

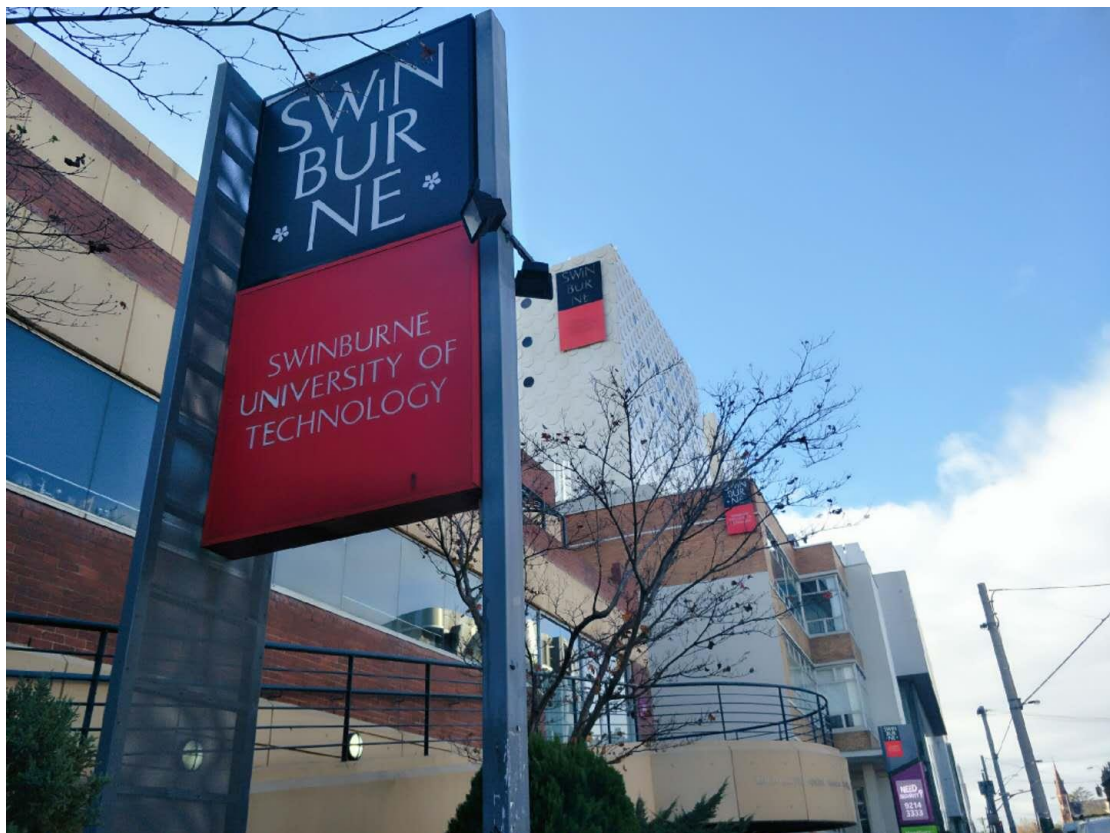
# 针对自闭症儿童 APP 的设计准则研究

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## 1. 课题背景

我们在斯威本科技大学参与了 Abdullah 教授以自闭症儿童为目标群体的用户体验设计项目研究中。我们的项目任务是收集一些现有的为自闭症儿童设计的移动应用程序，并为结合调研出的自闭症儿童特征分析已有的移动应用程序，最后用定性数据分析以及基准测试进行总结现有应用，总结出自闭症儿童开发出的移动应用程序中所存在的正确的设计点为自闭症儿童应用程序的设计准则。

Abdullah 教授为我们分配的任务是，张宇负责自闭症儿童社交能力应用程序的准则研究，侯炎之负责自闭症儿童学术教育的准则研究。



## 2.课题意义以及项目目标

自闭症是一种发育障碍类的疾病，病程持续一生，难以逆转，且患病率逐年升高，给患者的家庭和社会已经造成了巨大的经济和社会负担(段云峰，吴晓莉，金峰，2015)。根据美国疾病控制中心于 2009 年底发布的数据，自闭症在美国儿童中的发病率已近百分之一。

随着全球儿童精神病学家的持续短缺，自闭症儿童的治疗资源不足亟待解决，所以提供或增加自闭症谱系障碍的服务和技术方面的潜力是巨大的。与其他医疗行业一样，数字革命也影响了自闭症谱系障碍社区，因为基于移动设备的软件和智能手机/平板应用正在不断发展，并供患者及其家属使用 (Shic 和 Goodwin, 2015)。

在项目的阶段中，我们的目标是（1）审查自闭症儿童可用移动设备应用程序，（2）用 MARC 量表和用户评分两个方法进行分析（3）将探究目前市场上优秀和受欢迎的应用程序存在那些共性，为未来自闭症儿童设计提供设计准则。



## 3.张宇对自闭症儿童社交 APP 的设计准则研究

### 3.1 方法一：MARS 量表用来评估应用程序的质量。

#### Mobile Application Rating Scale (MARS)

##### App Classification

The Classification section is used to collect descriptive and technical information about the app. Please review the app description in iTunes / Google Play to access this information.

App Name: \_\_\_\_\_

Rating this version: \_\_\_\_\_ Rating all versions: \_\_\_\_\_

Developer: \_\_\_\_\_

N ratings this version: \_\_\_\_\_ N ratings all versions: \_\_\_\_\_

Version: \_\_\_\_\_ Last update: \_\_\_\_\_

Cost - basic version: \_\_\_\_\_ Cost - upgrade version: \_\_\_\_\_

Platform:     iPhone     iPad     Android

Brief description: \_\_\_\_\_

图：MARS 量表截图

#### 3.1.1 步骤一：搜索

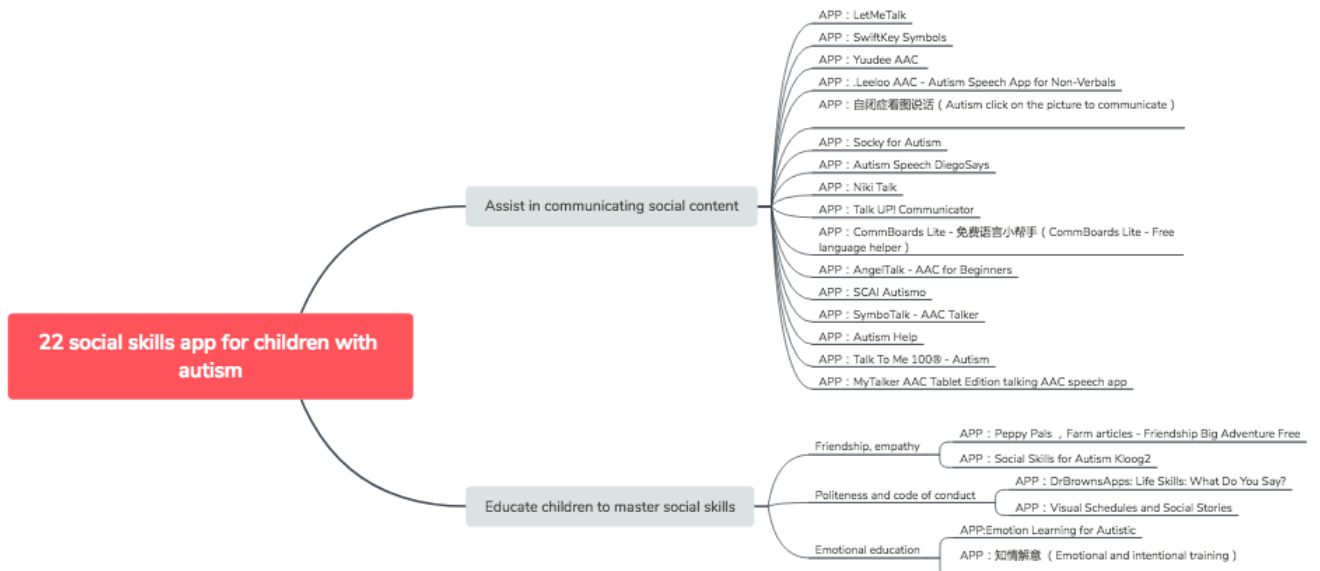
我搜索并记录了 Google Play 和中国（应用宝）两个应用程序商店中的 864 个自闭症社交技巧的安卓应用软件。

Search for Autism social skills	APPname	Rating	Number	AU Cost
社交和沟通技巧, 语言, 值得借鉴	PictoTEA	4.8		
教育 (无关)	How to Teach Autistic Children	0		
感官输入, 或需要调节, 舒缓的活动, 无关	The Sensory Processing Game - Autism & SPD FREE	3.4		
脑波治疗	Vital Tones 自闭症	4.5		
(下载) 辅导沟通	Talk To Me 100® Lite - Autism	3.1		
概念	Autism Treatment Guide	0		
语言越南	Lao Autism Talks	4.2		
(下载) 你的孩子的基本需求, 以提高自己的沟通能力初步分析	Autism Speech DiegoSays	3.6	83	
儿童的精细动作和社交技巧的应用程序, 下载	Trace & Share	4.1	60	
(手机没有)不能访问	Autism & PDD Yes/No Lite	4		
无关	Autism Speaks Survey	1		
(手机没有)不能访问	Autism & PDD Associations Lite	5		

表：自闭症儿童社交 864 个 APP 名字、摘要和筛选截取部分

### 3.1.2 步骤二：筛选

经过分析和筛除（筛选不相关的应用程序（教育，绘画，论坛，社区，讲座等），非英文，中文应用程序以及不易访问的应用程序。需要花费的应用程序）最终确定 22 个应用程序进入后续的分析。



图：22 个自闭症社交应用程序以及任务划分

### 3.1.3 步骤三：测量

运用 MARS 量表测评了 22 个 APP 并做了个表格，将每个部分的平均数整理出后按照分数高低进行排序。

APP	Emotional expression	Large image	Parental mode	Reasonable ordering	Courtesy expression
2. Yuudee AAC*	✓	✓	✓	✓	✓
3. Leeloo AAC - Autism Speech App for Non-Verbals	✓	✓		✓	✓
6. LetMeTalk	✓		✓	✓	
7. Socky for Autism	✓		✓		
9. Niki Talk	✓	✓		✓	
10. Talk UP! Communicator		✓			
11. CommBoards Lite	✓	✓	✓	✓	
12. AngelTalk - AAC for Beginners		✓	✓		
13. SCAI Autismo		✓		✓	
16. SwiftKey Symbols	✓		✓		✓
17. SymboTalk - AAC Talker	✓				
18. Autism Help*	✓	✓			
19. Autism speaks by looking at pictures #	✓	✓		✓	
20. Talk To Me 100® - Autism*		✓			
21. Autism Speech DiegoSays*		✓		✓	
22. MyTalker AAC Tablet Edition talking AAC speech app*		✓			

