Chemical Conversations: Linguistic Markers of Authenticity and Emotionality Under MDMA Influence

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Abstract

MDMA (3,4-methylenedioxymethamphetamine) has been widely studied for its potential therapeutic effects, particularly in facilitating emotional openness and enhancing psychotherapy outcomes. Recent research suggests that MDMA alters speech patterns, increasing emotional expressivity and authenticity, which may play a crucial role in therapeutic settings. This study aims to examine the linguistic markers of authenticity, emotionality, and fluency under the influence of MDMA, particularly in the context of familiarity with a conversational partner. Using a secondary analysis of data collected in a controlled clinical setting, this study employs linguistic analysis techniques, including the Linguistic Inquiry and Word Count (LIWC) tool, to quantify changes in speech. Participants engaged in conversations under four conditions—MDMA vs. placebo and familiar vs. unfamiliar partner—to assess the interaction of drug effects and social context. We hypothesize that MDMA will increase authenticity and emotional expression with familiarity further amplifying emotional expressivity. Understanding these linguistic shifts can provide valuable insights into MDMA-assisted therapy (MDMA-AT), informing therapeutic approaches and practitioner training."

Keywords: MDMA, MDMA-AT, linguistic, LIWC

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Background

3,4-methylenedioxymethamphetamine (MDMA) is a synthetic drug categorized as both a stimulant and a psychedelic, with effects comparable to methamphetamines("MDMA (Ecstasy/Molly)." 2024). It is more commonly known as ecstasy (pill form) and molly (crystal form). After its classification as a Schedule I drug in 1985,unregulated research and any clinical use of MDMA to treat psychological disorders like Post-Traumatic Stress Disorder (PTSD) came to a sudden halt. Initial research and testing from the 1970s had shown MDMA's potential as a less toxic,legal alternative to MDA (3,4-methylenedioxy-amphetamine) for assisting therapy seekers intheir emotional expression. Its clinical value centered on MDMA's unique ability to help patients open-up emotionally, encouraging deeper thought and introspection without overwhelming psychedelic hallucinations. Leading therapists and scholars within the field believed that these effects would enable otherwise hard to articulate experiences to become easily expressible in therapeutic settings(Passie, 2018).

Recent Clinical Developments and Methodological Challenges

In recent years, however, 11 Phase 2 and two Phase 3 trials of MDMA-Assisted Therapy (MDMA-AT) for PTSD treatment have been approved and conducted. Notably, a Phase 3 trial from 2021 involved participants receiving three MDMA doses over an 18-week period along with manualized therapy, with significant improvement compared to placebo: over 67% of participants no longer met the diagnostic threshold for PTSD across a broad range of symptoms, compared to 32% in the placebo group (Mitchell et al., 2021). Additional evidence suggests that a considerable proportion of self-reported substance users support MDMA research (68.1%), believe in the potential of MDMA-assisted therapy to help with alcohol and drug abuse Chemical Conversations 2 disorders and it's common comorbidity, PTSD (70.1%) and would be willing to participate if eligible (58.8%), across diverse racial and ethnic groups— a previous concern in the context of equitable distribution of MDMA-assisted therapy, given the disproportionate extent to which

substance abuse (and it's comorbidities) affect minorities (Jones, 2023). Even with these advances, the road to MDMA-AT's broad approval and adoption is long and complex. This is due to several concerns in the community, such as the potential for abuse and the investment required to train therapists with proper protocols (Madero & Alvarez, 2023). Additionally, there is a concern that persistent use of MDMA could lead to decreased cognitive function, which is a significant argument against MDMA-AT (Wagner et al., 2015). A gaping issue here is that it is almost impossible to construct a double-blind between placebo and MDMA conditions, given the obvious external effects of MDMA, which could impact the results. This exact rationale was behind the recent rejection of MDMA as a form or aid of treatment (KUPFERSCHMIDT, 2024). There are definite methodological advances that need to be put in place which accurately weight the risk and benefits of such therapeutic treatments including appropriate training and preparation for both the therapist and the individual receiving MDMA. Wider application for such methods will require research and analysis that cover current gaps about our knowledge of MDMA and the experience it induces, especially in a clinical setting with a practitioner.

