Neuromelanin, Substance Use, Reward Responding, etc

SDN Lab presentation, 30 June 2021

Overview

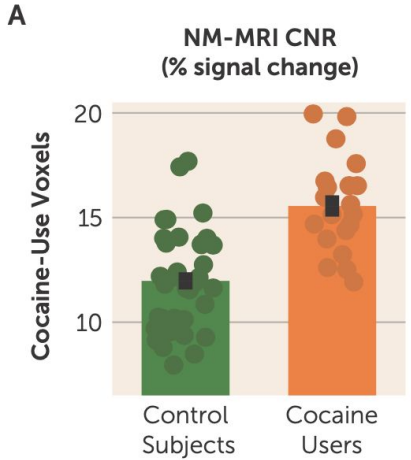
1. NM & substance use
2. NM & reward response
    a. Also: how to transform masks from MNI space to TLRC space
3. Future directions / Synthesis?

NM & Substance Abuse

- NM is a byproduct of dopamine that accumulates across the lifespan
  - Greater reward responding across the lifespan = greater dopamine production = greater NM accumulation

NM & Substance Abuse

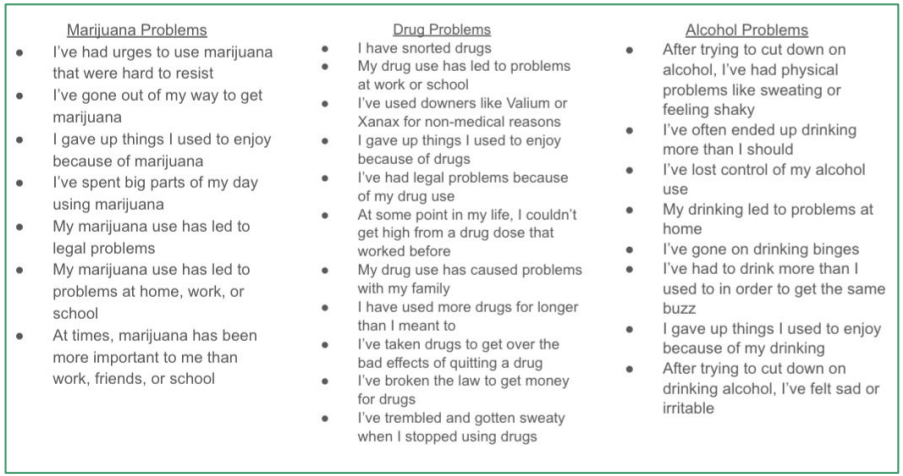
- NM is a byproduct of dopamine that accumulates across the lifespan
  - Greater reward responding across the lifespan = greater dopamine production = greater NM accumulation
- In relation to drug use, cocaine users have greater NM accumulation than non-cocaine users



Cassidy et al., 2020

Substance Use: Externalizing Spectrum Inventory (ESI-bf)

Substance Use Problems



Marijuana Problems

- I've had urges to use marijuana that were hard to resist
- I've gone out of my way to get marijuana
- I gave up things I used to enjoy because of marijuana
- I've spent big parts of my day using marijuana
- My marijuana use has led to legal problems
- My marijuana use has led to problems at home, work, or school
- At times, marijuana has been more important to me than work, friends, or school

Drug Problems

- I have snorted drugs
- My drug use has led to problems at work or school
- I've used downers like Valium or Xanax for non-medical reasons
- I gave up things I used to enjoy because of drugs
- I've had legal problems because of my drug use
- At some point in my life, I couldn't get high from a drug dose that worked before
- My drug use has caused problems with my family
- I have used more drugs for longer than I meant to
- I've taken drugs to get over the bad effects of quitting a drug
- I've broken the law to get money for drugs
- I've trembled and gotten sweaty when I stopped using drugs

Alcohol Problems

- After trying to cut down on alcohol, I've had physical problems like sweating or feeling shaky
- I've often ended up drinking more than I should
- I've lost control of my alcohol use
- My drinking led to problems at home
- I've gone on drinking binges
- I've had to drink more than I used to in order to get the same buzz
- I gave up things I used to enjoy because of my drinking
- After trying to cut down on drinking alcohol, I've felt sad or irritable

Patrick et al. (2013)

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Non-Problematic Substance Use

Marijuana Use

- I've smoked marijuana at parties
- I have enjoyed smoking marijuana with friends
- I have tried smoking marijuana
- I have snuck marijuana or hash into a public event
- I've gotten high using marijuana
- I've bought items used for smoking marijuana
- I have bought marijuana

Drug Use

- I have taken a drug like LSD or magic mushrooms
- I have never bought drugs (-)
- I've used drugs when it might be hazardous, like while driving a car
- I've taken an illegal drug that gave me a rush and made me more awake
- I've never taken illegal drugs (-)
- I have no interest in trying drugs (-)

Alcohol Use

- I've enjoyed getting drunk at parties
- I don't drink (-)
- I've gotten drunk
- At times I've drunk enough alcohol to pass out
- I'm not one who drinks much (-)
- I have not tried drinking hard liquor (-)
- I like having a drink of alcohol to relax
- I don't drink at parties (-)
- I'm not a drinker (-)

Patrick et al. (2013)

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- I like having a drink of alcohol to relax
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- I'm not a drinker (-)

T = True (3) t = somewhat true (2) f = somewhat false (1) F = False (0)

For each statement, circle the choice that describes you best. There are no right or wrong answers; just choose the answer that best describes you.

Patrick et al. (2013)

ESI-bf Use Scores in relation to Clinical Populations

Table 1. Mean, standard error, range, Cronbach's α and test-retest reliability (ICC) of ESI-NL subscale scores for the three subsamples.

		Patients*						Community						Undergraduates					
Subscales	n_{items}	*M*	SE	range	α	M_r	ICC	*M*	SE	range	α	M_r	ICC	*M*	SE	range	α	M_r	ICC
Alcohol problems	9	16.47	.79	0-27	.93	.61	.89	4.42	.32	0-19	.81	.32	.84	2.86	.19	0-14	.70	.20	.89
Alcohol use	9	18.34	.56	1-27	.81	.31	.85	15.35	.50	0-26	.85	.38	.92	14.70	.42	0-25	.86	.40	.94
Marijuana use	7	12.25	.68	0-21	.94	.69	.96	5.74	.55	0-21	.94	.68	.96	3.09	.37	0-21	.92	.63	.97
Marijuana problems	7	7.77	.63	0-21	.93	.65	.92	1.52	.27	0-21	.90	.57	.91	.36	.08	0-9	.71	.26	.84
Drug problems	11	18.10	.95	0-33	.93	.54	.91	2.17	.37	0-26	.90	.44	.91	.31	.07	0-7	.50	.08	.86
Drug use	6	11.56	.48	0-18	.84	.47	.89	5.33	.40	0-18	.83	.45	.86	3.12	.23	0-17	.72	.30	.91

*92.1% met the criteria of a substance use disorder

Soe-Agnie et al. (2021)

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Marijuana problems	7	7.77	.63	0-21	.93	.65	.92	1.52	.27	0-21	.90	.57	.91	.36	.08	0-9	.71	.26	.84
Drug problems	11	18.10	.95	0-33	.93	.54	.91	2.17	.37	0-26	.90	.44	.91	.31	.07	0-7	.50	.08	.86
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*92.1% met the criteria of a substance use disorder

Our participants:
n = 35 (22f)
Age: *M*=21.74, *SD*=4.26

Our results: similar to community/undergrads

Alcohol Use: *M* = 10.37, *SD* = 8.82

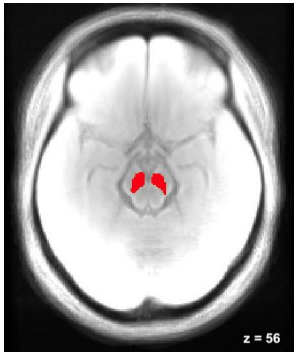
Marijuana Use: *M* = 5.60, *SD* = 7.2

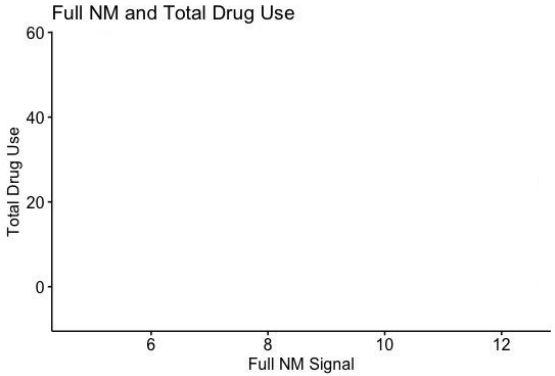
Drug Use: *M* = 3.69, *SD* = 4.73

Soe-Agnie et al. (2021)

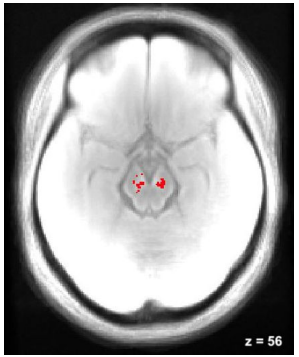
Negative relationship between ESI-bf USE Total Score & NM

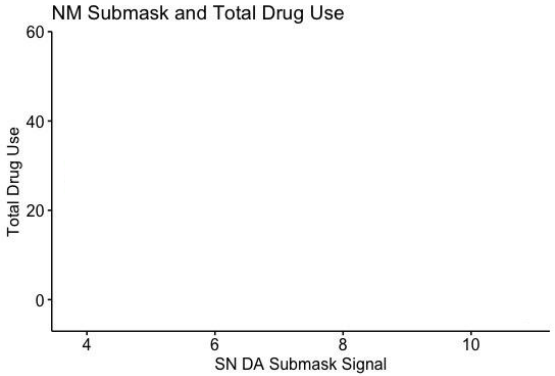
Full NM





SN DA Submask





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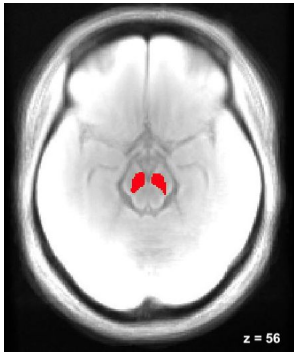

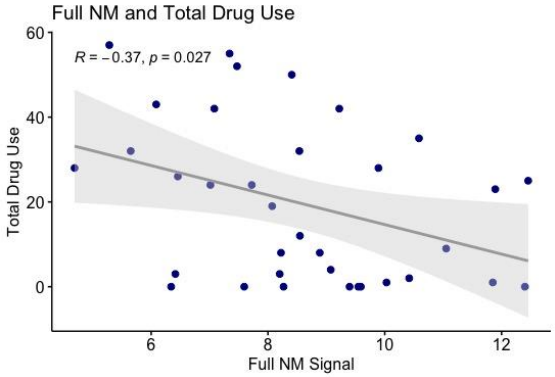

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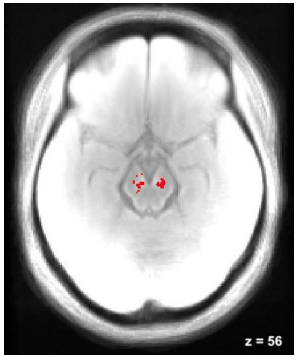