表：22 个 APPMARS 量表的排序

### 3.1.4 步骤四：分析

我分别分析了两个类别中的 MARS 分数高的 APP 和 MARS 分数低的 APP 的共性。

APP	Emotional expression	Large image	Parental mode	Reasonable ordering	Courtesy expression
2. Yuudee AAC*	✓	✓	✓	✓	✓
3. Leeloo AAC - Autism Speech App for Non-Verbals	✓	✓		✓	✓
6. LetMeTalk	✓		✓	✓	
7. Socky for Autism	✓		✓		
9. Niki Talk	✓	✓		✓	
10. Talk UP! Communicator		✓			
11. CommBoards Lite	✓	✓	✓	✓	
12. AngelTalk - AAC for Beginners		✓	✓		
13. SCAI Autismo		✓		✓	
16. SwiftKey Symbols	✓		✓		✓
17. SymboTalk - AAC Talker	✓				
18. Autism Help*	✓	✓			
19. Autism speaks by looking at pictures #	✓	✓		✓	
20. Talk To Me 100® - Autism*		✓			
21. Autism Speech DiegoSays*		✓		✓	
22. MyTalker AAC Tablet Edition talking AAC speech app*		✓			

分析过后我总结的自闭症儿童社交技巧的 APP 的优秀设计准则有

- 1, 定制化：家长可以操作设置难度级别的内容和表达。
- 2, 互动性：界面应该具有交互式提示，并且交互非常高。
- 3, 导航：逻辑完整，屏幕流程清晰直观。
- 4, 易用性：应该很容易学习如何使用该应用程序来降低错误率。
- 5, 布局：布局应该是合乎逻辑的，专业的，简单的，清晰的和逻辑上有序的，最好根据用户使用频率调整布局。
- 6, 视觉吸引力：界面的颜色应该是明亮的，带有卡通元素，增加声音效果，增加孩子的魅力。
- 7, 信息量：信息必须准确，质量和内容最全面。最好添加礼貌和友好的表达
- 8, 视觉信息：图像的含义应该清晰而合乎逻辑。

### 3.1.5 步骤五：四个维度分析

Abdullah 教授认为我们可以结合 MARS 量表中第二个部分质量中：参与度，功能，美学和信息质量四个维度来分析这 22 个APP。

就是看这四个维度中每一维度的最高分数的 APP 对比这一维度最低分数的 APP 找到的共性。来凸显优秀的 APP 所具有的特征具体是什么。

Engagement	Socre	Name	Parental customization	Content cannot be edited
High	4.30	Yuudee AAC*	√	
	4.20	Understand emotions and intentions#	√	
	4.00	Leeloo AAC - Autism Speech App for Non-Verbals	√	
	4.00	LetMeTalk	√	
Low	3.00	Peppy Pals		√
	2.90	MyTalker AAC Tablet Edition talking AAC speech app*		√
	2.70	Talk To Me 100® - Autism*		√

图：截取四个维度中的参与度分析

从参与度、功能性、美学、信息方面这四个方面分析出了7 条设计准则

1. 家长定制：家长可以操作设置难度级别的内容和表达。
2. 界面：界面应该有交互提示，交互应该有反应。
3. 布局：布局应该合乎逻辑，专业，合理，简单，清晰。最好根据用户使用频率来调整布局。
4. 导航：导航逻辑是完整，清晰，直观的屏幕流程。
5. 易用性：应该很容易学习如何使用应用程序来降低错误率。
6. 视觉吸引力：界面的颜色应鲜艳，具有可爱的卡通元素，增加音效，增加儿童的魅力。
7. 信息：信息必须准确，质量和内容最全面。最好添加表达情感和礼貌，友好的表达。

### 3.2 方法二：Double Check 分析用户评分评论

Abdullah 教授说用户评论的分析是在进行重复检验。由于 MARS 量表的分数主观评估，尽管我和侯炎之的信度具有非常高的一致性，但我们并不是自闭症

儿童社交技能应用程序的目标用户人群。因此，从真实用户群的想法分析是十分有必要的。Abdullah 教授建议我们不仅要看用户的评价，同时也要看 APP 下载数量，是否有相关积极和消极的评价，是否有改进的空间，找到建立新的 APP 的设计细节。

### 3.2.1 步骤一：记录

APP	Downloads	Rating	Star Rating	User1
1. Understand emotions and intentions# (T)	463	0	0	
2. Yuudee AAC*	500	3	5	
3. Leeloo AAC - Autism Speech App for Non-	1000	25	3.5	
4. Visual Schedules and Social Stories	1000	14	3.8	
5. SocialSkills for Autism K1oog2*	10000	12	4.2	功能评分（游戏5.0、控制5.0、图像5.0）
6. LetMeTalk	100000	885	4.4	
7. Socky for Autism	5000	31	4.5	
8. Emotion Learning for Autistic	1000	3	2	
9. Niki Talk	10000	200	3.8	
10. Talk UP! Communicator	1000	25	4.9	
11. CommBoards Lite	1000	62	4.4	
12. AngelTalk - AAC for Beginners	1000	23	4.7	
13. SCAI Autismo	5000	51	4	

表：22 个自闭症儿童社交 APP 星级评分、下载量、以及评分数量

### 3.2.2 步骤二：排序

我记录了 22 个 APP 的星级评分、下载量、以及评分数量和评分占比，并将这四个部分分数由高到低进行排序。

User Rating Sort	APP	Star Rating	Star Rating number
1	Yuudee AAC*	5.00	3
2	Talk UP! Communicator	4.90	25
3	AngelTalk - AAC for Beginners	4.70	23
4	Autism Help*	4.60	14
5	Socky for Autism	4.50	31



6	LetMeTalk	4.40	885
7	CommBoards Lite	4.40	62
14	Niki Talk	3.80	200
9	SymboTalk - AAC Talker	4.30	14
10	MyTalker AAC Tablet Edition talking AAC speech app*	4.30	9
11	SocialSkills for Autism Kloog2*	4.20	12
12	SCAI Autismo	4.00	51
13	Visual Schedules and Social Stories	3.80	14
8	SwiftKey Symbols	4.40	198
15	Peppy Pals	3.70	251
16	Autism Speech DiegoSays*	3.60	83
17	Leeloo AAC - Autism Speech App for Non-Verbals	3.50	25
18	Autism speaks by looking at pictures #	3.40	191
19	Talk To Me 100® - Autism*	3.10	34
20	Emotion Learning for Autistic	2.00	3
21	Understand emotions and intentions#(T)	0.00	0
22	DrBrownsApps: Life Skills: What Do You Say?	0.00	0

表：22 个 APP 的星级评分排序

### 3.2.3 步骤三：分析

在和 Abdullah 教授汇报后他建议我们应该找出来 MARS 量表得分高的 APP 同时用户星级评分高的 APP，分析这样优秀的 APP 的设计点是否有值得借鉴的地方。

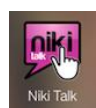
APP	Star Rating	Rating number	MARS Score
6. LetMeTalk	4.40	885	4.00
9. Niki Talk	3.80	200	3.83
16. SwiftKey Symbols	4.40	198	3.26
14. Peppy Pals	3.70	251	3.43
19. Autism speaks by looking at pictures #	3.40	191	3.09

表：用户星级评分高于平均值 3.66 的 APP

通过我的分析我决定用三个条件来确定质量 APP。条件 1: 用户评分大于 97  
条件 2: 用户星级评分高于平均值 3.66。条件 3: MARS 得分大于 3.62 的平均值。



后来只有两个 APP 符合以上 3 个标准。在 Let Me Talk 中，优秀的设计是用户点击照片就是可以发声的内容，播放按钮比较大并且 TTS 效果比



较好。另外一个 APP 的名字是 Niki Talk ，它出色功能是明亮多彩的界面，简单而合理的导航。它主页有两个选项（我想要）和（我的感受）。

### 3.2.4 步骤三：总结

我最后总结出这两个 APP 所存在的优秀共性是

1. 界面丰富多彩、
2. 声音清脆流畅、
3. 说话的卡片分布是合理的、
4. 导航是合乎逻辑且完整的、
5. 父母可编辑模式、
6. 社交内容包含情感表达。

### 3.3 自闭症儿童社交技能 app 的设计指南。

1. 家长可定制：家长可以操作设置难度级别的内容和表达。
2. 布局：布局要合理、专业、合理、简单、清晰。最好根据用户使用布局的频率来调整布局。
3. 导航：导航逻辑完整，清晰直观的流程贯穿始终。
4. 视觉吸引力：界面的颜色应该是明亮的，具有可爱的卡通元素，增加音效，增加孩子的魅力。
5. 信息：信息必须准确、优质、内容最全面。最好增加情感表达和礼貌、友好的表达。

## 4.侯炎之对自闭症儿童学术教育 APP 的设计准则研究

### 4.1 方法一：MARS 量表用来评估应用程序的质量。

#### App Quality Ratings

The Rating scale assesses app quality on four dimensions. All items are rated on a 5-point scale from "1.Inadequate" to "5.Excellent". Circle the number that most accurately represents the quality of the app component you are rating. Please use the descriptors provided for each response category.

##### SECTION A

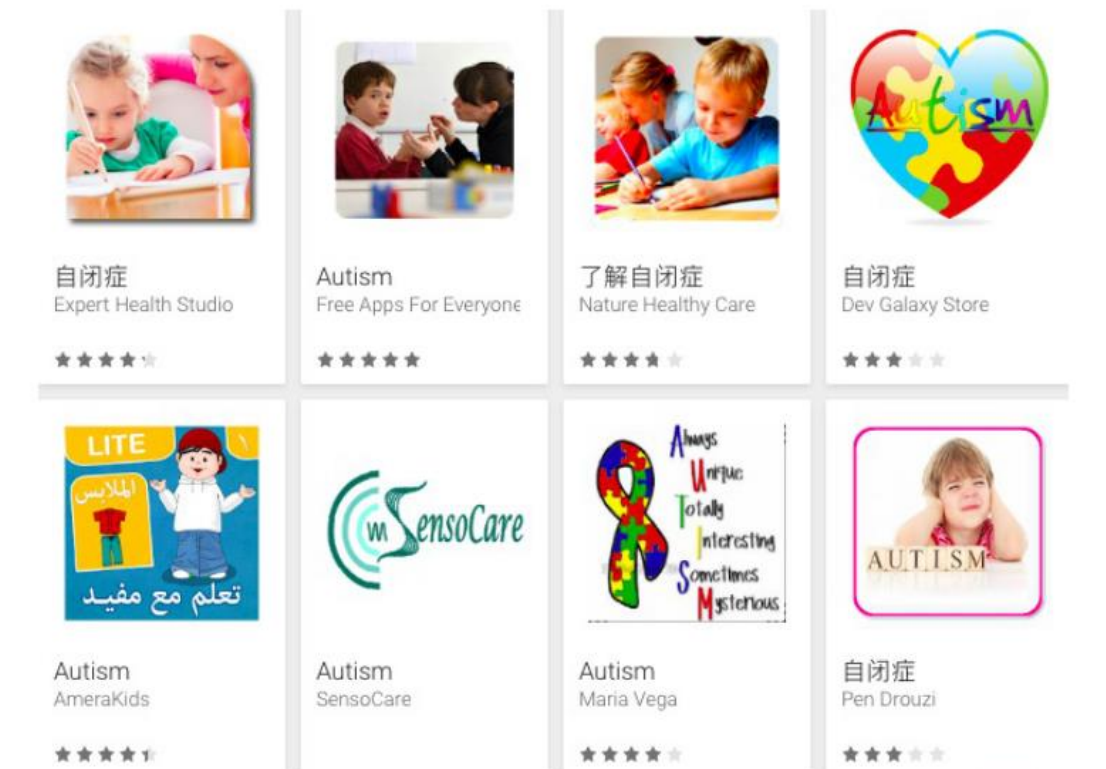
**Engagement – fun, interesting, customisable, interactive (e.g. sends alerts, messages, reminders, feedback, enables sharing), well-targeted to audience**