Research Gap and Thesis formation

One such analysis of interest is observing and understanding overt behavioral changes under MDMA influence, more specifically linguistic implications, to potentially inform the construction of a therapeutic aid. Since a critical part of PTSD therapy, like most others, involves discussing traumatic experiences and articulating emotions, understanding MDMA's effects on speech could deepen our knowledge of its impact beyond general emotional facilitation. Understanding these changes could help practitioners facilitate individuals who find it difficult to connect with or express emotions effectively in clinical settings. Some insights on this topic can be found in a study by Baggott et al. (2015), which demonstrated that MDMA alters speech content, particularly by increasing the use of social and emotional words during discussions about intimate relationships. The study found that MDMA enhances both positive and negative emotional language, using a software that assesses semantic content, the LIWC (Linguistic Inquiry and Word Count) software (Chung & Pennebaker, 2018) potentially helping patients in

therapy communicate complex emotions more effectively. These findings align with anecdotal reports of MDMA encouraging emotional disclosure and suggest that MDMA may help patients develop a language of emotional insight essential for successful trauma processing in therapy (Baggott et al., 2015). Further knowledge into MDMA's effects on speech are provided in a study by Marrone et al. (2010), which compared MDMA (dose) and methamphetamine (dose) on verbal fluency and coherence. This within-participant study showed that while methamphetamine increased speech fluency (ability to accurately string words together) and coherence (logical and consistent), MDMA tended to decrease fluency and impacted participants' self-rated concentration. Movie descriptions following MDMA were self-rated as less coherent than those after methamphetamine, suggesting that MDMA's effects on language may differ significantly from other amphetamines. While these studies examined MDMA's effects on linguistic fluency and emotional language in addition to scraping the surface with authenticity, they did so in a setting with no direct interaction with the participant. This thesis proposes an added variable of familiarity and unfamiliarity to an individual in the know of the procedure, known as the confederate. Including this variable provides a novel perspective on the research of MDMA, it may help decipher if presence and interaction with an individual (or practitioner) can encourage the participant even further to elucidate their emotional state. This addition may not only help measure the viability of the therapeutic procedure but also inform policies and training for it. Questions of the additive nature of both MDMA and familiarity to the individual are pertinent here.

Research Questions and Hypotheses

This thesis primarily aims to identify linguistic markers of authenticity and emotionality under the influence of MDMA to understand the extent of MDMA-assisted therapy (MDMA- AT) in in addition to the modulating effects of partner familiarity. To effectively examine these aims, it is essential to first define and contextualize the primary concepts relevant to this study: Authenticity and Emotionality. Authenticity refers to the degree to which an individual is monitoring their speech (LIWC — LIWC Analysis, n.d.), while emotionality is more about the

actual words spoken and their score within LIWC.

I hypothesize that MDMA will increase linguistic markers of authenticity and emotionality compared to placebo (Baggott et al., 2015; Molla et al., 2023) I expect to seehigher authenticity and emotionality markers in conversations with familiar partners. Familiarity can create a sense of comfort, making speech more natural and spontaneous (LIWC — LIWC Analysis, n.d.). On the other hand, when interacting with an unfamiliar partner, individuals may be more cautious about how they present themselves, leading to my hypothesis of a decrease in authenticity and emotionality markers as they self-monitor their language more closely.

Methods

This thesis project presents a secondary analysis of data from a clinical MDMA study performed at the Human Behavioral Pharmacology Lab by P.I. Harriet de Wit, post-doc Hanna Molla and other members of the Lab.

Ethical Approval

This study was approved by the University of Chicago. All participants provided informed consent to participate and were given a 250 dollars incentive after all sessions and 50 dollars if theydropped out before completion.