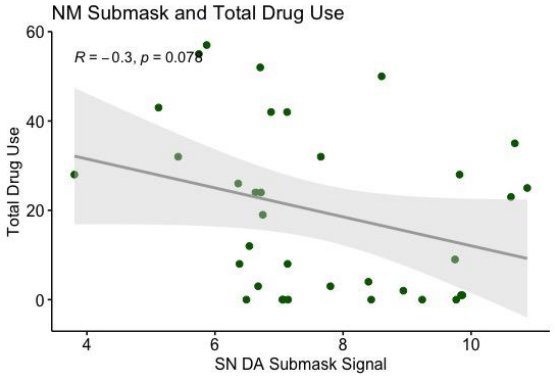

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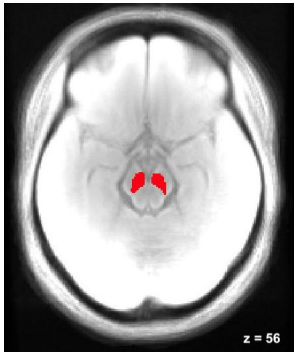

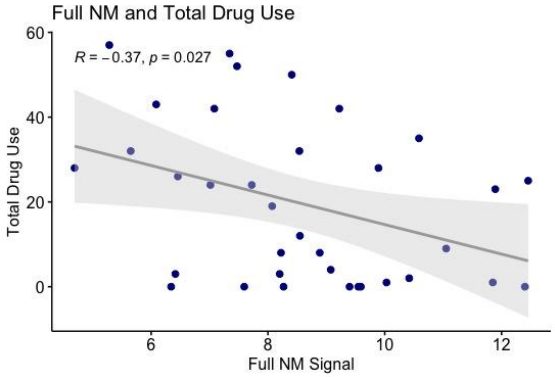

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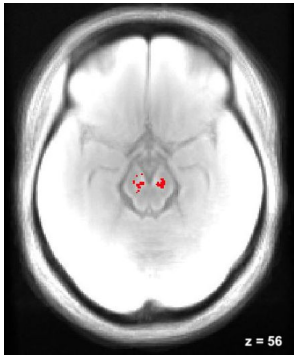
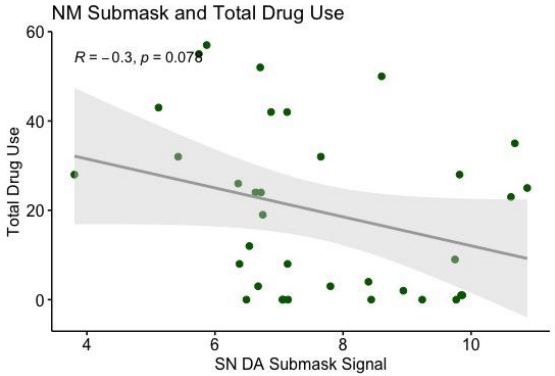
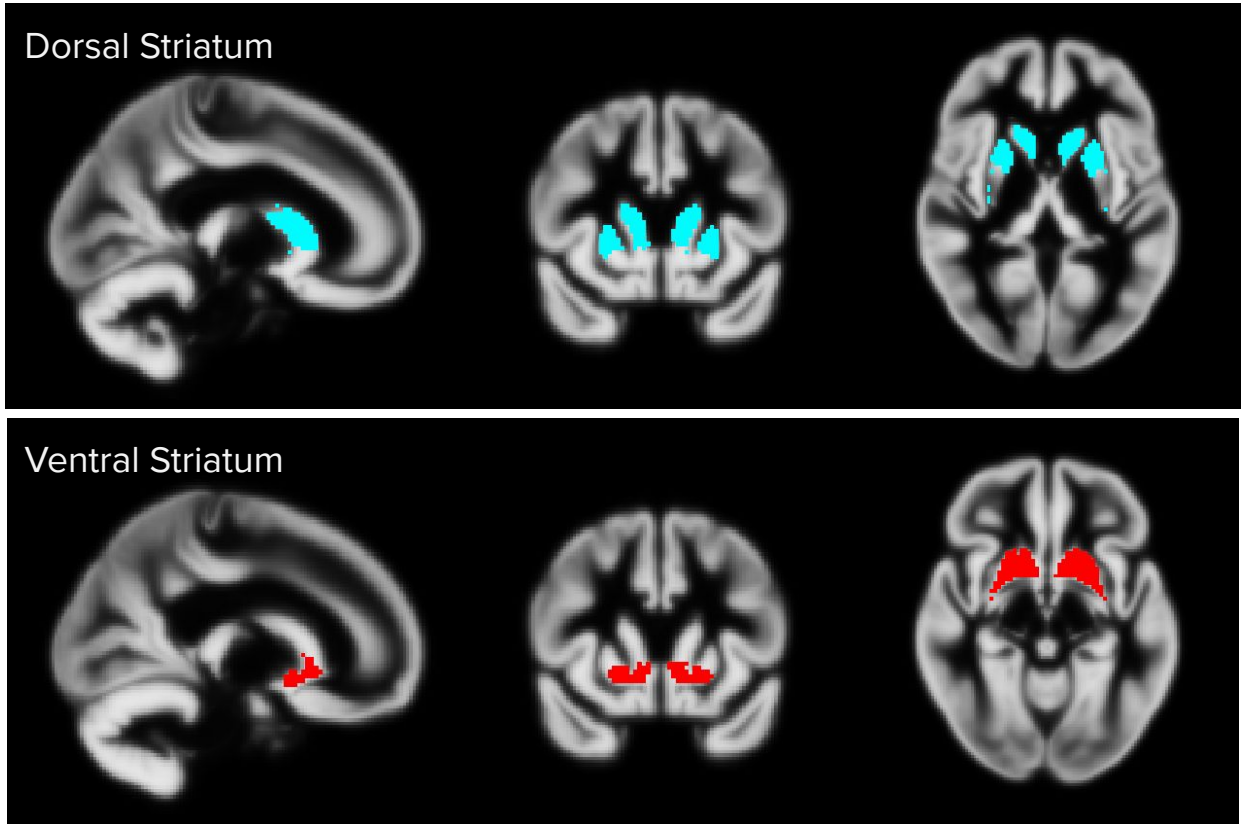




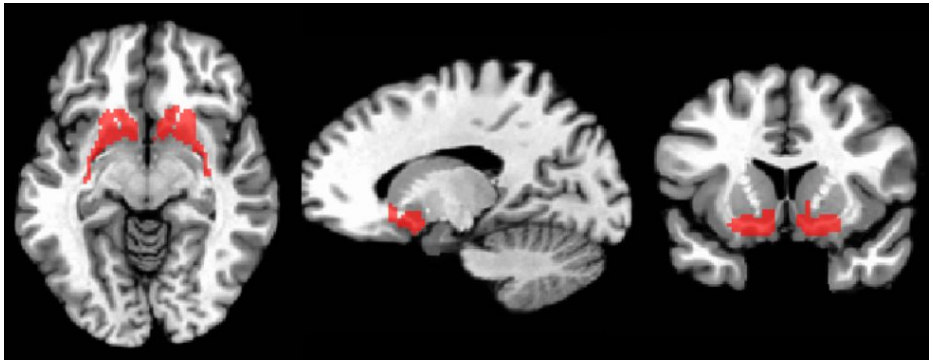
[Can this tell us anything new about reward responding/striatal activation?]

Goal: Transform Anatomical Masks from MNI to Talairach Space



Mask Transformation: MNI to Talairach (TLRC)

Old Mask (MNI Space)



x=15, y=-10, z=-6

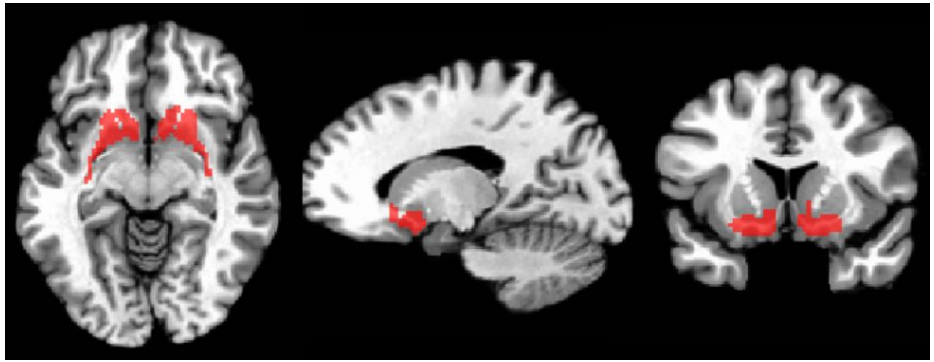
New Mask (TLRC Space)

Mask Transformation: MNI to Talairach (TLRC)

```
3dWarp -mni2tta ventralStriatum.nii
```

Old Mask (MNI Space)

New Mask (TLRC Space)



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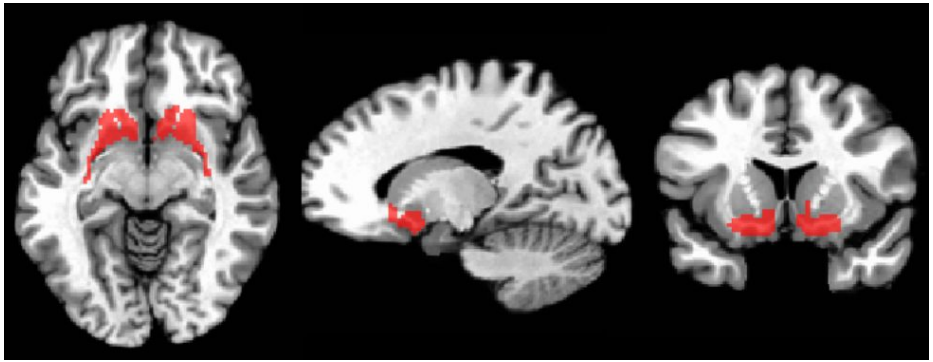

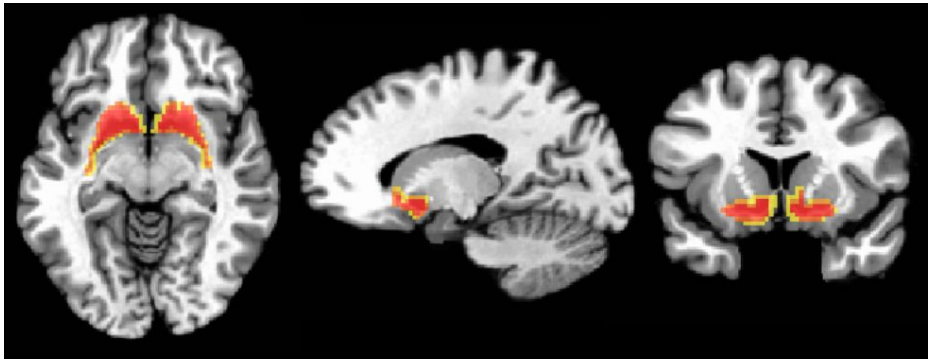

x=15, y=-10, z=-6

Mask Transformation: Data Axes Size

```
3dinfo ventralStriatum_anat+tlrc.
```

Dataset

```
Dataset File:    3dMVM.FB.NonSocial_PositivexNMvstri_NonInterp_052321+tlrc
Identifier Code: XYZ_yx549Ci77G38XVO7nq697C  Creation Date:
Template Space:  TT_N27
Dataset Type:    Func-Bucket (-fbuc)
Byte Order:      LSB_FIRST [this CPU native = LSB_FIRST]
Storage Mode:    BRIK
Storage Space:   18,240,000 (18 million) bytes
Geometry String: "MATRIX(2,0,0,-79,0,2,0,-79,0,0,2,-64):80,95,75"
Data Axes Tilt:  Plumb
Data Axes Orientation:
  first  (x) = Right-to-Left
  second (y) = Anterior-to-Posterior
  third  (z) = Inferior-to-Superior   [-orient RAI]
R-to-L extent:   -79.000 [R] -to-    79.000 [L] -step-     2.000 mm [ 80 voxels]
A-to-P extent:   -79.000 [A] -to-   109.000 [P] -step-     2.000 mm [ 95 voxels]
I-to-S extent:   -64.000 [I] -to-    84.000 [S] -step-     2.000 mm [ 75 voxels]
Number of values stored at each pixel = 16
  -- At sub-brick #0 '(Intercept) F' datum type is short:            0 to         32767 [internal]
                                     [*   0.00305185]              0 to           100 [scaled]
     statcode = fift;  statpar = 1 33
  -- At sub-brick #1 'NMvstri F' datum type is short:              0 to         32767 [internal]
                                [*  0.000910424]                   0 to       29.8319 [scaled]
     statcode = fift;  statpar = 1 33
  -- At sub-brick #2 'Outcome F' datum type is short:              0 to         32767 [internal]
                                [*   0.00150894]                   0 to       49.4434 [scaled]
     statcode = fift;  statpar = 1 33
** For info on all 16 sub-bricks, use '3dinfo -verb' **
```

