脑电数据预处理基本步骤(九步走)

- •1.导入数据
- •2.定位电极
- •3.剔除无用电极
- •4.重参考(即重新选择参考电极,位置随意)
- •5.滤波
- •6.分段(可在此步骤保存数据)
- •7.插值坏导和剔除坏段
- 8.Run ICA (可在此步骤保存数据)
- •9.剔除眼动成分等(保存)。如:眨眼,眼瞟,明显的噪声(乱动)。

来源: 彭薇薇老师

准备工作

启动EEGLAB

- 拷贝eeglab12_0_2_6b.zip.
 也可以在EEGLAB的网站上
 下载最新版本
- 解压缩
- 打开matlab
- Set path→Add with subfolders,然后选择已经 解压缩的文件夹
- 在matlab的任务窗口输入: eeglab

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解读: eeglab 是基于 MATLAB 的一个工具包,一般加载的时候都从添加子文件夹导入。在添加多个工具包,记得只保留必要的工具包,避免兼容报错的问题。

一、导入数据

步骤 1: File - Import data - 不同的数据格式不同的导入方法

解读:其中 BP 设备和 ANT 设备的数据,都是从.vhdr 中导入。

步骤 2: File - Load exiting dataset - eeglab_data.set

解读:若是导入 eeglab 保存的数据,则直接按照步骤 2 导入即可。

来源: AffectiveNeuroscience

<text>

二、定位电极(时间)

步骤: Plot - Channel data(scroll) - settings - time range to display -setting - number of channels to display value(调整幅度)

解读:可以在数据分析之前,浏览一下原始数据,自己对数据的好坏有一个评估。

Channel data (scroll) (位置任意)

- ➢ Plot→Channel data (scroll)
- Settings → Time range to display
- Settings \rightarrow Number of Channels to display
- Value (调整幅度)



三、定位电极(空间)

步骤: Edit - Channel locations - read locations (look up locs) - eeglab_chan64.locs(plot 2D)

解读: 在数据分析之前, 查看电极点的分布图, 方便后期进行使用插值法进行坏点替换。

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四、删除无用电极

步骤: Edit - Select data - 点上√, 即删除选取的电极; 不点√, 则是删除剩余的电极。

解读:删除记录多余的电极,只选取自己需要的电极。





四、重参考

步骤 1: Edit - Re-reference - re-reference data to channel(s) - 电极点 M1 M2 (TP9 TP10) (双侧乳突)

步骤 2: Edit - Re-reference - compute average reference (全脑平均)

步骤 3: 使用姚德忠老师的 re-reference 插件(零参考)

解读:重参考的方法常用的有双侧乳突、全脑平均、零参考,具体选取那种方法根据以往的 参考文献和自己的需要来进行选择。

重参考也是一种空间滤波,主要是通过另外一个角度来看问题。所以不同的在线参考其实对 于离线参考没有太大影响。

Re-reference

➤ Tools→Re-reference

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Compute average reference		Compute average reference			_
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五、滤波

步骤 1: Tools - Filter the data - basic FIR filter - (1 Hz high pass filter first) - Overwrite it in memory(根据需要获取目标频段)

步骤 2: Tools - Filter the data - Basic FIR filter - (30 Hz low pass filter second) - Overwrite it in memory

解读: 高通滤波,是指高频信号能正常通过,而低于设定临界值的低频信号则被阻隔、减弱。因而是进行 1Hz 的高通滤波,而选择的时候,1Hz 是频率通过的下限。

低通滤波,是指低频信号能正常通过,而超过设定临界值的高频信号则被阻隔、减弱。因而 是进行 **30Hz** 的低通滤波,而选择的时候,**30Hz** 是频率通过的上限。

早期的 eeglab 版本,不能够同时滤波,容易卡死;最新版本的 eeglab 是可以同时进行空间 滤波的。

若是后期要做时频分析,可以滤波的范围选择更宽一点,选择 0.1-100。若是只进行传统的 ERP 分析,可以选择 1-30 左右。

此外,若是进行 0.1-100Hz 的滤波,为了消除市电的干扰,可以进行 50Hz 的凹陷滤波。

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•凹陷滤波(消除特定频率的干扰,如50Hz工频干扰)



六、分段和基线矫正

步骤: Tools - Extract epochs(分段 marker 全选) - Automatic baseline correction

解读:分段的步骤,可以在去除眼电之前,也可以在去除眼电之后。其实最好是在去除眼电之后,因为连续的数据在跑 ICA 时更好,只是数据量比较大,跑的速度比较慢。

但是若是实验设计当中有出声、身体动,造成伪迹较多,数据杂乱,可以先分段,只是可以 在分段的时候,尽量分段长一点。

Epoch and remove baseline

- ➤ Tools →Extract epochs (分段marker 全选)
- Automatic baseline correction



界面变化

ile	Edit Tools REST Plo	t Study	Datasets	Help	
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	Filename: none				
	Channels per frame		61		
	Frames per epoch		600		
	Epochs		678		
	Events		678		
	Sampling rate (Hz)		500		
	Epoch start (sec)		-0.200		
	Epoch end (sec)		0.998		
	Reference		M1 M2		
	Channel locations		Yes		
	ICA weights		No		
	Dataset size (Mb)		101.4		