1. **Entertainment: Is the app fun/entertaining to use? Does it use any strategies to increase engagement through entertainment (e.g. through gamification)?**
  - 1 Dull, not fun or entertaining at all
  - 2 Mostly boring
  - 3 OK, fun enough to entertain user for a brief time (< 5 minutes)
  - 4 Moderately fun and entertaining, would entertain user for some time (5-10 minutes total)
  - 5 Highly entertaining and fun, would stimulate repeat use
  
2. **Interest: Is the app interesting to use? Does it use any strategies to increase engagement by presenting its content in an interesting way?**
  - 1 Not interesting at all
  - 2 Mostly uninteresting
  - 3 OK, neither interesting nor uninteresting; would engage user for a brief time (< 5 minutes)
  - 4 Moderately interesting; would engage user for some time (5-10 minutes total)
  - 5 Very interesting, would engage user in repeat use

图：MARS 量表截图

#### 4.1.1 步骤一：搜索

首先进行系统搜索，是对从澳大利亚访问的基于自闭症儿童的移动应用程序进行系统搜索。该搜索是使用 Google 应用程序搜索功能进行的。谷歌应用程序搜索包括自闭症，自闭症儿童和自闭症学术技能三个关键词。



图： 在应用程序搜索出 750 个应用程序的截图

#### 4.1.2 步骤二：筛选

之后，初步筛选删除重复的应用程序，不相关的应用程序（社交、医疗、音乐、通讯等），非英文也非中文的应用程序以及不易访问的应用程序，应用程序的费用超过 10 美元的程序也被剔除（因为它们不太可能被大量用户购买）。



图：筛选 APP 的记录明细截图

总结一下主要的调查结果，尽管搜索关于自闭症儿童的应用程序确定了 616 个应用程序，不包括重复内容，只有 13 个符合标准。社交技巧、沟通、放松或音乐方面的应用程序可以协助教育，但将它们分类为教育方面的应用程序是不恰当的。

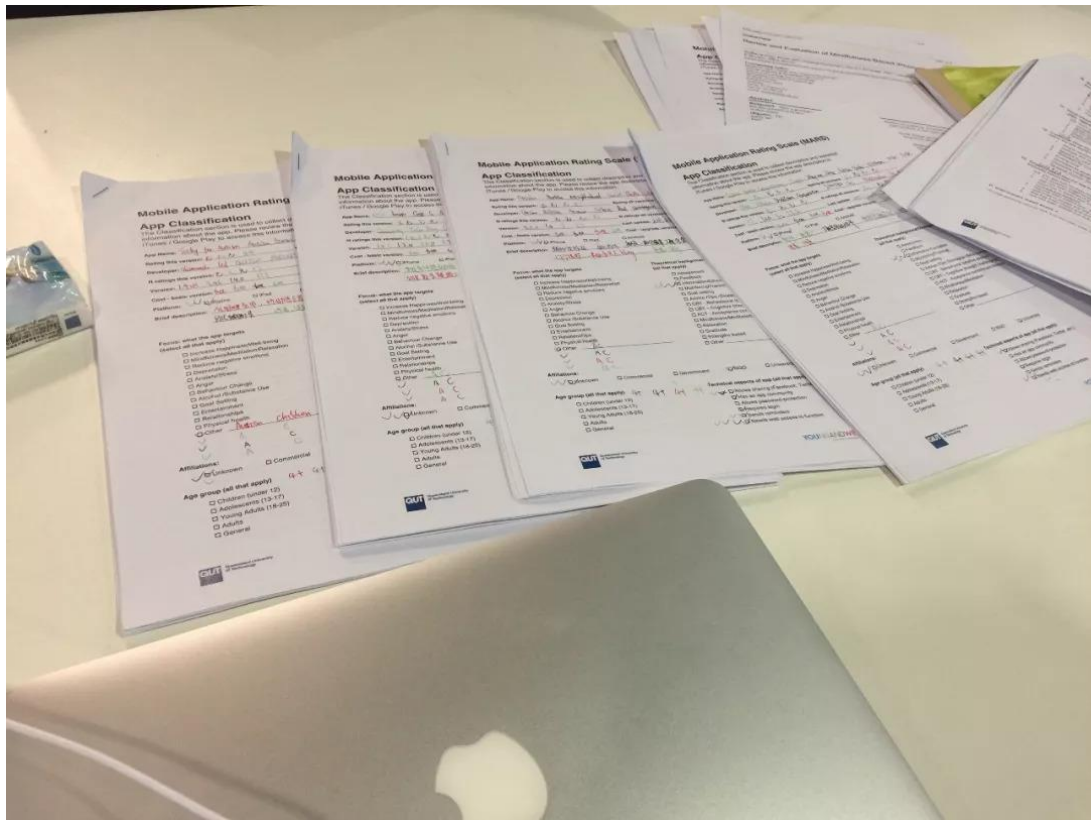
### 4.1.3 步骤三：测量

配合使用的评估工具是 MARS 将选择进入的应用程序通过 iPhone 6Plus 在 iOS 10.3.3 中评分和评审。每个应用程序都由我在现实环境中进行至少 30 分钟的测试。

App	Engagement	Functionality	Aesthetics	Information	Satisfaction	Overall
1.Otsimo	4.4	4.3	4	3.6	4.5	4.16
2.Socky for Autism	3.8	4.3	4	3.1	3.8	3.8
3.Sand Draw	3.4	4.3	3.7	3	3.3	3.54
4.Visual Schedule& Social stories	3.6	4	4	2.9	3	3.5
5.Autism Parenting Magazine	3.4	4	3.7	3.3	3	3.48
6.Autism iHelp-WH Question	3.8	3.8	3.3	3.1	3	3.4
7.Autism iHelp-Play	3.6	4	3	3	3	3.3
8.Autism Speech Sequencing Zapps	3.8	3.8	3.3	2.6	2.8	3.26
9.Lower Case S	2.8	3.5	3.3	2.9	3	3.1
10.Niki Talk	3.2	3.5	3	2.4	2.5	2.92
11.NAS	2.2	3.8	2.7	3.1	2.8	2.92
12.Autism Neighborhood	2.6	3.5	3	2.6	2.3	2.8
13.Autism Speaks Assessment	3.3	1.3	2.7	1.6	1.3	2.04

Table1 MARS Rating

表：13 个 APP 在 MARS 量表四个部分的得分情况



图：在图书馆用 MARS 评估完所有 APP 拍照的记录

#### 4.1.4 步骤四：分析

Otsimo 应用程序具有最高的平均 MARS 总数 (4.2) 和分量表分数。接下来的是 Socky for Autism (3.8)，Sand Draw (3.5) 和 Visual Schedule& Social stories (3.5)。Autism Speaks Assessment 得分最低 (2.0)。MARS 的中位数为 3.3,除一个以外的所有应用程序都达到或超过了 2.8 的最低可接受性分数。

满意度（唯一完全主观的分量表）未包含在总分中。

#	App	Voice interaction	Background music	Parents use ports	Daily life materials	Personality preferences setting	Game	Vision	App community	Social Media	painting
1	Otsimo	✓	✓	✓	✓	✓	✓	✓		✓	
2	Socky for Autism	✓		✓	✓	✓	✓	✓			
3	Sand Draw	✓			✓			✓		✓	✓
4	Visual Schedule& Social stories	✓	✓		✓			✓		✓	
5	Autism Parenting Magazine				✓			✓	✓	✓	
6	Autism iHelp-WH Question	✓			✓	✓	✓	✓			
7	Autism iHelp-Play	✓			✓	✓	✓	✓			
8	Autism Speech Sequencing Zappps	✓	✓		✓		✓	✓			
9	Lower Case S	✓	✓	✓	✓		✓	✓	✓	✓	
10	Niki Talk	✓			✓		✓	✓			✓
11	NAS				✓			✓	✓		
12	Autism Neighborhood				✓			✓	✓		
13	Autism Speaks Assessment				✓					✓	

Table2 Summary of education for children with autism app features

表：13 个 APP 分析分数高和分数低的特征

在高品质的针对自闭症儿童的应用程序的特点方面，我们总结了评估过的应用程序的特征。所有内容都包含日常生活素材，几乎所有的应用程序都提供了图片或视频等非纯文字视觉信息（自闭症儿童对图片反应好，是视觉型的学习者），一个没有视觉信息（Autism Speaks Assessment）。

大多数应用程序包含声音交互（包括语音和与 app 产生接触时出现的声音交互）和游戏模式（不包含绘画）。四个没有声音交互（Autism Parenting Magazine, NAS, Autism Neighborhood 和 Autism Speaks Assessment），六个没有游戏模式（Sand Draw, Visual Schedule& Social stories, Autism Parenting Magazine, NAS, Autism Neighborhood 和 Autism Speaks Assessment）。

六个应用程序提供了一个选项，以分享用户在 Facebook 和 Twitter 等社交网络中的体验（Otsimo, Sand Draw, Visual Schedule& Social stories, Autism Parenting Magazine, Lower Case S 和 Autism Speaks Assessment）。Autism Parenting Magazine, Lower Case S, NAS 和 Autism Neighborhood 有应用程序社区。三款应用程序提供应用程序内购买，其中包括额外的父母端服务，更多的使用工具和专业杂志（Otsimo, Sand Draw 和 Autism Parenting Magazine）。

### 4.1.5 步骤五：四个维度分析

评估应用程序的质量是评估其功效之前的关键步骤。本研究中回顾的 13 个为自闭症儿童提供的应用程序的客观质量中值为 3.3。这表明这些应用程序的质量总体上可以接受。然而，低平均参与度和中等中等美学以及信息分量表评分突出了潜在的改善目标。

App	Engagement
1.Otsimo	4.4
2.Socky for Autism	3.8
3.Autism iHelp-WH Question	3.8
4.Autism Speech Sequencing Zapps	3.8
5.Visual Schedule& Social stories	3.6
6.Autism iHelp-Play	3.6
7.Sand Draw	3.4
8.Autism Parenting Magazine	3.4
9.Autism Speaks Assessment	3.3
10.Niki Talk	3.2
11.Lower Case S	2.8
12.Autism Neighborhood	2.6
13.NAS	2.2

表：13 个 APP 在 MARS 分数的参与度评分

MARS 提供了四个客观量表（参与度，功能，视觉美学，信息质量）和一个主观量表的可靠度量。只有客观质量量表包含在总体应用质量分数中。在目前的研究中，50%的评估应用程序的专家评级具有高级别的评估者可靠性。然而，尽管 MARS 可用于评估现有应用程序的质量，但这并不能取代在自闭症儿童应用程序的设计中使用严格的以用户为中心的设计和以证据为基础的实践。