Mask

```
Dataset File:    ventralStriatum_anat+tlrc
Identifier Code: AFN_IrHuzzEOw56SM3sEGCDYhw  Creation Date: Wed Jun 16 10:23:32 2021
Template Space:  TLRC
Dataset Type:    Anat Bucket (-abuc)
Byte Order:      LSB_FIRST [this CPU native = LSB_FIRST]
Storage Mode:    BRIK
Storage Space:   3,610,516 (3.6 million) bytes
Geometry String: "MATRIX(2,0,0,-90,0,-2,0,126,0,0,2,-72):91,109,91"
Data Axes Tilt:  Plumb
Data Axes Orientation:
  first  (x) = Right-to-Left
  second (y) = Posterior-to-Anterior
  third  (z) = Inferior-to-Superior   [-orient RPI]
R-to-L extent:   -90.000 [R] -to-    90.000 [L] -step-     2.000 mm [ 91 voxels]
A-to-P extent:   -90.000 [A] -to-   126.000 [P] -step-     2.000 mm [109 voxels]
I-to-S extent:   -72.000 [I] -to-   108.000 [S] -step-     2.000 mm [ 91 voxels]
Number of values stored at each pixel = 1
  -- At sub-brick #0 '#0' datum type is float:              0 to             1 [internal]
                          [*            1]                 0 to             1 [scaled]
```

Mask Transformation: Data Axes Size

```
3dinfo ventralStriatum_anat+tlrc.
```

Dataset

```
Dataset File:    3dMVM.FB.NonSocial_PositivexNMvstri_NonInterp_052321+tlrc
Identifier Code: XYZ_yx549Ci77G38XVO7nq697C  Creation Date:
Template Space:  TT_N27
Dataset Type:    Func-Bucket (-fbuc)
Byte Order:      LSB_FIRST [this CPU native = LSB_FIRST]
Storage Mode:    BRIK
Storage Space:   18,240,000 (18 million) bytes
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                                [*   0.00150894]               0 to       49.4434 [scaled]
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** For info on all 16 sub-bricks, use '3dinfo -verb' **
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Mask

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Dataset File:    ventralStriatum_anat+tlrc
Identifier Code: AFN_IrHuzzEOw56SM3sEGCDYhw  Creation Date: Wed Jun 16 10:23:32 2021
Template Space:  TLRC
Dataset Type:    Anat Bucket (-abuc)
Byte Order:      LSB_FIRST [this CPU native = LSB_FIRST]
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  second (y) = Posterior-to-Anterior
  third  (z) = Inferior-to-Superior   [-orient RPI]
R-to-L extent:   -90.000 [R] -to-    90.000 [L] -step-     2.000 mm [ 91 voxels]
A-to-P extent:   -90.000 [A] -to-   126.000 [P] -step-     2.000 mm [109 voxels]
I-to-S extent:   -72.000 [I] -to-   108.000 [S] -step-     2.000 mm [ 91 voxels]
Number of values stored at each pixel = 1
  -- At sub-brick #0 '#0' datum type is float:            0 to             1 [internal]
                          [*            1]               0 to             1 [scaled]
```

Mask Transformation: Data Axes Size

```
3dresample -master
3dMVM.FB.NonSocial_PositivexNMvstri_NonInterp_052321+tlrc.
-prefix ventralStriatum_anat_TT+tlrc. -input
ventralStriatum_anat+tlrc.
```

Dataset

```
Dataset File:    3dMVM.FB.NonSocial_PositivexNMvstri_NonInterp_052321+tlrc
Identifier Code: XYZ_yx549Ci77G38XVO7nq697C  Creation Date:
Template Space:  TT_N27
Dataset Type:    Func-Bucket (-fbuc)
Byte Order:      LSB_FIRST [this CPU native = LSB_FIRST]
Storage Mode:    BRIK
Storage Space:   18,240,000 (18 million) bytes
Geometry String: "MATRIX(2,0,0,-79,0,2,0,-79,0,0,2,-64):80,95,75"
Data Axes Tilt:  Plumb
Data Axes Orientation:
  first  (x) = Right-to-Left
  second (y) = Anterior-to-Posterior
  third  (z) = Inferior-to-Superior   [-orient RAI]
R-to-L extent:   -79.000 [R] -to-    79.000 [L] -step-     2.000 mm [ 80 voxels]
A-to-P extent:   -79.000 [A] -to-   109.000 [P] -step-     2.000 mm [ 95 voxels]
I-to-S extent:   -64.000 [I] -to-    84.000 [S] -step-     2.000 mm [ 75 voxels]
Number of values stored at each pixel = 16
  -- At sub-brick #0 '(Intercept) F' datum type is short:           0 to         32767 [internal]
                                    [*   0.00305185]              0 to           100 [scaled]
     statcode = fift;  statpar = 1 33
  -- At sub-brick #1 'NMvstri F' datum type is short:             0 to         32767 [internal]
                                 [*  0.000910424]                0 to       29.8319 [scaled]
     statcode = fift;  statpar = 1 33
  -- At sub-brick #2 'Outcome F' datum type is short:             0 to         32767 [internal]
                                 [*   0.00150894]                0 to       49.4434 [scaled]
     statcode = fift;  statpar = 1 33
** For info on all 16 sub-bricks, use '3dinfo -verb' **
```

Mask

```
Dataset File:    ventralStriatum_anat+tlrc
Identifier Code: AFN_IrHuzzEOw56SM3sEGCDYhw  Creation Date: Wed Jun 16 10:23:32 2021
Template Space:  TLRC
Dataset Type:    Anat Bucket (-abuc)
Byte Order:      LSB_FIRST [this CPU native = LSB_FIRST]
Storage Mode:    BRIK
Storage Space:   3,610,516 (3.6 million) bytes
Geometry String: "MATRIX(2,0,0,-90,0,-2,0,126,0,0,2,-72):91,109,91"
Data Axes Tilt:  Plumb
Data Axes Orientation:
  first  (x) = Right-to-Left
  second (y) = Posterior-to-Anterior
  third  (z) = Inferior-to-Superior   [-orient RPI]
R-to-L extent:   -90.000 [R] -to-    90.000 [L] -step-     2.000 mm [ 91 voxels]
A-to-P extent:   -90.000 [A] -to-   126.000 [P] -step-     2.000 mm [109 voxels]
I-to-S extent:   -72.000 [I] -to-   108.000 [S] -step-     2.000 mm [ 91 voxels]
Number of values stored at each pixel = 1
  -- At sub-brick #0 '#0' datum type is float:              0 to             1 [internal]
                          [*            1]                 0 to             1 [scaled]
```

Mask Transformation: Data Axes Size

```
3dinfo
ventralStriatum_anat_TT+tlrc.
```

Dataset

```
Dataset File:    3dMVM.FB.NonSocial_PositivexNMvstri_NonInterp_052321+tlrc
Identifier Code: XYZ_yx549Ci77G38XVO7nq697C  Creation Date:
Template Space:  TT_N27
Dataset Type:    Func-Bucket (-fbuc)
Byte Order:      LSB_FIRST [this CPU native = LSB_FIRST]
Storage Mode:    BRIK
Storage Space:   18,240,000 (18 million) bytes
Geometry String: "MATRIX(2,0,0,-79,0,2,0,-79,0,0,2,-64):80,95,75"
Data Axes Tilt:  Plumb
Data Axes Orientation:
  first  (x) = Right-to-Left
  second (y) = Anterior-to-Posterior
  third  (z) = Inferior-to-Superior   [-orient RAI]
R-to-L extent:   -79.000 [R] -to-    79.000 [L] -step-     2.000 mm [ 80 voxels]
A-to-P extent:   -79.000 [A] -to-   109.000 [P] -step-     2.000 mm [ 95 voxels]
I-to-S extent:   -64.000 [I] -to-    84.000 [S] -step-     2.000 mm [ 75 voxels]
Number of values stored at each pixel = 16
  -- At sub-brick #0 '(Intercept) F' datum type is short:            0 to         32767 [internal]
                                     [*   0.00305185]               0 to           100 [scaled]
     statcode = fift;  statpar = 1 33
  -- At sub-brick #1 'NMvstri F' datum type is short:           0 to         32767 [internal]
                                [*  0.000910424]               0 to       29.8319 [scaled]
     statcode = fift;  statpar = 1 33
  -- At sub-brick #2 'Outcome F' datum type is short:           0 to         32767 [internal]
                                [*   0.00150894]               0 to       49.4434 [scaled]
     statcode = fift;  statpar = 1 33
** For info on all 16 sub-bricks, use '3dinfo -verb' **
```

Mask

```
Dataset File:    ventralStriatum_anat_TT+tlrc
Identifier Code: XYZ_Zm6S3dxcwqgEiiIsONZJ-g  Creation Date: Thu Jun 24 11:31:41 2021
Template Space:  TLRC
Dataset Type:    Anat Bucket (-abuc)
Byte Order:      LSB_FIRST [this CPU native = LSB_FIRST]
Storage Mode:    BRIK
Storage Space:   2,280,000 (2.3 million) bytes
Geometry String: "MATRIX(2,0,0,-79,0,2,0,-79,0,0,2,-64):80,95,75"
Data Axes Tilt:  Plumb
Data Axes Orientation:
  first  (x) = Right-to-Left
  second (y) = Anterior-to-Posterior
  third  (z) = Inferior-to-Superior   [-orient RAI]
R-to-L extent:   -79.000 [R] -to-    79.000 [L] -step-     2.000 mm [ 80 voxels]
A-to-P extent:   -79.000 [A] -to-   109.000 [P] -step-     2.000 mm [ 95 voxels]
I-to-S extent:   -64.000 [I] -to-    84.000 [S] -step-     2.000 mm [ 75 voxels]
Number of values stored at each pixel = 1
  -- At sub-brick #0 '#0' datum type is float:            0 to             1 [internal]
                          [*            1]               0 to             1 [scaled]
```