七、伪迹去除

步骤 1: Plot - Channel data(scroll) (删除坏的 trial) - 差值坏导 (代码)

步骤 2: File - Save as - 保存文件

解读: 伪迹去除是去除眼电之外的其他杂乱的伪迹, 使得在 Run ICA 之前的数据比较干净, 容易找到眼电成分。

Artifact rejection

▶ Plot → Channel data (scroll) (删除坏的trial)
▶ 插值坏导 (代码):
EEG.data(a,:,:)=mean(EEG.data([b c d e],:,:));

八、Run ICA

步骤: Tools - Run ICA - 'extended',1'pca',30 - OK

解读: Run ICA 的时候,可以写 30 个,也可以写 60 个主成分。去除的时候,需要去除自 己最肯定的成分,一般都是去除眼电成分。



Independent component analysis



Independent component analysis



九、眼电去除

步骤 1: Tools - Reject data using ICA - Reject component by map

步骤 2: Select each IC and observe

步骤 3: Tools - remove components - 填写删除电极的数字 - OK

解读:眼电判断的时候,除了看地形图,也可以看频率分布图、每个成分的波形图,以及矫正之后的脑电图是否有差异,进行综合的评估。

只有自己很确定的伪迹主成分才删除,不然可能会删除自己想要的成分。

若是出来的成分,没有出现明显的伪迹成分,可以多跑几次 ICA;或者不分段重新跑一次; 再或者再看看原始数据,删除杂乱的成分,重新再跑一次。

这是一步是很需要经验的步骤,若是前期自己把握不准,可以让有经验的人帮忙看看。

通过 Adjust 插件,也可以进行一个简单的伪迹成分的评估,不过最终的确定还是需要自己来进行评估。

Independent component analysis

> Tools \rightarrow Reject data using ICA \rightarrow Reject component by map



Independent component analysis

pop_p

• Select each IC and observe



Independent component analysis

 \succ Tools \rightarrow Remove components

#2:	Change sampling rate		
	Filter the data		Remove components from data pop_subcomp()
Filen	Re-reference	set	Component(s) to remove from data:
Fram	Reject continuous data by eye		Component(s) to retain (overwrites "Component(s) to remove")
Epoc Even	Extract epochs Remove baseline		Help Cancel Ok
Epoc	Run ICA		
Epoc	Remove components		

眼电去除的标准

来源: 彭薇薇老师

OK



- 经典成分-眨眼
- 判断依据:
- 1 前端分布
- 2 小方块
- 3 随机分布
- 4 低频能量高
- 5 成分排序靠前
- 注意:颜色的深浅有意义 但是红蓝无所谓,大红大蓝 都可以。
- 经典成分-眼漂
- •判断依据:
- 1 前端两侧分布, 红蓝相对
- 2 长条状,红蓝相间
- 3 随机分布
- 4 低频能量高
- 5 成分排序靠前, 但一般排在眨眼 后面





- 经典成分:头动
- 1 周围分布
- 2 长条状
- 3 随机分布
- 4 在单个trial里有
 非常明显的漂
 務



- 其他成分
- 心电
- •呈雨点般散落状。



- 其他成分: 工频干扰
- 1 分布在地线 周围
- 2 单个Trial上 的分布非常 有规律
- 3 50Hz左右能 量最高



十、预处理的批处理

步骤: eeg.history - 出现之前处理的代码 - 进行每个被试的批处理 - 然后处理完之后再 手动去除眼电成分 - 保存为处理干净的脑电信号 - 进行下一步的分析

解读:脑电数据的预处理是为了提高信噪比,去除噪音,得到比较干净的数据。从而进行下一步的分析。

Matlab scripts

• >> EEG.history (预处理)

- EEG = pop_loadbv('C:\Users\11125\Desktop\TaskforJuly\eeg\',[num2str(i),'.vhdr'], [], []);
- EEG = eeg_checkset(EEG);
- EEG = pop_chanedit(EEG, 'lookup','C:\\Users\\11125\\Desktop\\TaskforJuly\\eeglab12_0_2_6b\\plugins\\dipfit2.2\\standard_BESA\\standard-10-5-cap385.elp');
- EEG = eeg_checkset(EEG);
- EEG = pop_select(EEG, 'nochannel', {'BIP1' 'BIP2'});
- EEG = eeg_checkset(EEG);
- EEG = pop_reref(EEG, [13 19]);
- EEG = eeg_checkset(EEG);
- EEG = pop_eegfiltnew(EEG, [], 1, 1650, true, [], 1);
- EEG = eeg_checkset(EEG);
- EEG = pop_eegfiltnew(EEG, [], 30, 220, 0, [], 1);
- EEG = eeg_checkset(EEG);
- EEG = pop_epoch(EEG, { 's1' 's126' 's127' 's128' 's2' 's25' 's26' 's27' 's3' 's4' 's5' 's6' }, [-0.2 1], 'epochinfo', 'yes');
- EEG = eeg_checkset(EEG);
- EEG = pop_rmbase(EEG, [-200 0]);
- EEG = eeg_checkset(EEG);
- EEG = pop_saveset(EEG,'filename',[num2str(i),'.set'],'filepath','C:\Users\11125\Desktop\TaskforJuly\eeg\epoch\');