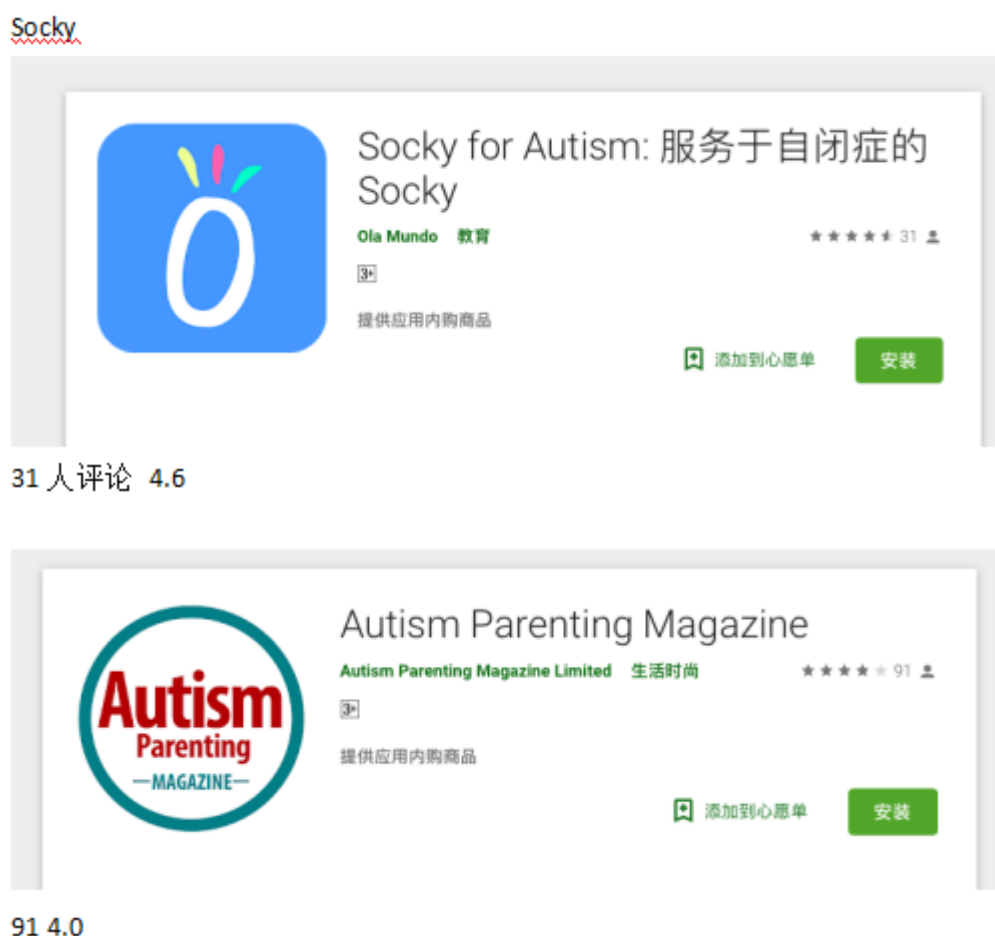
## 4.2 方法二：Double Check 分析用户评分评论

Abdullah 教授给了我们第三篇论文 A Preliminary Evaluation of Android based Alcoholism Apps in the Current App Market 目的是让我和侯炎之模仿这篇论文中的研究方法，主要是分析用户评分评论，Abdullah 教授称这个双检查



double check。我和张宇各自总结出了针对自闭症儿童的教育和社交领域的应用程序的特点，中期研究需要我们再彼此审查对方的应用程序，进行二次核查，再对我们总结出的特点进行归类 and 抽取，以发现针对自闭症儿童的应用程序，无论是什么类型的，谁去设计，都可以使用的设计准则。

### 4.2.1 步骤一：记录



图：对 APP 的评分和评价以及评价次数统计截屏

### 4.2.2 步骤二：分析

记录了 13 个 APP 的星级评分、下载量、评分数量和 MARS 量表的评分，找出来 MARS 量表得分与用户星级评分都高的 APP，分析这样的 APP 的设计点中值

得借鉴的地方。

App	Star Rating	Number of Rating	Number of Comments	MARS's Rating
1.Otsimo	4.1	204	0	4.16
2.Socky for Autism	4.6	31	0	3.8
3.Sand Draw	4.3	75649	42	3.54
4.Visual Schedule& Social stories	3.9	14	0	3.5
5.Autism Parenting Magazine	4.0	91	0	3.48
6.Autism iHelp-WH Question	None	None	0	3.4
7.Autism iHelp-Play	4.0	41	0	3.3
8.Autism Speech Sequencing Zapps	4.5	13	0	3.26
9.Lower Case S	None	None	0	3.1
10.Niki Talk	3.9	200	0	2.92
11.NAS	5	2	0	2.92
12.Autism Neighborhood	None	None	0	2.8
13.Autism Speaks Assessment	1	2	0	2.04

Table11 Double Check

### 4.2.3 步骤三：总结

我最后总结出好的 APP 所存在的优秀共性有：

1. 有声音交互，在自闭症儿童使用 app 的过程中，会有声音的反馈
2. 背景音乐
3. 父母端
4. app 中主要呈现的是日常生活中的素材
5. 个人偏好设置，不同情况的小朋友，可以设置适合自己的声音、内容、昵称和头像等
6. app 内含游戏的形式
7. 视觉图像，自闭症儿童是视觉学习者，图像信息比文字信息更有利于自闭症儿童的学习
8. app 交流社区
9. 社交媒体分享
10. 内含绘画功能

## 5.结论

以下是侯炎之和张宇汇总出 8 条设计准则以及对应每一条准则都有合适的设计详解。希望这套设计准则可以帮助更多的设计师创造出适用于自闭症儿童且体验非常好的应用程序。

Design Principles	Suitable Design
1 Interface image	The interface and pictures of the app designed for autistic children are colorful. Pictures must have realistic and cartoon elements, click on the picture to have sound effects.
2 Amount of information	The content should cover relevant information that is accessible to children with autism. Information must be accurate, rich and high quality.
3 Interactive sound feedback	The autistic children's operator interface should have immediate audible feedback to attract the attention of autistic children with non-irritating sounds.
4 Game	The game image is cartoon, logically simple, interactive, and has background music.
5 Navigation	The navigation logic is clear and complete, throughout the entire process. And the navigation icon should be clear and obvious.
6 Parents use ports	Parents can set learning content, express content and corresponding difficulty.
7 Personality preferences setting	Personalized identity tags, sound size, image size, and how images are laid out.
8 Use tutorial	In order to increase APP usability and reduce the mistakes of children with autism, it is best to use video when you just download and add new features to guide your child and parents about APP layout and features.

## 6.寄语

侯炎之：有两点对之后交换的师弟师妹说，一是国外国内的学业同等重要，都要兼顾。在外国交换的时候，国外的学习是很重要，但是国内的课程同样重要。二是合理规划时间，如果出国交换的时间和秋招的时间重合，国内国外作业又很赶，会出现压力大、疲惫和熬夜的情况。需要自己去调节，不需要惧怕，都是人生的一种经历。交换本身这个经历，也是很重要的一种成长形式，但是这个机会，并不是每个人都会拥有。我记得一句话，经历的越多，懂得越多。



张宇：在澳洲斯威本科技大学交换学习 Abdullah 教授给了我们很多帮助，教授非常 nice，他尊重学生、鼓励学生。他我们项目的汇报都不做正确和错误的评价，教授对我们的项目内容都会评价“非常好，但是如果有一些调整效果会更好”教授会建议我们如何调整，需要我们要继续迭代和改善。在这样的教育方式下，我

们有很多空间去发挥，我认为对创新非常有帮助。



最后对选择校外导师的学弟学妹说，毕业论文一定要上点心，多和导师沟通，甚至主动找校内导师沟通，老师们都非常愿意帮忙哒。出国交换在高密度的国外学习生活可以体验到不同文化的教育方式也会感受到不同教育方式带来的不同成长，如果对自己的要求更高，此时就需要自己有更强烈的主动意识去学习。

## 7.附录

### 7.1 张宇的英文原版论文

# Review and Evaluate Android apps Based on Social Skills for Children With Autism

## *Abstract*

Communication barriers are one of the three major obstacles for children with autism. Improving the social skills of autistic children not only relieves the burden of caretakers (parents of autistic children) but also helps autistic children achieve higher well-being. With the increase in the number of mobile phone users, and the continuous development of applications in various fields. More apps are bringing more lifestyle conveniences to mobile phone users. Children can be educated, play games, and even socialize in many applications. Of course, there are many apps designed for autistic children on the market, and children with autism can learn, play games, and socialize on the program. Mobile phones can be a vehicle to help smoother communication between family members of autistic children. The app can also help children with autism master multiple levels of social skills. Children with autism have special psychological and physiological characteristics, and the application designed for this target group is very difficult. However, there is no authoritative design guidelines in the field of autistic children's applications.

This study looked at two feedback sources (user star rating, MARS App quality score) from the 22 Android autism social skills app in Google Play and China Application of treasure. After data analysis, we expect to know which users have positive or negative reactions to which apps. The purpose of this study was to analyze existing social applications for children with autism in Android to provide design guidelines for future autistic children's applications. The study found five design guidelines for social skills in children with autism

1. Parental customization: Parents can operate to set difficulty level content and expression.
2. The layout: The layout should be logical, professional, reasonable、 simple,and clear.
3. The navigation : The

navigation logic is complete, clear and intuitive screen flow throughout. 4.

Visual appeal: The color of the interface should be bright, with cute cartoon elements, increase the sound effect, and increase the charm of children. 5.

Information: Information must be accurate, quality, and content the most

comprehensive. Best to add expression of emotion and polite, friendly

expression. This study combines the application design guidelines for academic education for autistic children and summarizes the overall design guidelines for applications for target users of autistic children.

## **KEYWORDS**

Autistic child Social skills Mobile application

### **1.Introduction**

#### 1.1 Autistic children and social skills

Autism spectrum disorder (ASD) is defined as a multifaceted, persistent behavior and neurodevelopmental disorder that manifests itself at the beginning or initial stage of childhood. ASD includes Classical Autism (CA), Asperger Syndrome (AS), Child Disintegration Syndrome (CDD), Rett Syndrome (RT), and Generalized Developmental Disorder (PDD) [1]. Signs of injury begin to appear in children with an initial age of 2 or 3 years. Several behavior-based therapists and psychologists initially used several interview-based questionnaires to diagnose ASD and its types [2,3]. Autism has three symptoms: (1) social interaction in the challenge of recognizing and understanding other people's emotions and expressing one's emotions; (2) communication between verbal and non-verbal language; (3) adapting to new Environmental related restrictions or repetitive behavior patterns [4]. People with ASD show delayed development of speech and language [5]. Because of the deterioration of communication, about 50% of people with this disease show any type of functional language deficiency [6]. In addition, interaction and communication with children with autism is challenging because they lack verbal and nonverbal communication skills [7]. Many studies have demonstrated that the ability to learn and communicate can be developed among children with ASD through the use of "assisted techniques" [8]. Studies have shown that children diagnosed at earlier ages have better opportunities for improvement [9]. Therefore, it is important to help autistic children improve their design skills. This study also summarizes the design criteria for applications for children with autism, based on data analysis of the autism academic education application.