Mask Transformation: Datum Type

```
3dinfo
ventralStriatum_anat_TT+tlrc.
```

Dataset

```
Dataset File:    3dMVM.FB.NonSocial_PositivexNMvstri_NonInterp_052321+tlrc
Identifier Code: XYZ_yx549Ci77G38XVO7nq697C  Creation Date:
Template Space:  TT_N27
Dataset Type:    Func-Bucket (-fbuc)
Byte Order:      LSB_FIRST [this CPU native = LSB_FIRST]
Storage Mode:    BRIK
Storage Space:   18,240,000 (18 million) bytes
Geometry String: "MATRIX(2,0,0,-79,0,2,0,-79,0,0,2,-64):80,95,75"
Data Axes Tilt:  Plumb
Data Axes Orientation:
  first  (x) = Right-to-Left
  second (y) = Anterior-to-Posterior
  third  (z) = Inferior-to-Superior   [-orient RAI]
R-to-L extent:   -79.000 [R] -to-    79.000 [L] -step-     2.000 mm [ 80 voxels]
A-to-P extent:   -79.000 [A] -to-   109.000 [P] -step-     2.000 mm [ 95 voxels]
I-to-S extent:   -64.000 [I] -to-    84.000 [S] -step-     2.000 mm [ 75 voxels]
Number of values stored at each pixel = 16
  -- At sub-brick #0 '(Intercept) F' datum type is short:           0 to         32767 [internal]
                                     [*   0.00305185]             0 to           100 [scaled]
     statcode = fift;  statpar = 1 33
  -- At sub-brick #1 'NMvstri F' datum type is short:            0 to         32767 [internal]
                                [*  0.000910424]                 0 to       29.8319 [scaled]
     statcode = fift;  statpar = 1 33
  -- At sub-brick #2 'Outcome F' datum type is short:            0 to         32767 [internal]
                                [*   0.00150894]                 0 to       49.4434 [scaled]
     statcode = fift;  statpar = 1 33
** For info on all 16 sub-bricks, use '3dinfo -verb' **
```

Mask

```
Dataset File:    ventralStriatum_anat_TT+tlrc
Identifier Code: XYZ_Zm6S3dxcwqgEiiIsONZJ-g  Creation Date: Thu Jun 24 11:31:41 2021
Template Space:  TLRC
Dataset Type:    Anat Bucket (-abuc)
Byte Order:      LSB_FIRST [this CPU native = LSB_FIRST]
Storage Mode:    BRIK
Storage Space:   2,280,000 (2.3 million) bytes
Geometry String: "MATRIX(2,0,0,-79,0,2,0,-79,0,0,2,-64):80,95,75"
Data Axes Tilt:  Plumb
Data Axes Orientation:
  first  (x) = Right-to-Left
  second (y) = Anterior-to-Posterior
  third  (z) = Inferior-to-Superior   [-orient RAI]
R-to-L extent:   -79.000 [R] -to-    79.000 [L] -step-     2.000 mm [ 80 voxels]
A-to-P extent:   -79.000 [A] -to-   109.000 [P] -step-     2.000 mm [ 95 voxels]
I-to-S extent:   -64.000 [I] -to-    84.000 [S] -step-     2.000 mm [ 75 voxels]
Number of values stored at each pixel = 1
  -- At sub-brick #0 '#0' datum type is float:              0 to             1 [internal]
                          [*            1]                 0 to             1 [scaled]
```

Mask Transformation: Datum Type

```
3dinfo
ventralStriatum_anat_TT+tlrc.
```

Dataset

```
Dataset File:    3dMVM.FB.NonSocial_PositivexNMvstri_NonInterp_052321+tlrc
Identifier Code: XYZ_yx549Ci77G38XVO7nq697C  Creation Date:
Template Space:  TT_N27
Dataset Type:    Func-Bucket (-fbuc)
Byte Order:      LSB_FIRST [this CPU native = LSB_FIRST]
Storage Mode:    BRIK
Storage Space:   18,240,000 (18 million) bytes
Geometry String: "MATRIX(2,0,0,-79,0,2,0,-79,0,0,2,-64):80,95,75"
Data Axes Tilt:  Plumb
Data Axes Orientation:
  first  (x) = Right-to-Left
  second (y) = Anterior-to-Posterior
  third  (z) = Inferior-to-Superior   [-orient RAI]
R-to-L extent:   -79.000 [R] -to-    79.000 [L] -step-     2.000 mm [ 80 voxels]
A-to-P extent:   -79.000 [A] -to-   109.000 [P] -step-     2.000 mm [ 95 voxels]
I-to-S extent:   -64.000 [I] -to-    84.000 [S] -step-     2.000 mm [ 75 voxels]
Number of values stored at each pixel = 16
  -- At sub-brick #0 '(Intercept) F' datum type is short:           0 to         32767 [internal]
                             [*  0.003051853]           0 to           100 [scaled]
     statcode = fift;  statpar = 1 33
  -- At sub-brick #1 'NMvstri F' datum type is short:           0 to         32767 [internal]
                             [*  0.000910424]           0 to       29.8319 [scaled]
     statcode = fift;  statpar = 1 33
  -- At sub-brick #2 'Outcome F' datum type is short:           0 to         32767 [internal]
                             [*   0.00150894]           0 to       49.4434 [scaled]
     statcode = fift;  statpar = 1 33
** For info on all 16 sub-bricks, use '3dinfo -verb' **
```

Mask

```
Dataset File:    ventralStriatum_anat_TT+tlrc
Identifier Code: XYZ_Zm6S3dxcwqgEiiIsONZJ-g  Creation Date: Thu Jun 24 11:31:41 2021
Template Space:  TLRC
Dataset Type:    Anat Bucket (-abuc)
Byte Order:      LSB_FIRST [this CPU native = LSB_FIRST]
Storage Mode:    BRIK
Storage Space:   2,280,000 (2.3 million) bytes
Geometry String: "MATRIX(2,0,0,-79,0,2,0,-79,0,0,2,-64):80,95,75"
Data Axes Tilt:  Plumb
Data Axes Orientation:
  first  (x) = Right-to-Left
  second (y) = Anterior-to-Posterior
  third  (z) = Inferior-to-Superior   [-orient RAI]
R-to-L extent:   -79.000 [R] -to-    79.000 [L] -step-     2.000 mm [ 80 voxels]
A-to-P extent:   -79.000 [A] -to-   109.000 [P] -step-     2.000 mm [ 95 voxels]
I-to-S extent:   -64.000 [I] -to-    84.000 [S] -step-     2.000 mm [ 75 voxels]
Number of values stored at each pixel = 1
  -- At sub-brick #0 '#0' datum type is float:           0 to             1 [internal]
                             [*                1]           0 to             1 [scaled]
```

Mask Transformation: Datum Type

```
3dcalc -a old_mask -prefix new_mask -expr a -datum short
```

Dataset

```
Dataset File:    3dMVM.FB.NonSocial_PositivexNMvstri_NonInterp_052321+tlrc
Identifier Code: XYZ_yx549Ci77G38XVO7nq697C  Creation Date:
Template Space:  TT_N27
Dataset Type:    Func-Bucket (-fbuc)
Byte Order:      LSB_FIRST [this CPU native = LSB_FIRST]
Storage Mode:    BRIK
Storage Space:   18,240,000 (18 million) bytes
Geometry String: "MATRIX(2,0,0,-79,0,2,0,-79,0,0,2,-64):80,95,75"
Data Axes Tilt:  Plumb
Data Axes Orientation:
  first  (x) = Right-to-Left
  second (y) = Anterior-to-Posterior
  third  (z) = Inferior-to-Superior   [-orient RAI]
R-to-L extent:   -79.000 [R] -to-    79.000 [L] -step-     2.000 mm [ 80 voxels]
A-to-P extent:   -79.000 [A] -to-   109.000 [P] -step-     2.000 mm [ 95 voxels]
I-to-S extent:   -64.000 [I] -to-    84.000 [S] -step-     2.000 mm [ 75 voxels]
Number of values stored at each pixel = 16
  -- At sub-brick #0 '(Intercept) F' datum type is short:          0 to         32767 [internal]
                             [*  0.003051]          0 to           100 [scaled]
     statcode = fift;  statpar = 1 33
  -- At sub-brick #1 'NMvstri F' datum type is short:            0 to         32767 [internal]
                             [*  0.000910424]          0 to       29.8319 [scaled]
     statcode = fift;  statpar = 1 33
  -- At sub-brick #2 'Outcome F' datum type is short:            0 to         32767 [internal]
                             [*   0.00150894]          0 to       49.4434 [scaled]
     statcode = fift;  statpar = 1 33
** For info on all 16 sub-bricks, use '3dinfo -verb' **
```

Mask

```
Dataset File:    ventralStriatum_anat_TT+tlrc
Identifier Code: XYZ_Zm6S3dxcwqgEiiIsONZJ-g  Creation Date: Thu Jun 24 11:31:41 2021
Template Space:  TLRC
Dataset Type:    Anat Bucket (-abuc)
Byte Order:      LSB_FIRST [this CPU native = LSB_FIRST]
Storage Mode:    BRIK
Storage Space:   2,280,000 (2.3 million) bytes
Geometry String: "MATRIX(2,0,0,-79,0,2,0,-79,0,0,2,-64):80,95,75"
Data Axes Tilt:  Plumb
Data Axes Orientation:
  first  (x) = Right-to-Left
  second (y) = Anterior-to-Posterior
  third  (z) = Inferior-to-Superior   [-orient RAI]
R-to-L extent:   -79.000 [R] -to-    79.000 [L] -step-     2.000 mm [ 80 voxels]
A-to-P extent:   -79.000 [A] -to-   109.000 [P] -step-     2.000 mm [ 95 voxels]
I-to-S extent:   -64.000 [I] -to-    84.000 [S] -step-     2.000 mm [ 75 voxels]
Number of values stored at each pixel = 1
  -- At sub-brick #0 '#0' datum type is float:              0 to             1 [internal]
                             [*                1]          0 to             1 [scaled]
```

Mask Transformation: Datum Type

```
3dinfo new_mask
```

Dataset

```
Dataset File:    3dMVM.FB.NonSocial_PositivexNMvstri_NonInterp_052321+tlrc
Identifier Code: XYZ_yx549Ci77G38XVO7nq697C  Creation Date:
Template Space:  TT_N27
Dataset Type:    Func-Bucket (-fbuc)
Byte Order:      LSB_FIRST [this CPU native = LSB_FIRST]
Storage Mode:    BRIK
Storage Space:   18,240,000 (18 million) bytes
Geometry String: "MATRIX(2,0,0,-79,0,2,0,-79,0,0,2,-64):80,95,75"
Data Axes Tilt:  Plumb
Data Axes Orientation:
  first  (x) = Right-to-Left
  second (y) = Anterior-to-Posterior
  third  (z) = Inferior-to-Superior   [-orient RAI]
R-to-L extent:   -79.000 [R] -to-    79.000 [L] -step-     2.000 mm [ 80 voxels]
A-to-P extent:   -79.000 [A] -to-   109.000 [P] -step-     2.000 mm [ 95 voxels]
I-to-S extent:   -64.000 [I] -to-    84.000 [S] -step-     2.000 mm [ 75 voxels]
Number of values stored at each pixel = 16
  -- At sub-brick #0 '(Intercept) F' datum type is short:           0 to         32767 [internal]
                             [*  0.003051]           0 to           100 [scaled]
     statcode = fift;  statpar = 1 33
  -- At sub-brick #1 'NMvstri F' datum type is short:           0 to         32767 [internal]
                             [*  0.000910424]           0 to       29.8319 [scaled]
     statcode = fift;  statpar = 1 33
  -- At sub-brick #2 'Outcome F' datum type is short:           0 to         32767 [internal]
                             [*   0.00150894]           0 to       49.4434 [scaled]
     statcode = fift;  statpar = 1 33
** For info on all 16 sub-bricks, use '3dinfo -verb' **
```