Participants

Healthy male and non-pregnant female healthy adults, aged 18 to 35, were recruited through posters, print and internet advertisements, and word-of-mouth referrals (n=45, f = 20; 44.5% and m= 25; 55.5%). Eligible candidates were those who reported prior psychedelic use (1-40 occasions) and demonstrated verbal fluency in English. All participants passed comprehensive medical and psychiatric screenings, including a structured clinical interview, SCL-90R assessment, electrocardiogram, and physical examination. Major exclusion mental and physical criteria include previous treatment for drug or alcohol problems or current substance dependence (American Psychiatric Association, 2013); past year panic disorder, history of psychotic or manic episodes (American Psychiatric Association, 2013); cardiovascular illness or high bloodpressure, abnormal EKG, and pregnancy or lactation (females).

Procedure

Participants engaged in four laboratory sessions, conducted in random order: Receive MDMA (100 mg) and engage in a conversation with an Unfamiliar partner (MU), Receive placebo and engage in a conversation with an Unfamiliar partner (PU), Receive MDMA (100 mg) and engage in a conversation with a Familiar partner (MF), and Receive placebo and engage in a conversation with a Familiar partner (PF).

The partners were strangers before each session, but before participants received drug, familiarity was established with two of the partners with a bonding conversation procedure (Aron et al., 1992, 1997). One hour before ingesting the drug or placebo, participants either engaged in a 45-min conversation to establish familiarity with a partner (familiar sessions), or they spent time in a room without talking (Unfamiliar sessions).

On each session, baseline measures of heart rate, blood pressure, and oxytocin (plasma sample were collected) were obtained, and participants were tested for recent drug use and pregnancy. Then the participants spent 45 minutes in the same room as their partners with or without social interaction and filled out surveys. Following this they ingested MDMA (100 mg) or a placebo capsule, under a double-blind condition. Subjective measures were taken at every 30-minute mark. At the peak drug effect (60 minutes), the confederate joined the participant for a 15-minute test conversation (which was audio recorded), this conversation was about an important person in the participant's life which they had already listed at the orientation. At the end of this conversation and then the entire session, additional plasma samples were collected. At the 240-minute mark, the participant was provided with a snack and allowed to leave at the experimenter's discretion.

Data Cleaning and Outcome Measures

The main source of data in this project are the audio recordings obtained through test conversations. These will be transcribed into text files using Happy Scribe and human review, with dialogues from the confederate removed. This clean text will be run through Linguistic Inquiry and Word Count (LIWC), which is designed to count words associated with specific psychological

and grammatical dimensions to provide quantitative data (Chung & Pennebaker, 2018).

For perceived authenticity, LIWC's developers categorized it as the degree to which an individual self-monitors their speech. While high authenticity scores can be observed in impromptu conversations between friends, prewritten speeches tend to score lower (LIWC — LIWC Analysis, n.d.). This measure has been utilized by (Markowitz et al., 2023) in studying the social benefits of authentic speech.

For emotional content (emotionality), LIWC analyzes both positive and negative emotional expressions through specific word categories. Positive emotions are tracked through words like "good" and "love," while negative emotions are identified through terms such as "bad" and "hurt." The analysis further breaks down negative emotions into specific states, including anxiety (measured through words like "worry" and "nervous"), anger (identified by terms such as "mad" and "angry"), and sadness (tracked through words like "cry" and "disappoint").