#### 1.2 APP for children with autism

In the past decade, we have seen digital technologies, especially mobile phones and smartphones, that have changed the way people around the world communicate and access information. There are more mobile phones than people in the world today [10]. Like other healthcare industries, the digital revolution has also affected the ASD community, as mobile-based software and smartphone/tablet applications are being developed and commercialized for use by patients and their families [11]. And

other healthcare industries. Similarly, the digital revolution has also affected the ASD community, as mobile-based software and smartphone/tablet applications are being developed and commercialized for use by patients and their families [11]. The limited papers that do exist provide encouraging evidence of the potential and feasibility of applications in ASD [12], but generally little is known about the effectiveness of these applications in real-world environments [10]. So explore the current application of social skills for autistic children in the Android market. The quality of the program is very necessary. In the future, there will be many organizations or companies that want to design applications for social skills for children with autism. This study will also explore the commonalities of current and popular applications on the market and provide a reference for future designs.

In this study, our goal was to (1) review the available mobile device applications for social skills for autistic children in Android, (2) analyze them using the MARC scale and user ratings (3) discuss quality. A relatively good application that provides design guidelines for children who are not designed for children with autism.

## **2.Methods**

### **2.1 Phase One: Systematic Search**

A systematic search of Autism Social Skills-based mobile apps accessible from Australia and China was conducted in July 2018. The search was conducted using the Google app search function and the search feature of "Application of treasure" (The Application of Treasure, there are 13.6 billion downloads of android's largest app store, In China). The keywords searched were autism, autistic children and social skills.

The initial screening removes irrelevant applications (academic education, games, paintings, forums, communities, lectures, etc.), non-English, Chinese applications, and applications that are not easily accessible. The application that needs to be spent (affected by research funding). Of course, apps that educate social skills are retained because they are related to social skills.

These apps are scored and reviewed by the Chinese version of the Android phone. Each application is tested by at least one researcher in a real-world environment for at least 30 minutes. And ensure that 30% of the app is rated by two researchers.

### **2.2 Phase 2: App Quality Rating**

MARS [13] was used to assess the quality of the application. It consists of 23 items in 3 parts: classification, application quality and satisfaction [14]. Each MARS project uses a 5-point scale (1 point is insufficient, 2 points is bad, 3 points are acceptable, 4 points are good, and 5 points are excellent) [14]. Classification section: For descriptive purposes only. Quality section: 19 entries from four sections: engagement, functionality, aesthetics and information quality. Subjective quality section: Includes 4 projects that assess overall user satisfaction [14]. The MARS is calculated by calculating the average score of the application quality subscale and the total average score. Subjective quality projects are rated as individual projects [14]. MARS has shown good internal consistency ( $\alpha = 0.92$ ) and inter-rater reliability (ICC = 0.85) [13]. The second researcher evaluated 30% of the applications on MARS to achieve higher reliability [14].



### 2.2.1 Result Of System Search

Searching for Google and "App Treasures" identified 734 applications and 129 applications. There are 366 applications, which are duplicate applications. However, there are 37 inaccessible, 45 are languages other than English and Chinese, and 287 are irrelevant (academic education, painting, games, forums, community, adults, lecture). There are 106 need to pay for downloads, and finally 22 meet the inclusion criteria .

**Table 1.** Systematic search for a social skills search application for autistic children in stores.

Search identified	863
Duplicates	- 366
Irrelevant	- 287
Pay	- 106
language	- 45
Not accessible	- 37
Apps met inclusion criteria and were reviewed	22

### 2.2.2 App Quality

Table 2 shows the subscales and overall scores for applications using MARS ratings. 7 applications (30%) were evaluated by two researchers and had an excellent internal assessment reliability level(Cronbach 's Alpha = 0.93).This apps named Understand emotions and intentions has the highest total number of MARS (4.48).The next highest is Yuudee AAC (4.24), Lee loo AAC(4.22)and Visual Schedules(4.04).My Talker AAC scored the lowest (2.8 ) .

The median of MARS was 3.62, and all but one of the applications met or exceeded the minimum acceptability score of 3.0 . Satisfaction (the only fully subjective subscale) is not included in the total score.

**Table 2.** MARS Rating

APP	Engagement	Functionality	Aesthetics	Information	Satisfaction	Overall
1.Understand emotions and intentions#	4.20	5.00	4.67	4.00	3.75	4.48
2.Yuudee AAC*	4.30	4.25	4.33	4.29	4.00	4.24
3.Lee loo AAC - Autism Speech App for Non-Verbals	4.00	4.75	4.67	4.14	3.75	4.22
4.Visual Schedules	3.80	4.50	4.67	3.86	3.75	4.04
5.SocialSkills for Autism Kloog2*	3.80	4.38	4.50	3.86	4.00	4.04
6.LetMeTalk	4.00	4.75	4.00	4.14	3.00	4.00
7.Socky for Autism	3.80	4.25	4.67	3.71	3.50	3.91
8.Emotion Learning for Autistic	3.60	4.50	4.33	4.00	2.75	3.83
9.Niki Talk	3.20	4.00	4.67	3.86	3.75	3.83

10.Talk UP! Communicator	3.60	4.50	4.33	3.57	2.50	3.65
11.CommBoards Lite	3.50	4.00	4.50	3.57	2.75	3.61
12.AngelTalk - AAC for Beginners	3.80	4.50	4.33	3.43	2.25	3.61
13.SCAI Autismo	3.60	4.50	3.33	3.71	2.50	3.57
14.Peppy Pals	3.00	4.00	4.67	3.29	2.75	3.43
15.DrBrownsApps: Life Skills: What Do You Say?	3.40	4.00	4.00	3.57	2.25	3.43
16.SwiftKey Symbols	3.40	4.00	3.00	3.43	2.25	3.26
17.SymboTalk - AAC Talker	3.20	4.00	3.33	3.57	2.00	3.26
18.Autism Help*	3.10	3.63	3.33	3.43	2.63	3.24
19.Autism speaks by looking at pictures #	3.20	4.00	2.67	3.43	1.75	3.09
20.Talk To Me 100® - Autism*	2.70	3.75	3.17	3.43	2.00	3.04
21.Autism Speech DiegoSays*	3.30	3.25	2.67	3.14	2.38	3.00
22.MyTalker AAC Tablet Edition talking AAC speech app*	2.90	3.13	2.50	3.29	2.00	2.85

# Chinese APP

\* The score is assessed by two raters for reliability purposes and the score is the average of the two raters.

### 2.2.3 Features of High-Quality Autism Social Skills Apps

After analyzing 22 APPs, I found that these APPs can be divided into two categories, Category 1 Autism Communication Assistance System; Category 2 Education Autistic Children Social Skills System, the classification rule is whether users can achieve social communication on the APP or master Social skills.

It can be seen from Table 3 that there are 12 APPs belonging to the Autism Communication Assistance System, and they have at least the following common features. 1-3 points are popular features of APP, 4-8 points are high quality APP features.

1. The sound is clear and slow
2. Bright color, yellow 、 green 、 red
3. Click on the photo to automatically play the sound
4. Courtesy expression
5. Parental editing mode
6. The content is sorted reasonably
7. Auxiliary emotional expression

APP	Emotional expression	Large image	Parental mode	Reasonable ordering	Courtesy expression
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8.	2.Yuudee AAC	✓	✓	✓	✓	✓
Pictures and logos are large	3.Leeloo AAC - Autism Speech App for Non-Verbals	✓	✓			✓
	6.LetMeTalk	✓		✓	✓	
Table 3. Summary of Autism Communication Assistance System apps features.	7.Socky for Autism	✓		✓		
	9.Niki Talk	✓	✓			✓
Table 4. Ther e are 6 apps in Table 4 that help children master social	10.Talk UP! Communicator		✓			
	11.CommBoards Lite	✓	✓	✓	✓	
Table 4. Ther e are 6 apps in Table 4 that help children master social	12.AngelTalk - AAC for Beginners		✓	✓		
	13.SCAI Autismo		✓			✓
Table 4. Ther e are 6 apps in Table 4 that help children master social	16.SwiftKey Symbols	✓		✓		✓
	17.SymboTalk - AAC Talker	✓				
Table 4. Ther e are 6 apps in Table 4 that help children master social	18.Autism Help	✓	✓			
	19.Autism speaks by looking at pictures #	✓	✓			✓
Table 4. Ther e are 6 apps in Table 4 that help children master social	20.Talk To Me 100@ - Autism		✓			
	21.Autism Speech DiegoSays		✓			✓
Table 4. Ther e are 6 apps in Table 4 that help children master social	22.MyTalker AAC Tablet Edition talking AAC speech app		✓			
	# Chinese APP					

skills. They contain at least the following six features, of which 1-3 are popular features of APP, and 4-6 are high quality APP features.

- 1.Social skills teaching
- 2.Story presentation
- 3.Play music
4. Educational method step by step
5. Emotional adjustment methods
6. Game mode

**Table 4.** Summary of Education Autistic Children Social Skills System apps features.

Social skills education	Emotion regulation	The game	The story	music	Educational method step by step
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1.Understand emotions and intentions#	✓	✓	✓	✓	✓
4.Visual Schedules	✓			✓	✓
5.SocialSkills for Autism Kloog2	✓	✓	✓	✓	✓
8.Emotion Learning for Autistic	✓		✓	✓	✓
14.Peppy Pals		✓	✓	✓	✓
15.DrBrownsApps: Life Skills: What Do You Say?	✓			✓	

### 2.2.4 Comparative analysis

MARS evaluates the quality of APP from four parts: participation, function, aesthetics and information quality, so it is necessary to compare the highest-rated APP among the four parts to the lowest-rated APP. The reason for analyzing the high score is the criterion for this part of the APP design.

Table 5 is the highest and lowest APP comparison analysis in the performance of the Engagement score in MARS. The commonality of the highest-scoring APPs is Parental customization, which is designed to help parents develop usage habits and increase expressions. This adds to the user's sense of participation. The commonality of the lowest score APP is that the content of the APP cannot be added or changed.

Table 5. APP comparison analysis in the performance of the Engagement.

Engagement	Socre	Name	Parental customization	Content cannot be edited
High	4.30	Yuudee AAC*	✓	
	4.20	Understand emotions and intentions#	✓	
	4.00	Leeloo AAC - Autism Speech App for Non-Verbals	✓	
	4.00	LetMeTalk	✓	
Low	3.00	Peppy Pals		✓
	2.90	MyTalker AAC Tablet Edition talking AAC speech app*		✓
	2.70	Talk To Me 100® - Autism*		✓

In Table 6, it can be seen that in Functionality, the feature with the highest score of APP is The navigation logic is clear and intuitive screen flow throughout. The feature that exists in the lowest-rated APP is Low ease of use, limited instructions; menu Icons are confusing and complicated.