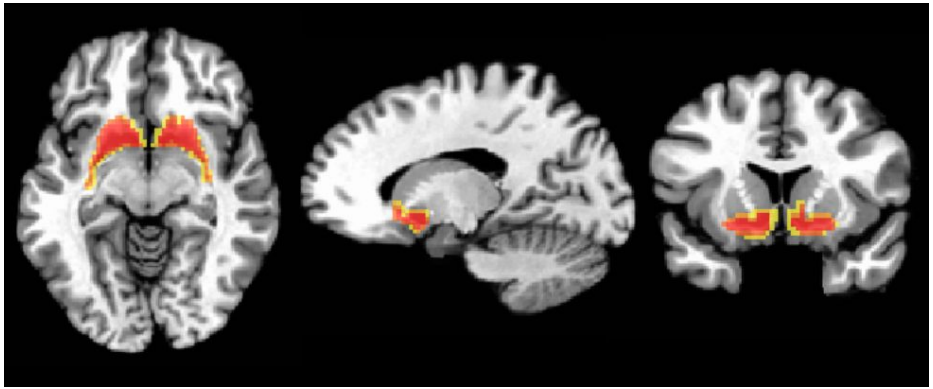
Mask

```
Dataset File:    ventralStriatum_anat_TT_short+tlrc
Identifier Code: XYZ_O6UpU-aXz2GPK8mS_u_98A  Creation Date: Fri Jun 25 11:16:11 2021
Template Space:  TLRC
Dataset Type:    Echo Planar (-epan)
Byte Order:      LSB_FIRST [this CPU native = LSB_FIRST]
Storage Mode:    BRIK
Storage Space:   1,140,000 (1.1 million) bytes
Geometry String: "MATRIX(2,0,0,-79,0,2,0,-79,0,0,2,-64):80,95,75"
Data Axes Tilt:  Plumb
Data Axes Orientation:
  first  (x) = Right-to-Left
  second (y) = Anterior-to-Posterior
  third  (z) = Inferior-to-Superior   [-orient RAI]
R-to-L extent:   -79.000 [R] -to-    79.000 [L] -step-     2.000 mm [ 80 voxels]
A-to-P extent:   -79.000 [A] -to-   109.000 [P] -step-     2.000 mm [ 95 voxels]
I-to-S extent:   -64.000 [I] -to-    84.000 [S] -step-     2.000 mm [ 75 voxels]
Number of values stored at each pixel = 1
  -- At sub-brick #0 '#0' datum type is short:           0 to         32767 [internal]
                          [*  3.05185e-05]           0 to             1 [scaled]
```

Mask Transformation: Warped Values

Old Mask

New Mask



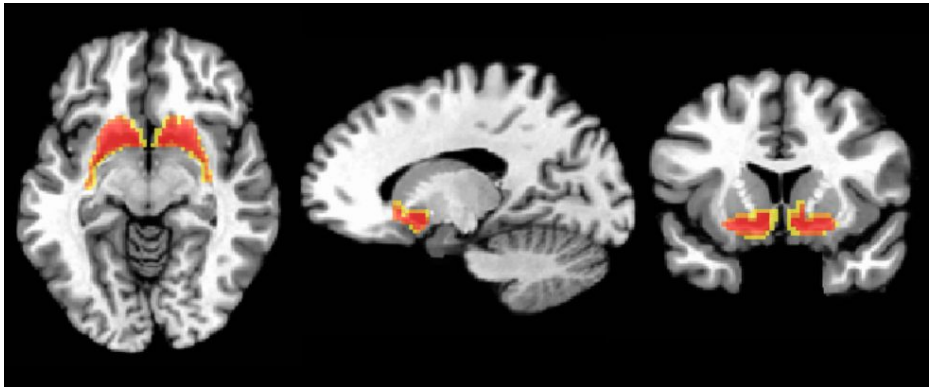
x=15, y=-10, z=-6

Mask Transformation: Warped Values

```
3dcalc -a old_mask -expr “astep(a,.000001)” -prefix new_mask
```

Old Mask

New Mask



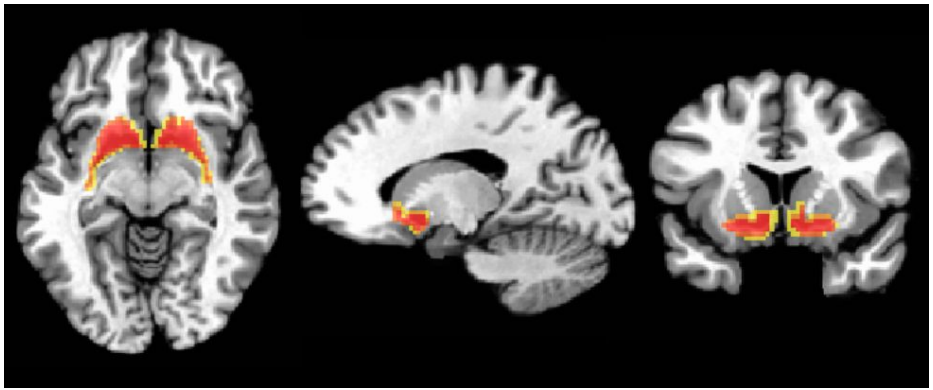
x=15, y=-10, z=-6

Mask Transformation: Warped Values

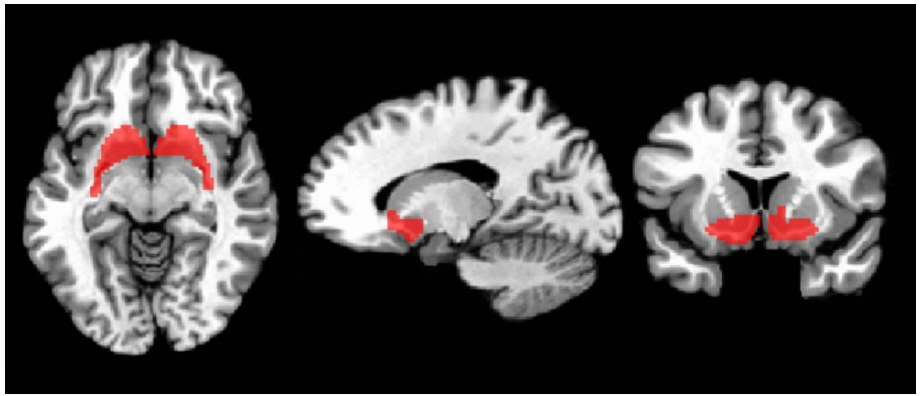
```
3dcalc -a old_mask -expr “astep(a,.000001)” -prefix new_mask
```

Old Mask

New Mask

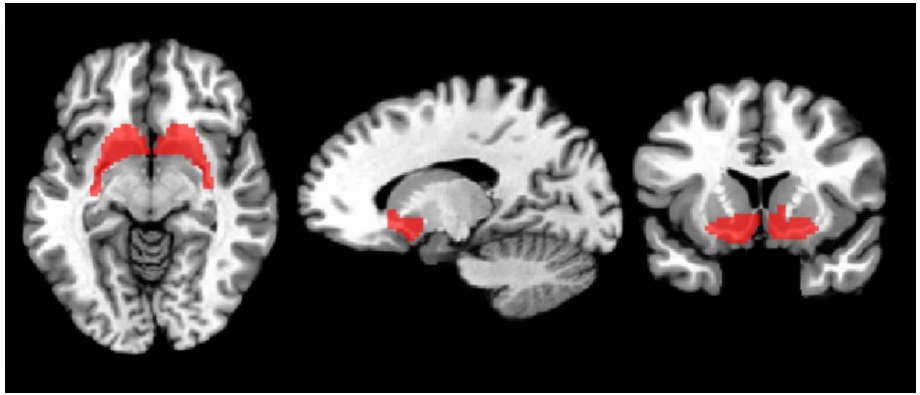


x=15, y=-10, z=-6



Mask Transformation: Removing White Matter

Old Mask



x=15, y=-10, z=-6

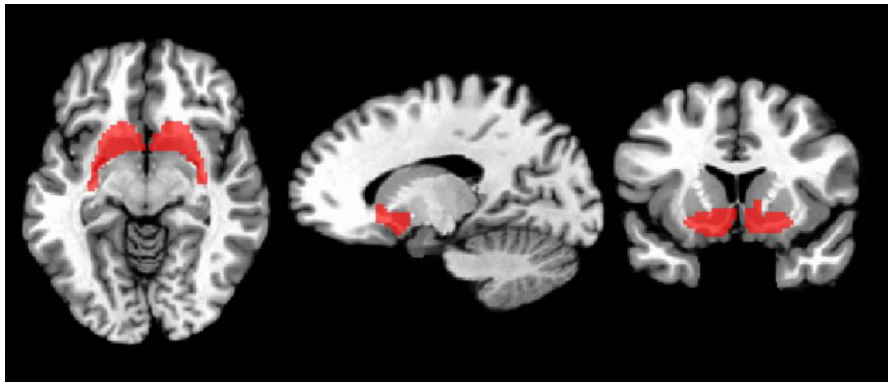
New Mask

Mask Transformation: Removing White Matter

```
3dmask_tool -input old_mask -prefix new_mask -dilate_input -1
```

Old Mask

New Mask

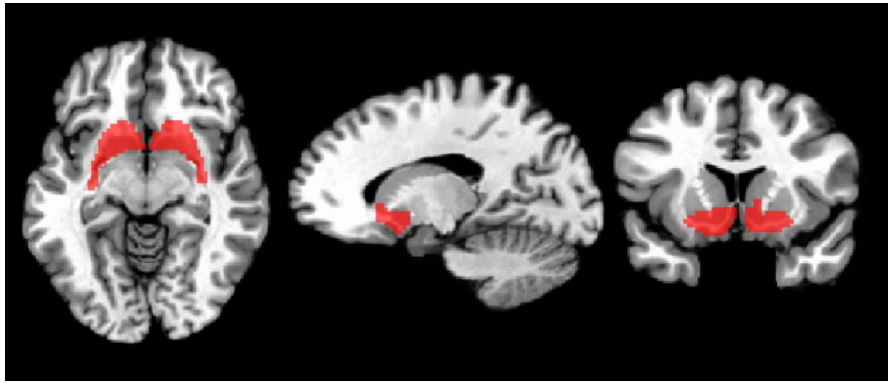


x=15, y=-10, z=-6

Mask Transformation: Removing White Matter

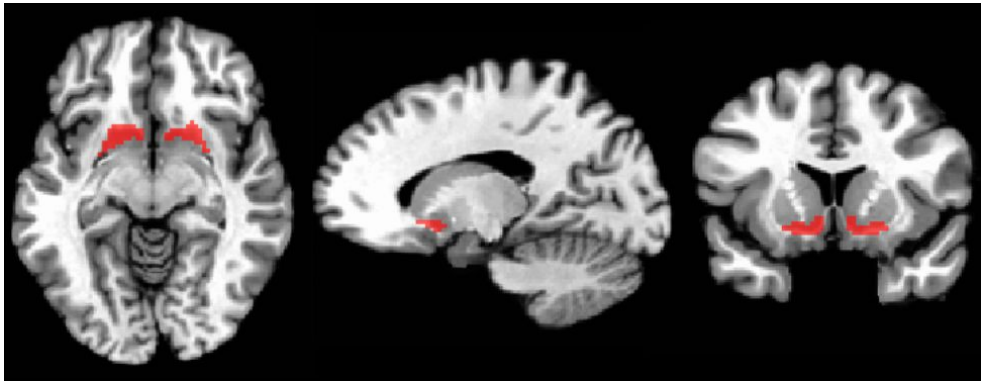
```
3dmask_tool -input old_mask -prefix new_mask -dilate_input -1
```