#Results

Prior to running a multiple regression model on the data, novel variables are to be defined and categorized

```
# Fit the mixed-effects models
mlfit1 <- lme(Authenticity ~ Familiarity * Drugcondition , random =  ~ 1 | SubjectID, da
mlfit2 <- lme(emotion ~ Familiarity * Drugcondition , random =  ~ 1 | SubjectID, data =
mlfit3 <- lme(emo_pos ~ Familiarity * Drugcondition , random =  ~ 1 | SubjectID, data =
mlfit4 <- lme(emo_neg ~ Familiarity * Drugcondition , random =  ~ 1 | SubjectID, data =
mlfit5 <- lme(emo_anx ~ Familiarity * Drugcondition , random =  ~ 1 | SubjectID, data =
mlfit6 <- lme(emo_anger ~ Familiarity * Drugcondition , random =  ~ 1 | SubjectID, data
mlfit7 <- lme(emo_sad ~ Familiarity * Drugcondition , random =  ~ 1 | SubjectID, data =
mlfit8 <- lme(focuspast ~ Familiarity * Drugcondition , random =  ~ 1 | SubjectID, data
mlfit9 <- lme(focuspresent ~ Familiarity * Drugcondition , random =  ~ 1 | SubjectID, da
mlfit10 <- lme(focusfuture ~ Familiarity * Drugcondition , random =  ~ 1 | SubjectID, da
```

```
# Summarize the models
summary(mlfit1)
```

```
Linear mixed-effects model fit by maximum likelihood
  Data: df
       AIC      BIC    logLik
  1143.656 1160.862 -565.8282

Random effects:
 Formula: ~1 | SubjectID
        (Intercept) Residual
StdDev:    11.11839 16.50317

Fixed effects:  Authenticity ~ Familiarity * Drugcondition
                                    Value Std.Error DF   t-value p-value
(Intercept)                      59.46309  3.563337 94 16.687472  0.0000
FamiliarityU                     -0.02975  4.165045 94 -0.007143  0.9943
Drugconditionplacebo              2.16123  4.203411 94  0.514161  0.6083
FamiliarityU:Drugconditionplacebo  1.56938  5.890587 94  0.266421  0.7905
 Correlation:
                                  (Intr) FmlrtU Drgcnd
FamiliarityU                      -0.595
Drugconditionplacebo              -0.590  0.505
FamiliarityU:Drugconditionplacebo  0.421 -0.707 -0.714

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
```

```
-2.0936116 -0.7325942  0.2158792  0.6743910  2.0539500

Number of Observations: 130
Number of Groups: 33
```

```
summary(mlfit2)
```

```
Linear mixed-effects model fit by maximum likelihood
  Data: df
       AIC      BIC    logLik
  170.5056 187.7108 -79.25281

Random effects:
 Formula: ~1 | SubjectID
        (Intercept)  Residual
StdDev:   0.2398419 0.3977035

Fixed effects:  emotion ~ Familiarity * Drugcondition
                                      Value  Std.Error DF   t-value p-value
(Intercept)                         1.2852191 0.08321683 94 15.444221  0.0000
FamiliarityU                        0.0969021 0.10035774 94  0.965567  0.3367
Drugconditionplacebo               -0.1337020 0.10126730 94 -1.320288  0.1899
FamiliarityU:Drugconditionplacebo -0.0623586 0.14193423 94 -0.439349  0.6614
 Correlation:
                                   (Intr) FmlrtU Drgcnd
FamiliarityU                       -0.614
Drugconditionplacebo               -0.608  0.505
FamiliarityU:Drugconditionplacebo  0.434 -0.707 -0.713
```

```
Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-2.2649974 -0.6296680 -0.1406118  0.4929599  2.8623365

Number of Observations: 130
Number of Groups: 33
```

```
summary(mlfit3)
```

```
Linear mixed-effects model fit by maximum likelihood
  Data: df
       AIC      BIC    logLik
  93.82333 111.0285 -40.91167

Random effects:
 Formula: ~1 | SubjectID
        (Intercept)  Residual
StdDev:   0.1716005 0.2981563

Fixed effects:  emo_pos ~ Familiarity * Drugcondition
                                       Value  Std.Error DF   t-value p-value
(Intercept)                        0.7954449 0.06165480 94 12.901590  0.0000
FamiliarityU                       0.0878884 0.07523320 94  1.168213  0.2457
Drugconditionplacebo              -0.0670418 0.07591031 94 -0.883171  0.3794
FamiliarityU:Drugconditionplacebo -0.0375037 0.10640075 94 -0.352476  0.7253
 Correlation:
                                  (Intr) FmlrtU Drgcnd
```

```