Table 6. APP comparison analysis in the performance of the Functionality

Functionality	Socre	Name	The navigation logic is clear and intuitive screen flow throughout	Low ease of use , limited instructions; menu icons are confusing and complicated.
---------------	-------	------	--	---

High	5.00	Understand emotions and intentions#	√
	4.75	Leeloo AAC - Autism Speech App for Non-Verbals	√
	4.75	LetMeTalk	√
Low	3.13	MyTalker AAC Tablet Edition talking AAC speech app*	√
	3.25	Autism Speech DiegoSays*	√
	3.63	Autism Help*	√

In Table 7, the APP's highest performance in Aesthetics has the commonality of the interface layout and the consistent picture design style, but the commonality in the worst performing APP is that the interface color is boring, unattractive, and the picture is no more than two colors, and there is no cartoon cute character.

**Table 7.** APP comparison analysis in the performance of the Aesthetics

Aesthetics	Socre	Name	Reasonable layout	Consistent image design style	No more than 2 colors	No cute cartoon image
High	4.67	Understand emotions and intentions#	√	√		
	4.67	Leeloo AAC - Autism Speech App for Non-Verbals	√	√		
	4.67	Visual Schedules	√	√		
	4.67	Socky for Autism	√	√		
	4.67	Niki Talk	√	√		
	4.67	Peppy Pals	√	√		
Low	3.00	SwiftKey Symbols			√	√
	2.67	Autism speaks by looking at pictures#			√	√
	2.67	Autism Speech DiegoSays*			√	√
	2.50	MyTalker AAC Tablet Edition talking AAC speech app*			√	√

The comparative analysis in Table 8 is that the commonality of the highest-rated App in Information is that the information is of high quality and richly covers all the scenarios in which the user needs to socialize. The commonality in the lowest-rated APPs is that they do not express emotions.

Expressing emotions is a very important part of autistic children's social interaction.

**Table 8.** APP comparison analysis in the performance of the information

Information	Score	Name	Quantity of information: Comprehensive and concise	No emotional expression
High	4.29	Yuudee AAC*	√	
	4.14	Leeloo AAC - Autism Speech App for Non-Verbals	√	
		LetMeTalk	√	
Low	3.14	Autism Speech DiegoSays*		√
	3.29	MyTalker AAC Tablet Edition talking AAC speech app*		√
		3.29	Peppy Pals	

### 2.3 Phase 3:User Star Rating

Since the MARS scale is a subjective assessment by the researchers, although the two researchers have very consistent consistency and the researcher has experience in user experience design, the researcher is not a user of the social skills app for autistic children. Therefore, it is necessary to analyze the current user ratings of 22 APPs. From the feedback of users, we hope to see what kind of design users will think that APP is good.

Table 9 is a record of the user's star rating. The average number of users of the 22 APPs is about 97. The number of people above 97 is defined as a reliable score. APPs below 97 will not be considered. There are three conditions to determine the quality of the APP, condition one: the user rating is greater than 97; condition two: the user star rating is greater than the average of 3.66; condition three: the MARS score is greater than the average of 3.62. Finally only two APP (Let Me Talkand Niki Talk) meet the above three criteria.

User Rating Sort	APP	Star Rating	Star	Rating number
1	Yuudee AAC*	5.00		3
2	Talk UP! Communicator	4.90		25
3	AngelTalk - AAC for Beginners	4.70		23
4	Autism Help*	4.60		14
5	Socky for Autism	4.50		31
6	LetMeTalk	4.40		885
7	CommBoards Lite	4.40		62
14	Niki Talk	3.80		200
9	SymboTalk - AAC Talker	4.30		14
10		4.30		9

MyTalker AAC Tablet Edition talking AAC speech app*			
11	SocialSkills for Autism Kloog2*	4.20	12
12	SCAI Autismo	4.00	51
13	Visual Schedules and Social Stories	3.80	14
8	SwiftKey Symbols	4.40	198
15	Peppy Pals	3.70	251
16	Autism Speech DiegoSays*	3.60	83
17	Leeloo AAC - Autism Speech App for Non-Verbals	3.50	25
18	Autism speaks by looking at pictures #	3.40	191
19	Talk To Me 100® - Autism*	3.10	34
20	Emotion Learning for Autistic	2.00	3
21	Understand emotions and intentions# (T)	0.00	0
22	DrBrownsApps: Life Skills: What Do You Say?	0.00	0

**Table 9.** Record of the user's star rating.

In Let Me Talk, the user clicks on the photo to be the content that can be voiced., the play button is quite big, and the TTS clear effect is quite good . And the outstanding features in Niki Talk are bright and colorful interface, simple and logical navigation. The home page has two entries (I want) and (I am). In Table 10, it is concluded that the 6-point feature is common to the two APPs that have higher scores for user ratings after Double check.

**Table 10.**A summary of the common features of Let Me Talk and Niki Talk

Common features of two Double Check premium apps	
1	The interface is colorful
2	The sound is crisp and smooth
3	Express card sorting is reasonable
4	Navigation is logical and complete throughout
5	Parent editable mode
6	Card content contains emotional expression

## 2.4 Phase 4:Analysis Education APP

In this project, the main goal of the research on social skills mobile applications for children with

autism is to summarize the excellent design guidelines. This project has conducted an extended study to analyze the design criteria for mobile app design for autistic children's academic education by combining the previously designed design guidelines for autistic children's social skills applications. The extended study led to a mobile application design guideline for the overall population of autistic children. In future designs, designers can choose the appropriate guidelines to follow.

Design guidelines for academic education app for autistic children summarized by Yazmin 1. Voices when interacting.2. Background music .3. Parent port .4. Daily life material. 5. Personal preference setting .6. Game. 7. Visual image. 8. Painting. 9. Community .10 share to social media. The design guidelines for social skills for autistic children in my project are 1. Parental Customization: Parents set the difficulty level of the content and table. 2. Layout: The layout should be logical, professional, reasonable, concise and clear. 3 Navigation: It is complete, clear, and throughout. 4. Visual appeal: the interface is colorful, with cute cartoon elements, increasing the sound effect and increasing the appeal to children. 5. Information: The information is accurate, high quality and comprehensive.

By analyzing the characteristics of academic education applications for children with autism with high MARS scores and talking to Yazmin, we found that our design guidelines have many things in common. We believe that the common characteristics of good education and social applications are design guidelines. Of course, there are many different characteristics of good education and social applications. We also add the criteria that make the characteristics very suitable for children with autism to the final design guidelines. . The final design guidelines are shown in Table 11.

Design Principles	Suitable Design
1 Interface image	The interface and pictures of the app designed for autistic children are colorful. Pictures must have realistic and cartoon elements, click on the picture to have sound effects.
2 Amount of information	The content should cover relevant information that is accessible to children with autism. Information must be accurate, rich and high quality.
3 Interactive sound feedback	The autistic children's operator interface should have immediate audible feedback to attract the attention of autistic children with non-irritating sounds.
4 Game	The game image is cartoon, logically simple, interactive, and has background music.
5 Navigation	The navigation logic is clear and complete, throughout the entire process. And the navigation icon should be clear and obvious.
6 Parents use ports	Parents can set learning content, express content and corresponding difficulty.
7 Personality preferences setting	Personalized identity tags, sound size, image size, and how images are laid out.
8 Use tutorial	In order to increase APP usability and reduce the mistakes of children with autism, it is best to use video when you just download and add new features to guide your child and parents about APP layout and features.

**Table11** .Design Principles (The commonality of the excellent social and educational APP for autistic children)

### 3 Conclusion and Next Step

In summary, we used two methods to analyze the app of 22 social skills of autistic children on Android phones. Seven common features were analyzed from APPs with good MARS scores. There are parents setting mode, timely interaction, clear and reasonable layout, complete navigation logic, easy



APP usability, colorful interface with cartoon image, comprehensive information quality and high emotional content. The user's star rating is analyzed to perform a double check on the APP. It is found that the characteristics of the user with a high star rating and the characteristics of the high score APP analyzed by the MARS score are similar.

This study combines the application design guidelines for academic education for autistic children and summarizes the overall design guidelines for applications for target users of autistic children.

In the future design, these five features can be called the design guidelines for social skills APP for children with autism.

1. Parental customization: Parents can operate to set difficulty level content and expression. People's understanding of autistic children has also been deepened, and their attention has gradually changed from "supporting individuals" to "supporting families", in order to improve their family functions and promote the better development of autistic children[15].

2. The layout: The layout should be logical, professional, reasonable、 simple,and clear. It's best to keep adjusting the layout based on how often users use it. Through the symbolic and visual art form, the designer clearly and accurately expresses the information connotation of image symbols, and the successful design of image symbols will bring users a new visual enjoyment and operation experience[16].

3. The navigation : The navigationlogic is complete、 clear and intuitive screen flow throughout. In mobile interface design, the use of various menu controls to simplify the interface is attractive to designers -- especially on small screen devices[17].

4. Visual appeal: The color of the interface should be bright, with cute cartoon elements, increase the sound effect, and increase the charm of children. Children with autism also have a special preference for color, which can also help stimulate their vision[18].

5. Information: Information must be accurate, quality, and content the most comprehensive. Best to add expression of emotion and polite 、 friendly expression. There are persistent deficiencies in social communication and social interaction, manifested as the following. Social affective disorder. For example, abnormal social contact and the inability to have regular conversations back and forth reduces interest, mood, or emotion Cannot initiate or respond to social interactions. 2. The defect of nonverbal communication in social interaction. For example, language and nonverbal communication are difficult to integrate, abnormal eye contact and Body language or difficulty in understanding and using gestures, complete lack of facial expressions and nonverbal communication. 3. Develop, maintain and understand the defects of relationships. For example, it's hard to adjust your behavior to social situations and share your thoughts The elephant has difficulty in playing or making friends and lacks interest in his companions[19].

Next, we will conduct user research in China, collect user needs and try to design an app that enhances the social skills of children with autism.

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## 7.2 侯炎之的英文原版论文

# Review and Evaluation of Education for Children with Autism Mobile Apps

### *Abstract*

**Background:** A growing body of evidence suggests that children with autism can have a positive impact by using mobile apps for education. While there are hundreds of such apps, there is little information on their quality.

**Objective:** This study aimed to conduct a systematic review of education for children with autism mobile apps and to evaluate their quality using a recently-developed expert rating scale, the Mobile Application Rating Scale (MARS). It also aimed to describe features of selected high-quality education for children with autism apps.

**Methods:** A search for “Autism” was conducted in Apple store and Google Apps Marketplace. Apps that provided training and education were included. Those containing only social skills, medical, music or communications were excluded. An expert rater reviewed and rated app quality using the MARS engagement, functionality, visual aesthetics, information quality and subjective quality subscales. A second rater provided MARS ratings on 50% of the apps for inter-rater reliability purposes.

**Results:** The “autism” search identified 750 apps. However, 137 were duplicates, 9 were not accessible and 72 were neither in English nor in Chinese. Of the remaining 532, 13 apps met inclusion criteria and were reviewed. The median MARS score was 3.3 (out of 5.0), which exceeded the minimum acceptable score (2.8). The Otsimo app had the highest average score (4.16), followed by Socky for Autism (3.8), Sand Draw (3.54) and Visual Schedule& Social stories (3.5). There was a high level of inter-rater reliability between the two MARS raters.

**Conclusions:** Though many apps claim to be children with autism-related, most were only social skills, medical, music or communications. Very few had high ratings on the MARS subscales of visual aesthetics, engagement, functionality or information quality. Little evidence is available on the efficacy of the apps in developing mindfulness.