Old Mask

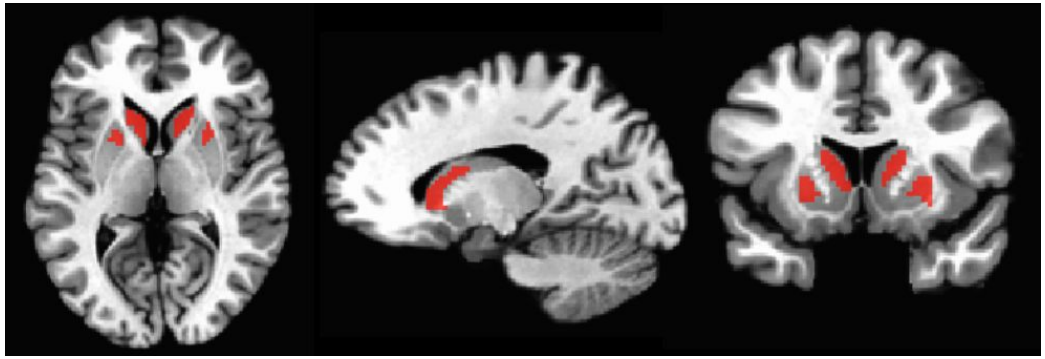


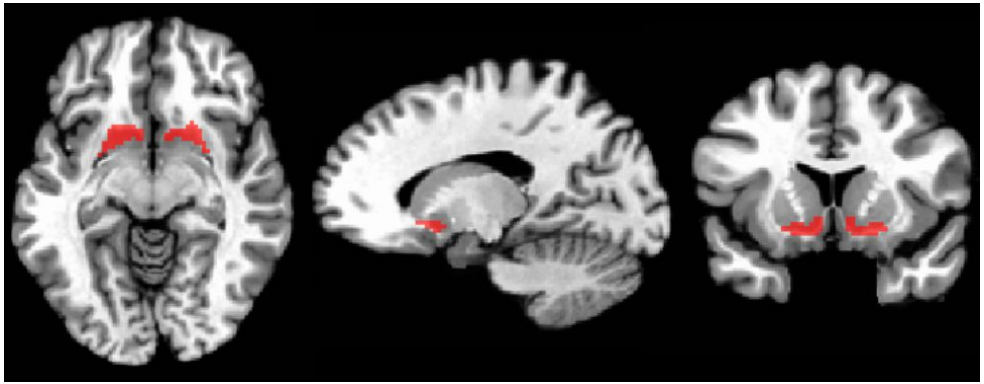
x=15, y=-10, z=-6

New Mask

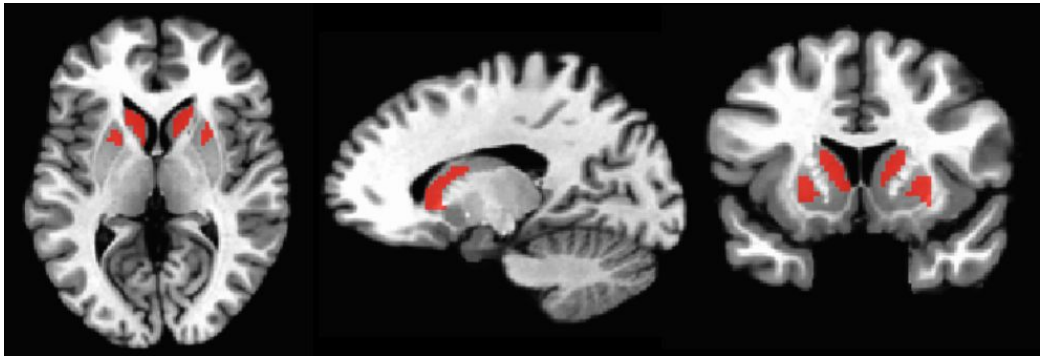


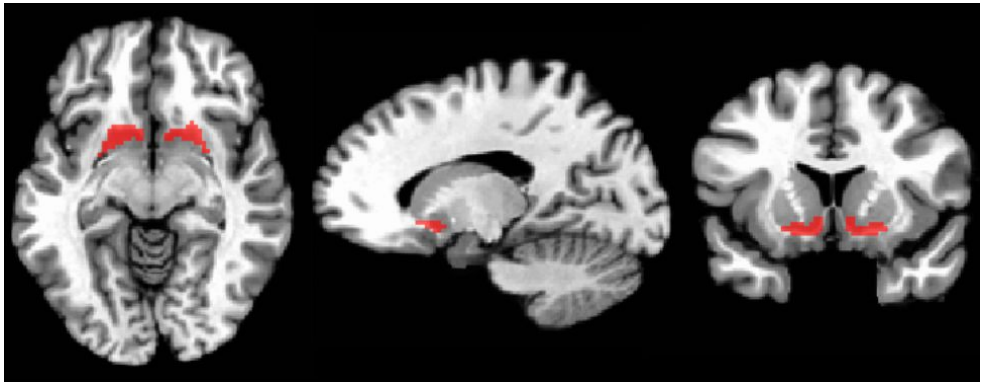
Same process for ventral & dorsal



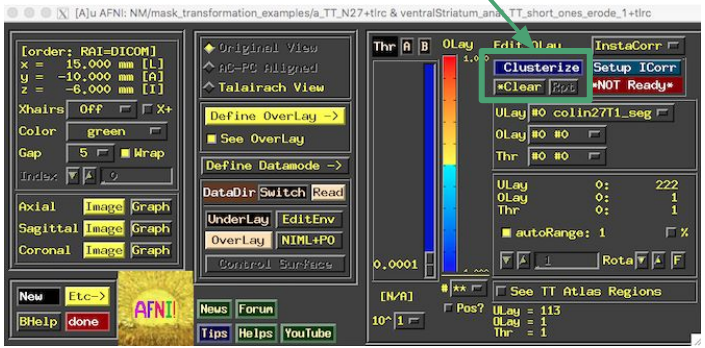


Same process for ventral & dorsal striatum



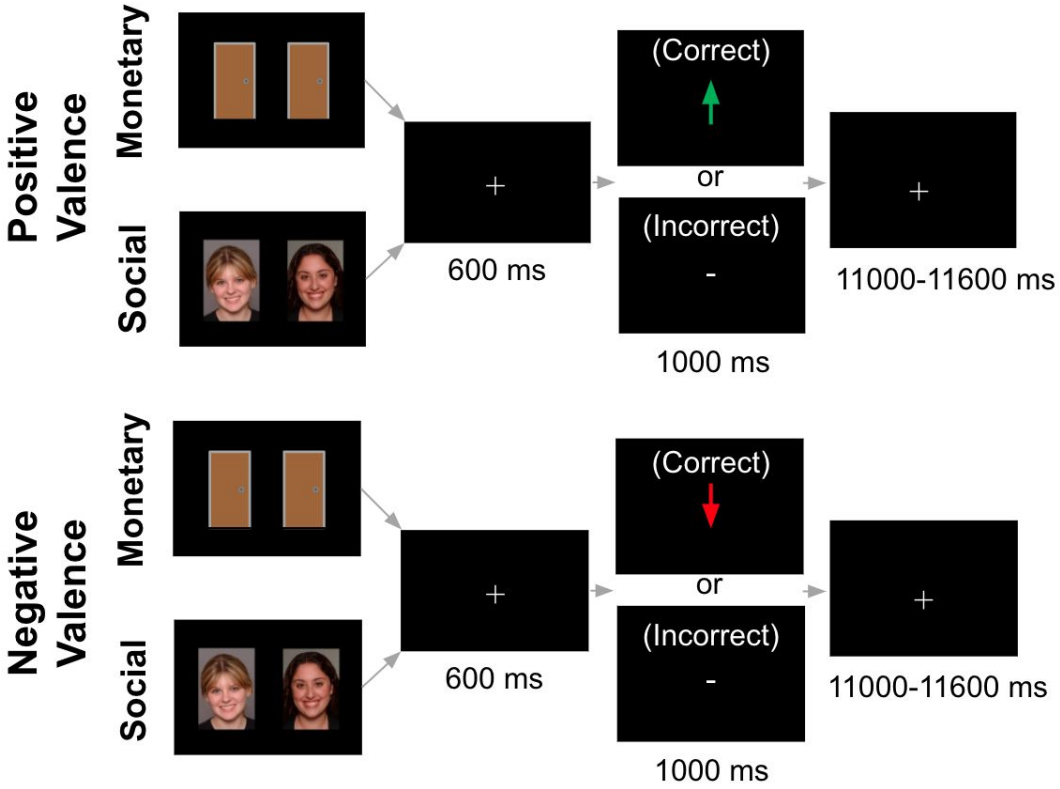


(In AFNI, you can use ‘Clusterize>Rpt’ to isolate clusters)

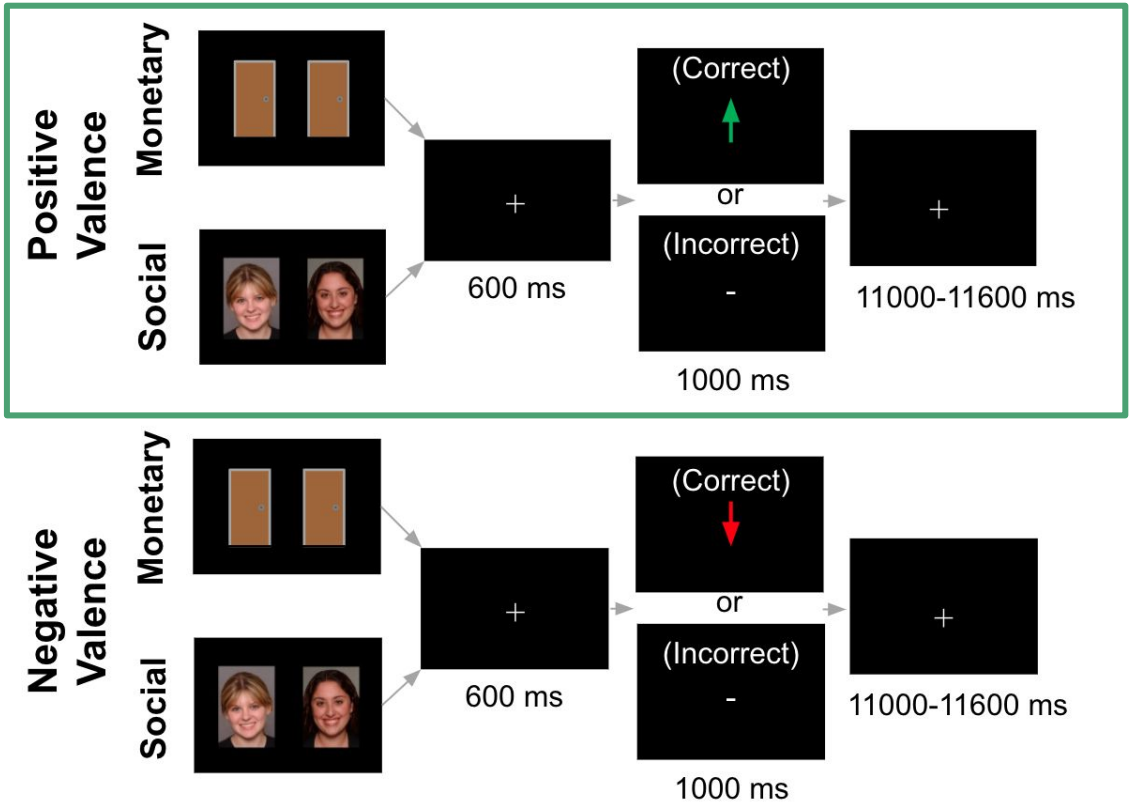


Does striatal activation vary by NM or Accuracy?

