rehabilitation programs could be developed for older adults experiencing psychosis.

Declarations

1. Ethics approval and consent to participate: Our study was approved by Yuli Hospital Institution Review Board, and the approval number was YLH-IRB-10702.

2. Consent for publication:

3. Availability of data and materials: The datasets generated and/or analysed during the current study are not publicly available due to our data were part of personal chart, IRB only permit to analyze and write paper but no sharing data.

4. Competing interests: The authors declare that they have no competing interests.

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6. Authors’ contributions: Dr. Kun-Hua Lee responsible for study design, data analysis, writing and submitted paper.

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**Figures**
**Figure 1**

The trend of CASI scores, Attention subscale, Orientation subscale and Fluency subscale at visit 1 and visit 2 among three groups. *SZ: schizophrenia; ASD: Schizoaffective disorder; BD: bipolar disorder
Figure 2

The trend of Language subscale, Short-term memory subscale, long-term memory subscale, Visual Construction subscale and Abstraction and Judgment subscale at visit 1 and visit 2 among three groups. *SZ: schizophrenia; ASD: Schizoaffective disorder; BD: bipolar disorder