## **KEYWORDS**

Children with autism; mobile apps; education; health

## *Introduction*

### **Background**

Autism is a disease of developmental disorder. The course of disease lasts for a lifetime, it is difficult to reverse, and the prevalence rate is increasing year by year. It has caused enormous economic and social burden to the family and

society of patients [1]. Autism as a general neurodevelopmental disorder, biomedical science has not yet provided clear etiological conclusions and targeted drug treatments [2].

According to data released by the Centers for Disease Control and Prevention in late 2009, the incidence of autism in American children is nearly one percent. In other countries and regions of the world, the incidence of autism is also on the rise.

In general, the physical, physiological and psychological development of autistic children have certain defects, and the obstacles in thinking are one of the important signs of children with autism. Many of the children with autism are middle-heavy and non-healthy children. These children have various defects in physical development and intelligence. These defects make these children's educational adaptability poor. There are major difficulties in the exchange and communication between the students [3].

## **Apps for Health**

The global prevalence and burden of mental disorders is substantial, and delivering mental health services effectively to millions in need remains a challenge [4]. While Web-based interventions are gaining empirical support [5], mobile interventions are still in their infancy [6]. Mobile health (mHealth) is an emerging field that uses wireless technologies such as mobile phones and other devices in health practice. The advent of apps has created new opportunities. Smartphones can keep the user connected to the Internet at all times. Smartphones and apps provide computing facility comparable to personal computers and software with the advantage of mobility.

In the past decade, we have seen digital technologies, especially mobile phones and smartphones, that have changed the way people around the world communicate and access information. There are more mobile phones than people in the world, and the use of smartphones is growing rapidly [7]. In a 2015 study, smartphones accounted for 25% of total Web usage. A study [8] by Australia in the past reported that 88% of respondents used websites or apps on their mobile phones and predicted that 92% of respondents had smartphones by October 2015. Global mobile app downloads are expected to reach 269 billion by 2017 [9]. Young people's smartphone usage is particularly high: the Australian Communications and Media Authority reported that in May 2013, 89% of people aged 18-24 had smartphones, and 83% of the age group had been in the past six months. Have downloaded the app [10].

With the continuing shortage of child psychiatrists around the world, the potential for providing or increasing the services and technology of autism

spectrum disorders is enormous. Like other healthcare industries, the digital revolution has also affected communities of autism spectrum disorders, as mobile-based software and smartphone/tablet applications are evolving and used by patients and their families [11]. However, few autism spectrum disorders applications have been formally tested or documented to test their actual use during patient use. But the limited papers that do exist provide encouraging evidence for the potential and feasibility of applications in autism spectrum disorders [12].

## *Methods*

### **Systematic Search**

A systematic search of education for children with autism mobile apps accessible from Australia was conducted in June 2018. The search was conducted using the Google app search function as well as the search feature in the Apple store. The Google search included autism, children with autism, and academic skills autism. “Autism” and “children with autism” were the search term used in Apple store, as the search feature was more limited.

Preliminary screening removed irrelevant apps (social skills, medical, music, communications, etc.), apps neither English nor Chinese, and those that were not readily accessible, and were apps that cost more than \$10 (on the grounds that they were unlikely to be purchased by a large number of users).

The apps were rated and reviewed in iOS 10.3.3 with an iPhone 6Plus. Each app was tested by at least one author for a minimum of 30 minutes in a real-world setting.

### **Measures/Rating Tool**

The MARS [1] was used to rate app quality. It contains 23 items in 3 sections: classification, app quality, and satisfaction. Each MARS item uses a 5-point scale (1-Inadequate, 2-Poor, 3-Acceptable, 4-Good, 5-Excellent). The classification section is only for descriptive purposes. The 19-item app quality section rates apps on four subscales: engagement, functionality, aesthetics, and information quality. The subjective quality section contains 4 items evaluating the user’s overall satisfaction. The MARS is scored by calculating the mean scores of the app quality subscales and the total mean score. The subjective

quality items are scored separately as individual items. The MARS has demonstrated excellent internal consistency ( $\alpha=0.92$ ) and interrater reliability (ICC=.93) [13]. A second rater reviewed and rated 50% of the apps on the MARS for interrater reliability purposes (Table 1).

App	Engagement	Functionality	Aesthetics	Information	Satisfaction	Overall	Author's rating
1.Otsimo	5	4.3	4.3	3.1	3.8	4.1↓	4.16
2.Visual Schedule& Social stories	4	4	4	3.1	3.5	3.72↑	3.5
3.Sand Draw	4	3.8	4	3	3.5	3.66↑	3.54
4. Autism iHelp-WH Question	3.2	4	3.3	3	3.3	3.36↓	3.4
5.Autism Speech Sequencing Zapps	3.6	3.5	3.7	3.1	2.8	3.34↓	3.26
6. Autism iHelp-Play	2.8	4.3	3.3	3	3	3.28↓	3.3
7. Lower Case S	3.2	4.3	3.3	3	2.3	3.22↑	3.1

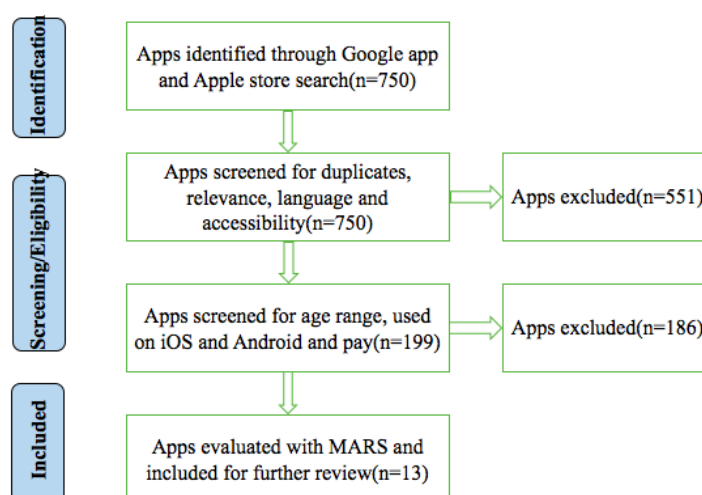
Table1 MARS Rating of the Second Expert

## Results

### Systematic Search

The Google and Apple searches identified 750 apps (Figure 1). Excluding duplicates, there were 613 apps. However, 9 were not accessible, 72 were in languages neither English or Chinese, and 333 were not relevant (ie music/relaxation, social skills, medical, communications, etc). Of the remaining 199 apps, 13 met the inclusion criteria. Excluded apps comprised those age range is not 6-12 years old (60), not be used on iOS and Android (39). Exclude all paid apps, but there may be in-app purchases(87).

Figuer1. Systematic search for education about children with autism apps



### App Quality

Table 2 shows the subscale and overall scores of apps rated with MARS. Since most apps do not present a definitive efficacy study on Google, it is not possible to guarantee item 19 a correct and valid rating. Seven apps (50%) were evaluated by two expert MARS raters, and there was an excellent level of interrater reliability (two-way mixed ICC=.93).

The Otsimo app had the highest average MARS total (4.16) and subscale scores. The next highest were Socky for Autism (3.8), Sand Draw (3.54) and Visual Schedule& Social stories (3.5). Autism Speaks Assessment scored the lowest (2.04). The median MARS was 3.3, and all but one of the apps met or beat the minimum acceptability score of 2.8. Satisfaction (the only totally subjective subscale) was not included in the overall score.

## Features of High-Quality Apps

Features of the reviewed apps are summarized in Tables 3. All content includes daily life materials.

Table2 MARS Rating

App	Engagement	Functionality	Aesthetics	Information	Satisfaction	Overall
1.Otsimo	4.4	4.3	4	3.6	4.5	4.16
2.Socky for Autism	3.8	4.3	4	3.1	3.8	3.8
3.Sand Draw	3.4	4.3	3.7	3	3.3	3.54
4.Visual Schedule& Social stories	3.6	4	4	2.9	3	3.5
5.Autism Parenting Magazine	3.4	4	3.7	3.3	3	3.48
6.Autism iHelp-WH Question	3.8	3.8	3.3	3.1	3	3.4
7.Autism iHelp-Play	3.6	4	3	3	3	3.3
8.Autism Speech Sequencing Zapps	3.8	3.8	3.3	2.6	2.8	3.26
9.Lower Case S	2.8	3.5	3.3	2.9	3	3.1
10.Niki Talk	3.2	3.5	3	2.4	2.5	2.92
11.NAS	2.2	3.8	2.7	3.1	2.8	2.92
12.Autism Neighborhood	2.6	3.5	3	2.6	2.3	2.8
13.Autism Speaks Assessment	3.3	1.3	2.7	1.6	1.3	2.04



#	App	Voice interaction	Background music	Parents use ports	Daily life materials	Personality preferences setting	Game	Vision	App community	Social Media	painting
1	Otsimo	✓		✓	✓	✓	✓	✓			
2	Socky for Autism	✓		✓	✓	✓	✓	✓			
3	Sand Draw	✓			✓			✓		✓	✓
4	Visual Schedule& Social stories	✓	✓		✓			✓		✓	
5	Autism Parenting Magazine				✓			✓	✓	✓	
6	Autism iHelp-WH Question	✓			✓	✓	✓	✓			
7	Autism iHelp-Play	✓			✓	✓	✓	✓			
8	Autism Speech Sequencing Zapps	✓	✓		✓		✓	✓			
9	Lower Case S	✓	✓	✓	✓		✓	✓	✓	✓	
10	Niki Talk	✓			✓		✓	✓			✓
11	NAS				✓			✓	✓		
12	Autism Neighborhood				✓			✓	✓		
13	Autism Speaks Assessment				✓					✓	

Table3 Summary of education for children with autism app features

Almost all applications provide non-pure text information such as pictures or videos (children with autism respond well to pictures, are visual learners), and only one have no visual information (Autism Speaks Assessment). Because children with autism respond well to pictures and are visual learners, most applications provide text and video to interact with autistic children, and few applications (such as the Autism Speaks Assessment) offer only text. Otsimo mentions the use of applied behavior analysis to break down the skills to be learned into executable behavioral units. This design has a theoretical basis.

The majority of apps contained voice interaction (including voice and sound interactions when making contact with the app) and game mode (without painting). Four did not have voice interaction (Autism Parenting Magazine, NAS, Autism Neighborhood, and Autism Speaks Assessment) and six did not have game mode (Sand Draw, Visual Schedule& Social stories, Autism Parenting Magazine, NAS, Autism Neighborhood, and Autism Speaks Assessment).

Four apps provided personality preferences setting (Otsimo, Socky for Autism, Autism iHelp-WH Question and Autism iHelp-Play). Otsimo provides two ports for parents and children. The Applied Behavior Analysis is used to decompose the skills to be learned into executable behavior units. Parents can set different content, and several stages must be unlocked. Many specific details can be customized. Socky provides two ports for parents and children. Parents and children can communicate on this platform, enter the mailbox to create an account, set a password, and set personal avatar and nickname. Autism iHelp-WH Question has basic options, whether random, whether there is audio, audio type is male or female, whether to present home-next page buttons, whether to present question text, whether to render answer text, present a few answers. Autism iHelp-Play also has basic options, whether to render image name, whether it is random image, whether there is audio, audio type is male or female, whether there is game audio.