Social Doors Task



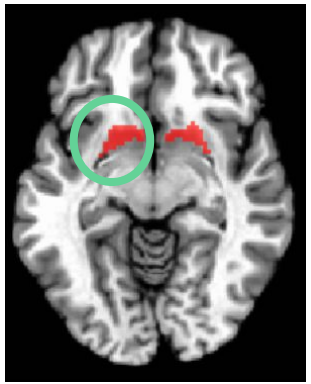
Social Doors Task

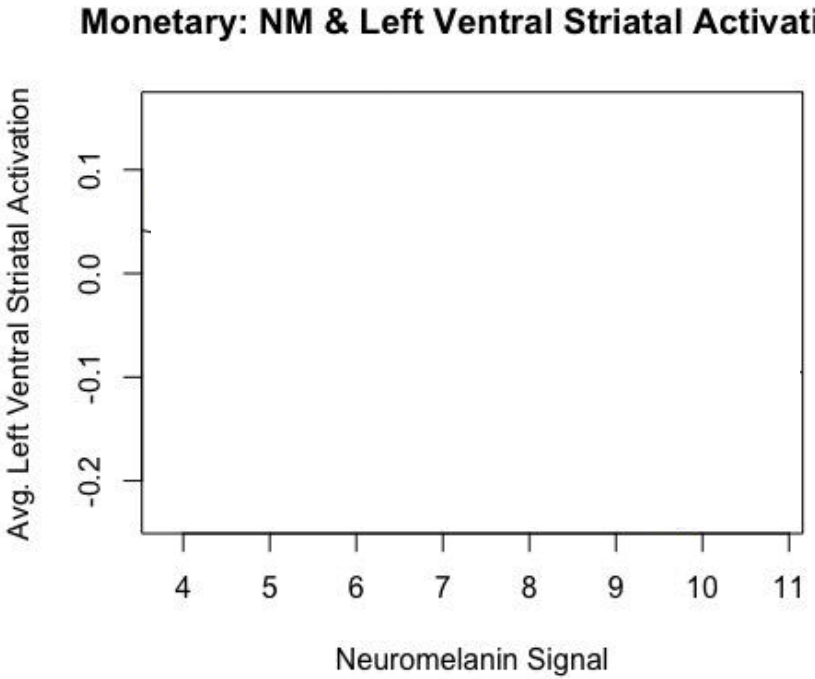


Does striatal activation vary by NM or Accuracy?

Does striatal activation vary by NM or Accuracy?

Left VS

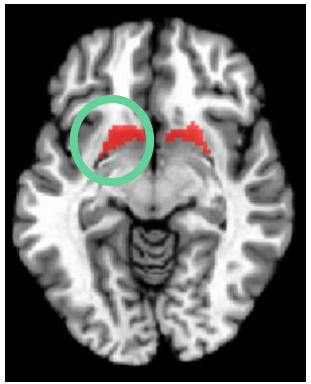


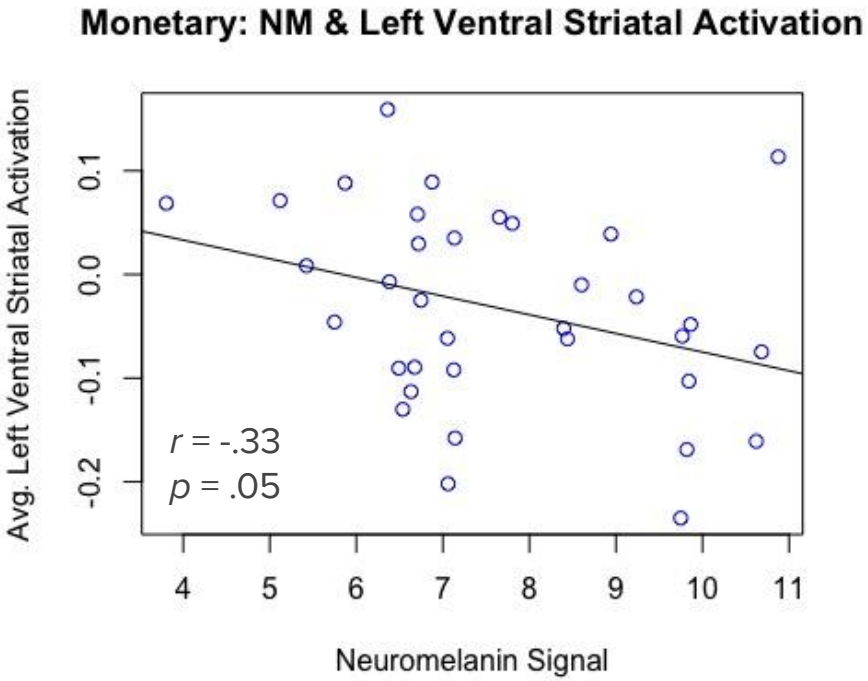


Monetary Domain:
Negative relationship between NM and left VS reward response

Does striatal activation vary by NM or Accuracy?

Left VS

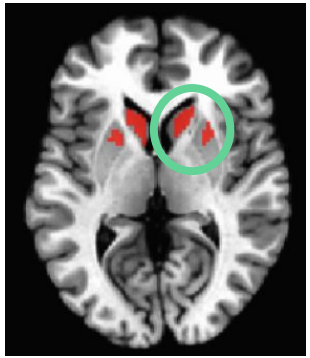




Monetary Domain:
Negative relationship between NM and left VS reward response

Does striatal activation vary by NM or Accuracy?

Right DS

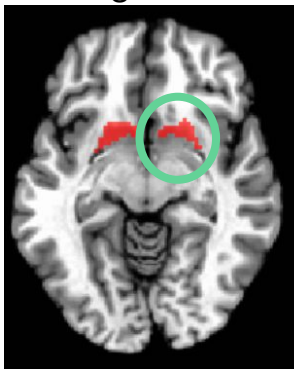


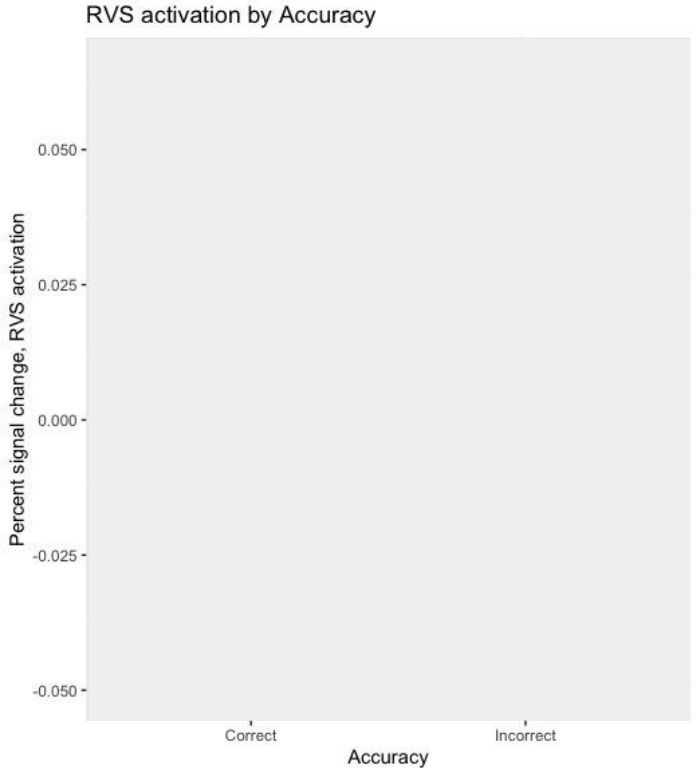
Social Domain: Negative relationship between NM and right DS reward response

Does right ventral striatal activation vary by Accuracy, Domain, or NM?

Does right ventral striatal activation vary by Accuracy, Domain, or NM?

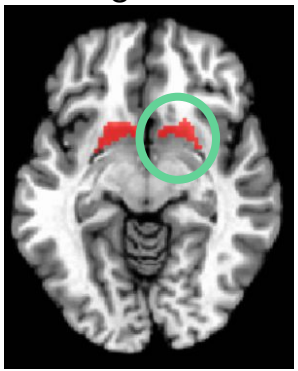
Right VS

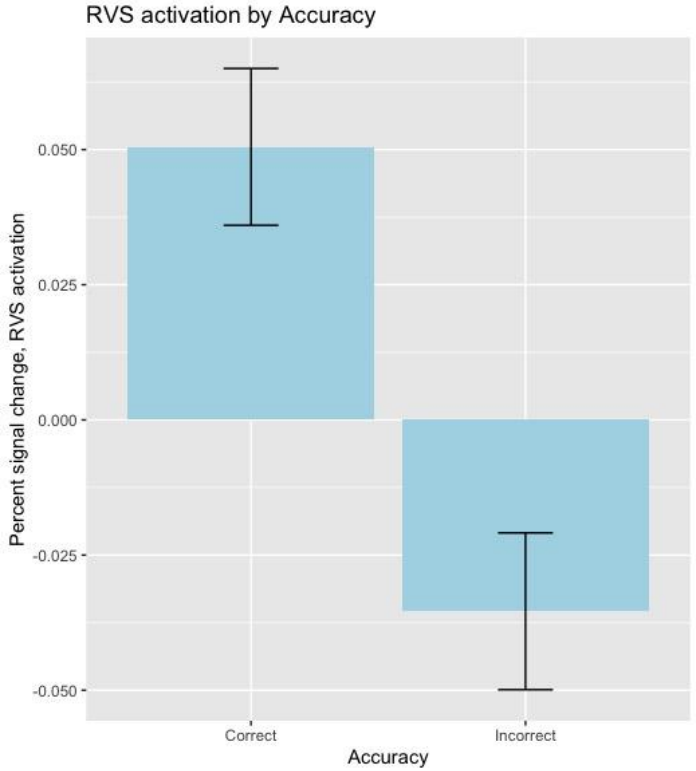




Does right ventral striatal activation vary by Accuracy, Domain, or NM?

Right VS

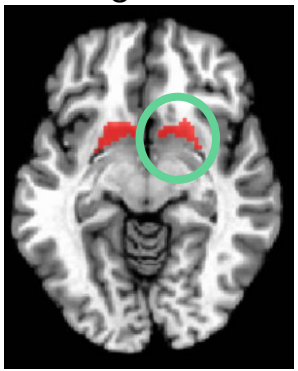


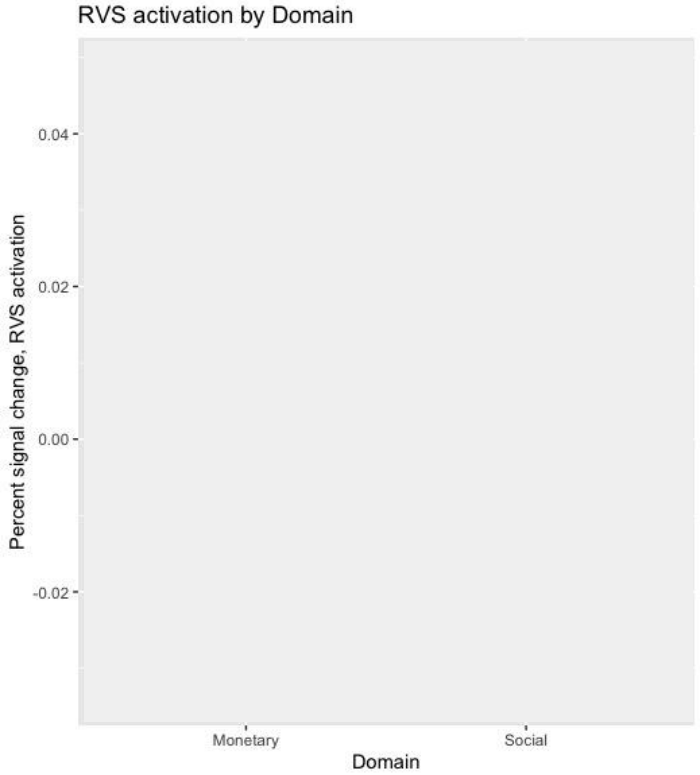


RVS reward response is greater for correct responses to positive stimuli than for incorrect responses

Does right ventral striatal activation vary by Accuracy, Domain, or NM?