FamiliarityU                        -0.621
Drugconditionplacebo                -0.616  0.505
FamiliarityU:Drugconditionplacebo    0.439 -0.707 -0.713

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.5804930 -0.6422927 -0.1166950  0.5245222  2.8454249

Number of Observations: 130
Number of Groups: 33
```

```
summary(mlfit4)
```

```
Linear mixed-effects model fit by maximum likelihood
  Data: df
       AIC      BIC    logLik
  29.24162 46.44683 -8.620809

Random effects:
 Formula: ~1 | SubjectID
        (Intercept)  Residual
StdDev:   0.1366629 0.2317612

Fixed effects:  emo_neg ~ Familiarity * Drugcondition
                                      Value  Std.Error DF   t-value p-value
(Intercept)                         0.3639451 0.04821501 94  7.548378  0.0000
FamiliarityU                        0.0021155 0.05848166 94  0.036174  0.9712
Drugconditionplacebo               -0.0689389 0.05900992 94 -1.168260  0.2457
```

```
FamiliarityU:Drugconditionplacebo -0.0034853 0.08270950 94 -0.042140  0.9665
 Correlation:
                                  (Intr) FmlrtU Drgcnd
FamiliarityU                      -0.617
Drugconditionplacebo              -0.612  0.505
FamiliarityU:Drugconditionplacebo  0.437 -0.707 -0.713

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.8351745 -0.5814421 -0.1782547  0.4478096  3.7413607

Number of Observations: 130
Number of Groups: 33
```

```
summary(mlfit5)
```

```
Linear mixed-effects model fit by maximum likelihood
  Data: df
       AIC       BIC   logLik
  -256.6664 -239.4612 134.3332

Random effects:
 Formula: ~1 | SubjectID
        (Intercept)   Residual
StdDev:  0.03374981 0.08054363

Fixed effects:  emo_anx ~ Familiarity * Drugcondition
                                        Value  Std.Error DF   t-value p-value
```

```
(Intercept)                          0.08193151 0.01566859 94  5.229030  0.0000
FamiliarityU                         0.00534121 0.02031544 94  0.262914  0.7932
Drugconditionplacebo                -0.01253720 0.02048988 94 -0.611873  0.5421
FamiliarityU:Drugconditionplacebo -0.01322038 0.02873126 94 -0.460139  0.6465
 Correlation:
                                    (Intr) FmlrtU Drgcnd
FamiliarityU                        -0.659
Drugconditionplacebo                -0.654  0.504
FamiliarityU:Drugconditionplacebo  0.466 -0.707 -0.713

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.2498753 -0.6356720 -0.2672938  0.3357720  4.6370664

Number of Observations: 130
Number of Groups: 33
```

```
summary(mlfit6)
```

```
Linear mixed-effects model fit by maximum likelihood
  Data: df
        AIC       BIC   logLik
  -264.5747 -247.3695 138.2874

Random effects:
 Formula: ~1 | SubjectID
        (Intercept)   Residual
StdDev:  0.02066188 0.08114238
```

```
Fixed effects:  emo_anger ~ Familiarity * Drugcondition
                                        Value  Std.Error DF   t-value p-value
(Intercept)                          0.06750998 0.01503267 94  4.490884  0.0000
FamiliarityU                        -0.01235846 0.02045691 94 -0.604121  0.5472
Drugconditionplacebo                 0.00810745 0.02062257 94  0.393135  0.6951
FamiliarityU:Drugconditionplacebo -0.01568321 0.02893084 94 -0.542093  0.5890
 Correlation:
                                    (Intr) FmlrtU Drgcnd
FamiliarityU                        -0.691
Drugconditionplacebo                -0.686  0.504
FamiliarityU:Drugconditionplacebo    0.489 -0.707 -0.713

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.0567068 -0.6743870 -0.3585553  0.2244457  3.6624336

Number of Observations: 130
Number of Groups: 33
```

```
summary(mlfit7)
```

```
Linear mixed-effects model fit by maximum likelihood
  Data: df
        AIC      BIC   logLik
  -269.5932 -252.388 140.7966

Random effects:
```

```
 Formula: ~1 | SubjectID
        (Intercept)   Residual
StdDev:  0.04282398 0.07356941

Fixed effects:  emo_sad ~ Familiarity * Drugcondition
                                        Value  Std.Error DF   t-value p-value