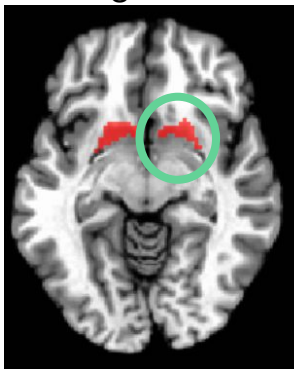
Right VS

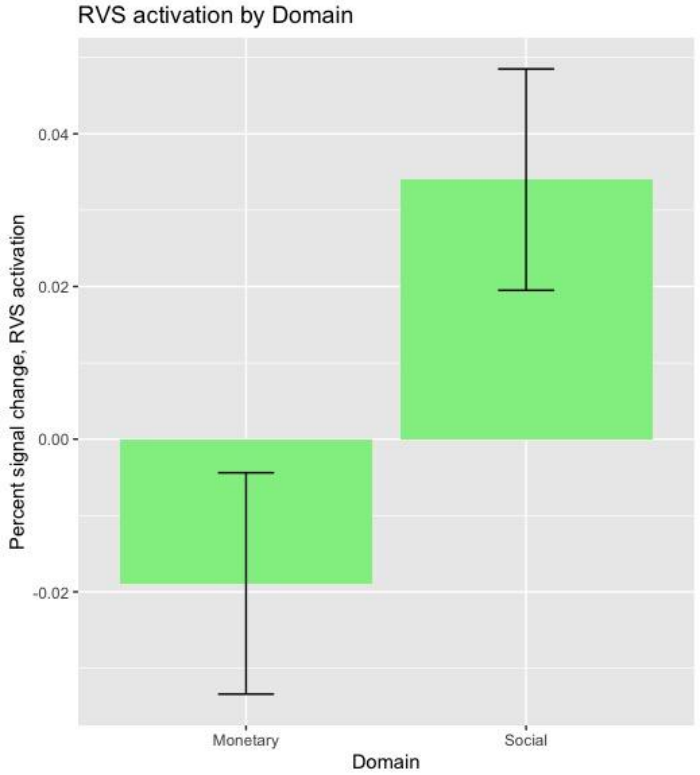




Does right ventral striatal activation vary by Accuracy, Domain, or NM?

Right VS

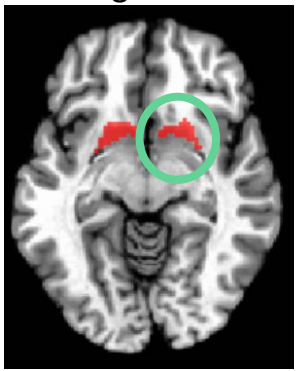


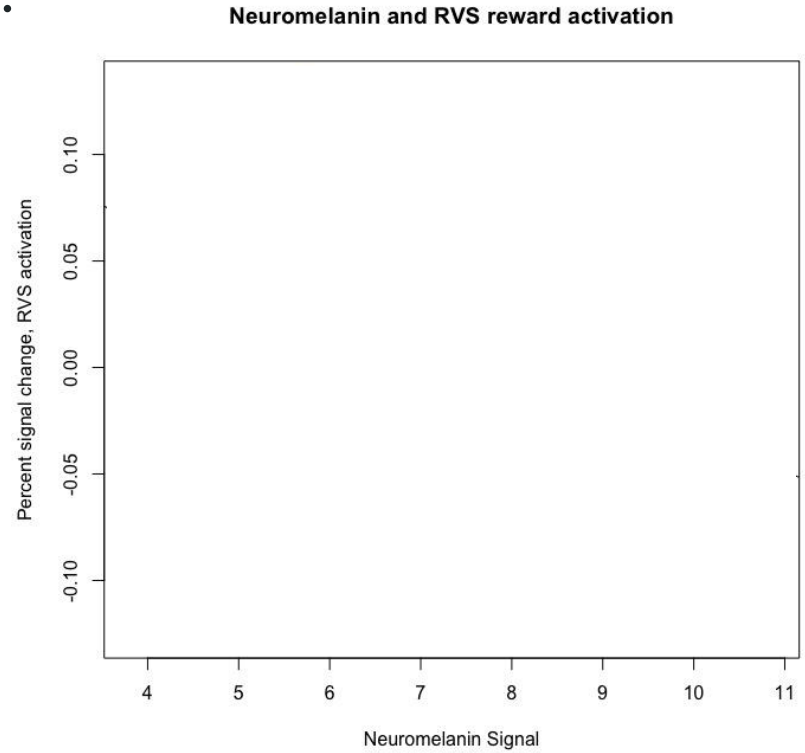


RVS reward response is greater in the social domain than in the monetary

Does right ventral striatal activation vary by Accuracy, Domain, or NM?

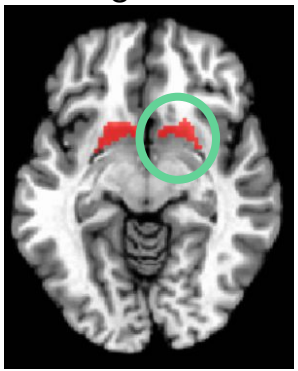
Right VS

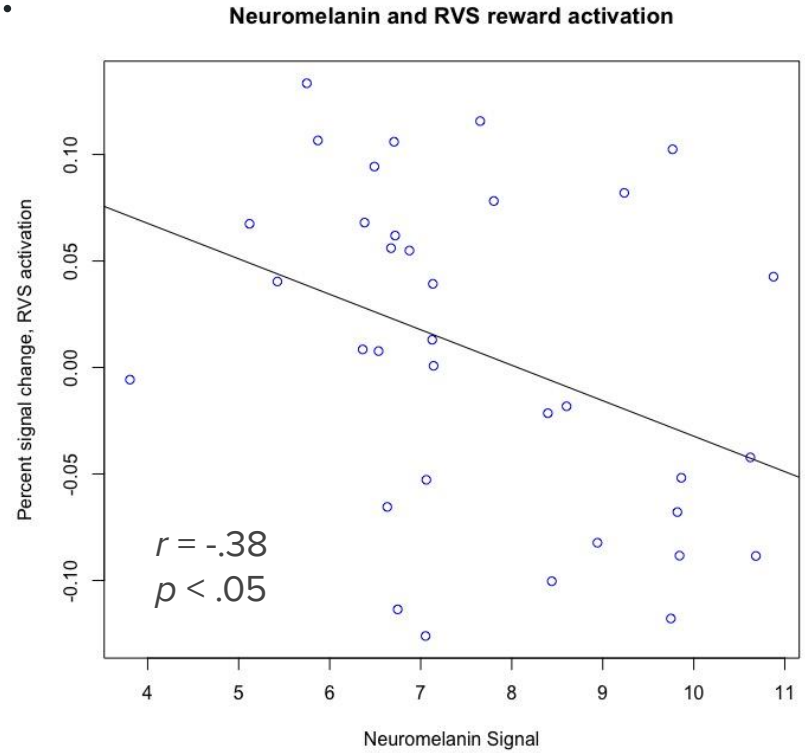




Does right ventral striatal activation vary by Accuracy, Domain, or NM?

Right VS





As NM signal increases, reward responding for positive stimuli decreases

Next steps

- Drug use = risk-taking behavior; drug use = lesser NM signal
  - Reward sensitivity as moderating factor?
  - Social Doors Kids

Next steps

- Drug use = risk-taking behavior; drug use = lesser NM signal
  - Reward sensitivity as moderating factor?
  - Social Doors Kids
- Replication in Locus Coeruleus
  - Shared connectivity with SN
  - LC connectivity to fronto-parietal regions increases with age (Zhang et al., 2016)

Reference Slide Repository:

NM & Substance Use

Marijuana Use

- I've had urges to use marijuana that were hard to resist
- I've gone out of my way to get marijuana
- I gave up things I used to enjoy because of marijuana
- I've spent big parts of my day using marijuana
- My marijuana use has led to legal problems
- My marijuana use has led to problems at home, work, or school
- At times, marijuana has been more important to me than work, friends, or school

Drug Use

- I have snorted drugs
- My drug use has led to problems at work or school
- I've used downers like Valium or Xanax for non-medical reasons
- I gave up things I used to enjoy because of drugs
- I've had legal problems because of my drug use
- At some point in my life, I couldn't get high from a drug dose that worked before
- My drug use has caused problems with my family
- I have used more drugs for longer than I meant to
- I've taken drugs to get over the bad effects of quitting a drug
- I've broken the law to get money for drugs
- I've trembled and gotten sweaty when I stopped using drugs

Alcohol Use

- After trying to cut down on alcohol, I've had physical problems like sweating or feeling shaky
- I've often ended up drinking more than I should
- I've lost control of my alcohol use
- My drinking led to problems at home
- I've gone on drinking binges
- I've had to drink more than I used to in order to get the same buzz
- I gave up things I used to enjoy because of my drinking
- After trying to cut down on drinking alcohol, I've felt sad or irritable

NM & Substance Use

Marijuana Use

- I've smoked marijuana at parties
- I have enjoyed smoking marijuana with friends
- I have tried smoking marijuana
- I have snuck marijuana or hash into a public event
- I've gotten high using marijuana
- I've bought items used for smoking marijuana
- I have bought marijuana

Drug Use

- I have taken a drug like LSD or magic mushrooms
- I have never bought drugs (-)
- I've used drugs when it might be hazardous, like while driving a car
- I've taken an illegal drug that gave me a rush and made me more awake
- I've never taken illegal drugs (-)
- I have no interest in trying drugs (-)

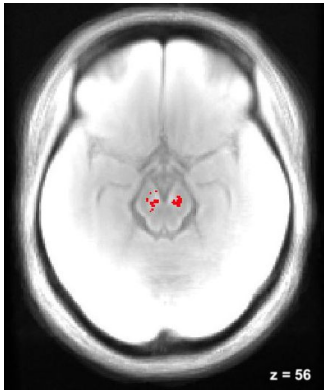
Alcohol Use

- I've enjoyed getting drunk at parties
- I don't drink (-)
- I've gotten drunk
- At times I've drunk enough alcohol to pass out
- I'm not one who drinks much (-)
- I have not tried drinking hard liquor (-)
- I like having a drink of alcohol to relax
- I don't drink at parties (-)
- I'm not a drinker (-)

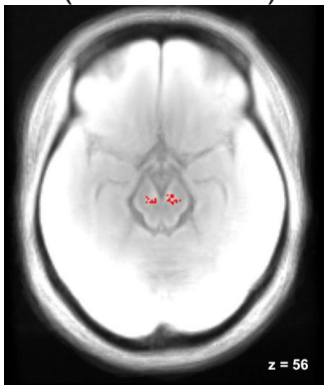
Relationship between ESI-bf USE Total Score & NM

Full NM

SN DA Submask



Voxelwise Submask (380* voxels)



* = significant at p < .05