(Intercept)                          0.07079553 0.01525563 94  4.640616  0.0000
FamiliarityU                        -0.01594704 0.01856390 94 -0.859035  0.3925
Drugconditionplacebo                -0.03594316 0.01873125 94 -1.918887  0.0580
FamiliarityU:Drugconditionplacebo    0.03745831 0.02625455 94  1.426736  0.1570
 Correlation:
                                    (Intr) FmlrtU Drgcnd
FamiliarityU                        -0.619
Drugconditionplacebo                -0.614  0.505
FamiliarityU:Drugconditionplacebo    0.438 -0.707 -0.713

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-2.4734592 -0.5663288 -0.3126884  0.3091479  4.3434391

Number of Observations: 130
Number of Groups: 33
```

```
summary(mlfit8)
```

```
Linear mixed-effects model fit by maximum likelihood
  Data: df
       AIC      BIC    logLik
```

```
  417.9542 435.1594 -202.9771

Random effects:
 Formula: ~1 | SubjectID
        (Intercept) Residual
StdDev:   0.6727249 1.015177

Fixed effects:  focuspast ~ Familiarity * Drugcondition
                                    Value Std.Error DF   t-value p-value
(Intercept)                      4.816097 0.2181015 94 22.081910  0.0000
FamiliarityU                     0.149964 0.2562035 94  0.585330  0.5597
Drugconditionplacebo            -0.287110 0.2585578 94 -1.110428  0.2696
FamiliarityU:Drugconditionplacebo  0.276201 0.3623460 94  0.762257  0.4478
 Correlation:
                                (Intr) FmlrtU Drgcnd
FamiliarityU                    -0.598
Drugconditionplacebo            -0.593  0.505
FamiliarityU:Drugconditionplacebo  0.423 -0.707 -0.714

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.63766349 -0.61229116 -0.09172441  0.57408009  1.99806744

Number of Observations: 130
Number of Groups: 33
```

```
summary(mlfit9)
```

```
Linear mixed-effects model fit by maximum likelihood
  Data: df
       AIC      BIC    logLik
  442.2929 459.4981 -215.1465

Random effects:
 Formula: ~1 | SubjectID
        (Intercept) Residual
StdDev:   0.8646638 1.079071

Fixed effects:  focuspresent ~ Familiarity * Drugcondition
                                    Value Std.Error DF   t-value p-value
(Intercept)                      7.331060 0.2473202 94 29.641975  0.0000
FamiliarityU                    -0.403484 0.2723914 94 -1.481267  0.1419
Drugconditionplacebo             0.155257 0.2749608 94  0.564653  0.5737
FamiliarityU:Drugconditionplacebo -0.167076 0.3852442 94 -0.433687  0.6655
 Correlation:
                                 (Intr) FmlrtU Drgcnd
FamiliarityU                     -0.561
Drugconditionplacebo             -0.556  0.505
FamiliarityU:Drugconditionplacebo  0.397 -0.707 -0.714

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-2.19778052 -0.67880115  0.06064628  0.59243472  2.65899958
```

```
Number of Observations: 130
Number of Groups: 33
```

```
summary(mlfit10)
```

```
Linear mixed-effects model fit by maximum likelihood
  Data: df
       AIC      BIC    logLik
  167.8772 185.0824 -77.93861

Random effects:
 Formula: ~1 | SubjectID
        (Intercept)  Residual
StdDev:   0.2372779 0.3937474

Fixed effects:  focusfuture ~ Familiarity * Drugcondition
                                       Value  Std.Error DF   t-value p-value
(Intercept)                         1.0434699 0.08237287 94 12.667640  0.0000
FamiliarityU                       -0.0816517 0.09935935 94 -0.821782  0.4133
Drugconditionplacebo               -0.0350795 0.10025976 94 -0.349886  0.7272
FamiliarityU:Drugconditionplacebo   0.0944734 0.14052221 94  0.672302  0.5030
 Correlation:
                                   (Intr) FmlrtU Drgcnd
FamiliarityU                       -0.614
Drugconditionplacebo               -0.609  0.505
FamiliarityU:Drugconditionplacebo   0.434 -0.707 -0.713
```

```
Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.88771283 -0.72137208 -0.08530682  0.53294660  2.93903489

Number of Observations: 130
Number of Groups: 33
```

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