Six apps provided an option to share the user’s experience in social networks such as Facebook and Twitter (Otsimo, Sand Draw, Visual Schedule& Social stories, Autism Parenting Magazine, Lower Case S, and Autism Speaks Assessment). Autism Parenting Magazine, Lower Case S, NAS, and Autism Neighborhood had an app community. Three apps provided in-app purchase that included additional parents use ports, more use of tools and professional magazines (Otsimo, Sand Draw, and Autism Parenting Magazine).

## Features of Subscale

Table4 MARS Rating in Engagement

App	Engagement
1.Otsimo	4.4
2.Socky for Autism	3.8
3.Autism iHelp-WH Question	3.8
4.Autism Speech Sequencing Zapps	3.8
5.Visual Schedule& Social stories	3.6
6.Autism iHelp-Play	3.6
7.Sand Draw	3.4
8.Autism Parenting Magazine	3.4
9.Autism Speaks Assessment	3.3
10.Niki Talk	3.2
11.Lower Case S	2.8
12.Autism Neighborhood	2.6
13.NAS	2.2

In engagement (Table 4), the scores of the four apps are higher (Otsimo, Socky for Autism, Autism iHelp-WH Question and Autism Speech Sequencing Zapps). These apps are fun/entertaining and interesting and use strategies to increase engagement through entertainment (e.g. through gamification) or presenting its content in an interesting way. They provide/retain all necessary settings/preferences for apps features (e.g. sound, content, notifications, etc.) and allow user input, provide feedback, contain prompts (reminders, sharing options, notifications, etc.). These apps content (visual information, language, design) are appropriate for your target audience. The scores of the three apps are lower (Lower Case S, Autism Neighborhood and NAS). They are not fun, interesting, customisable, interactive (e.g. sends alerts, messages, reminders, feedback, enables sharing) and well-targeted to audience.

Table5 MARS Rating in Functionality

App	Functionality
1.Otsimo	4.3
2.Socky for Autism	4.3
3.Sand Draw	4.3
4.Visual Schedule& Social stories	4
5.Autism Parenting Magazine	4
6.Autism iHelp-Play	4
7.Autism iHelp-WH Question	3.8
8.Autism Speech Sequencing Zapps	3.8
9.NAS	3.8
10.Lower Case S	3.5
11.Niki Talk	3.5
12.Autism Neighborhood	3.5
13.Autism Speaks Assessment	1.3

In functionality (Table 5), the scores of the six apps are higher (Otsimo, Socky for Autism, Sand Draw, Visual Schedule& Social stories, Autism Parenting Magazine and Autism iHelp-Play). These apps have good response and no technical bugs found. Users are able to use immediately; intuitive; simple. They have perfectly logical, easy, clear and intuitive screen flow throughout, or offers shortcuts and interactions (taps/swipes/pinches/scrolls) are consistent and intuitive across all components/screens. The scores of the one apps are lower (Autism Speaks Assessment). The app functioning, navigation, flow logic, and gestural design is bad. Meanwhile, the app is not easy to learn.

Table6 MARS Rating in Aesthetics

App	Aesthetics
1.Otsimo	4
2.Socky for Autism	4
3.Visual Schedule& Social stories	4
4.Sand Draw	3.7
5.Autism Parenting Magazine	3.7
6.Autism iHelp-WH Question	3.3
7.Autism Speech Sequencing Zapps	3.3

8.Lower Case S	3.3
9.Autism iHelp-Play	3
10.Niki Talk	3
11.Autism Neighborhood	3
12.NAS	2.7
13.Autism Speaks Assessment	2.7

In aesthetics (Table 6), the scores of the three apps are higher (Otsimo, Socky for Autism and Visual Schedule& Social stories). The buttons/icons/menus/content on the screen of these apps are professional, simple, clear, orderly, logically organized, device display optimized. Every design component has a purpose. The quality/resolution of graphics used for buttons/icons/menus/content is high and visual design is proportionate, stylistically consistent throughout. They have high level of visual appeal, seamless graphics and consistent and professionally designed. The scores of the two apps are lower (NAS and Autism Speaks Assessment). In graphic design, overall visual appeal, color scheme, and stylistic consistency, they are not up to standard.

Table7 MARS Rating in Information

App	Information
1.Otsimo	3.6
2.Autism Parenting Magazine	3.3
3.Socky for Autism	3.1
4.Autism iHelp-WH Question	3.1
5.NAS	3.1
6.Sand Draw	3
7.Autism iHelp-Play	3
8.Visual Schedule& Social stories	2.9
9.Lower Case S	2.9
10.Autism Speech Sequencing Zapps	2.6
11.Autism Neighborhood	2.6
12.Niki Talk	2.4
13.Autism Speaks Assessment	1.6

In information (Table 7), the scores of the two apps are higher (Otsimo and Autism Parenting Magazine). These apps have highly accurate description of

the app components/functions and specific, measurable and achievable goals (in app store). Apps content are correct, well written, and relevant to the goal/topic of the app. Quantity of information is the extent coverage within the scope of the app and comprehensive but concise. Visual explanation of concepts through charts/graphs/images/videos, etc. is clear, logical, correct and apps come from a legitimate source. The scores of the one apps are lower (Autism Speaks Assessment). The app does not contain high quality information (e.g. text, feedback, measures, references) from a credible source. It's worth noting that these apps don't present a reliable Evidence base. Apps do not have been trialled and outcome tested in > 3 high quality RCTs indicating positive results.

Table8 MARS Rating in Satisfaction

App	Satisfaction
1.Otsimo	4.5
2.Socky for Autism	3.8
3.Sand Draw	3.3
4.Visual Schedule& Social stories	3
5.Autism Parenting Magazine	3
6.Autism iHelp-WH Question	3
7.Autism iHelp-Play	3
8.Lower Case S	3
9.Autism Speech Sequencing Zapps	2.8
10.NAS	2.8
11.Niki Talk	2.5
12.Autism Neighborhood	2.3
13.Autism Speaks Assessment	1.3

In satisfaction (Table 8), the scores of the one apps are higher (Otsimo). Users would recommend this app to many people even everyone and use this app in the next 12 months >50 if it was relevant. People are willing to pay for the app and think this is one of the best apps. The scores of the one apps are lower (Autism Speaks Assessment). People don't think this is a good app, they don't want to pay for it, and they don't recommend it to others.

## *Discussion*

### **Principal Findings**

Though the search for autism apps identified 616 apps, excluding duplicates, only 13 standards compliant. Social skills, communication, relaxation, or music apps can assist in education, but categorizing them as education apps is inappropriate.

The lack of life skills for school-age children with autism not only burdens schools, families, and society, but also has a profound impact on their future independent living, self-efficacy, and quality of life [14]. Autistic children use educational apps to train a habit and daily life skills that requires regular practice and sustained effort to be effective. This is a challenge for both face-to-face and app-based educational training. Autism seriously affects the child's ability to live independently and communicate. Therefore, accurate assessment and training of self-care ability in rehabilitation therapy is one of the important contents to measure the progress of children [15]. Educational apps designed for children with autism provide 24/7 access to practice. Interactive mobile applications and aesthetically pleasing and well-designed apps are likely to be more effective in engaging the user in regular mindfulness practice. Otsimo, Socky for Autism, Autism iHelp-WH Question and Autism Speech Sequencing Zapps exceeded the minimum acceptable level score (3.0) on the MARS engagement subscale. These apps had high-quality graphics, simple and easy-to-use interfaces, and soothing interactive voices. Otsimo visually presents a dynamic, diffused star that complements the autistic children's eyes and nowhere to stay after interacting with the app. Unlike most apps that used a linear menu style, Socky for Autism used an interesting collapsible circular menu to choose the daily pictures. The low median score of the reviewed apps on the MARS engagement subscale, highlights the need to focus on engagement and motivation during the design process.

Empirical studies have shown that children with autism are more likely to accept stimuli in visual space, and children with autism have visual sensory learning advantages [16]. In the existing leisure skills intervention strategy for children with autism, the visual cue strategy is to use visual media such as photos, pictures, texts, line drawings, patterns, signs, schedules, calendars, work plans, etc. To make it known what to do and what to do in the future, this strategy is in line with the advantages of visual learning for autistic children, and it can alleviate the anxiety of children with autism, and has the

irreplaceable advantages of other methods [17]. Children with autism respond well to pictures and are visual learners, so most applications should provide visual information to interact with autistic children.

Participation in an app community can help motivate users to engage in healthy activities [18]. A supportive app community can help users share and discuss their experiences and the challenges. This could potentially complement or substitute for the support provided in face-to-face educational training. While nearly 50% of the reviewed apps provided social network sharing, only Autism Parenting Magazine, Lower Case S, NAS and Autism Neighborhood incorporated app community support. With the development and improvement of national community health services, it is possible to carry out early detection of childhood autism in the community, establish a child autism early detection management model suitable for community promotion, improve the child autism rehabilitation system, and expand the public. The understanding of autism is of great benefit to the well-established public system for the rehabilitation of children with autism [19]. Research is required to determine the impact of sharing in social media and participating in a supportive app community on the frequency of education for children with autism.

In terms of sound interaction, there is evidence that children with autism have a preference for sound [20]. A child with autism spectrum disorder has a reduced tolerance to sound in a normal environment or a persistent exaggeration or inappropriate response to a sound that does not feel any harm or discomfort to ordinary people. It is typically characterized by irritability and irritation to the sounds of everyday life. Emotional reactions such as panic. This disorder has seriously affected the family, school and community life of children with autism spectrum disorders and has also hindered the development of their social communication skills [21]. Therefore, choosing the right voice interaction or background music is critical to the educational apps of autistic children. Many experts in the United States and Britain have made a lot of attempts under the guidance of different music therapy models, which will improvise. Music therapy is used in the education and training process for children with autism [22].

At the same time, as a leading activity in children's early life, games are both a way for children to learn and integrate into society, and a child's right to be guaranteed [23]. Games are favorite and active activities for children. It is an activity that children reflect in real life and is one of the important means of education for children [24]. Studies have shown that children with autism can promote the development of their perception when they engage in perceptual sports games. Therefore, in the design of educational apps for children with autism, the form of games and the factors of game are obviously more beneficial to the education of children with autism.

It is worth mentioning that many people with autism find talents in the art field, especially painting. Previous studies have shown the art of painting for children with autism can promote the mental health development and recovery of cognitive function in children with autism [25]. Painting art therapy is a kind of art therapy. It is a kind of psychotherapy that is close to nature and feels the environment. It can relax the comprehensive feeling and form useful cognitive behavior. Art painting treatment provides the possibility to treat autism, revealing the content of autistic children's inner meaning or subconscious in a non-verbal form, which can reduce the psychological defense level of autistic children and their parents. It makes it better to express inner feelings and make them interact with each other, and the therapist can understand them more deeply, so as to achieve the purpose of intervening autistic [26].

Although there are many common problems in the education of children with autism, the "one size fits all" approach to evaluation is not conducive to the correct understanding and assessment of autistic children. To a certain extent, it leads to the generalization and lack of pertinence of therapeutic interventions, which in turn affects the final treatment. So far, mainstream interventions have neglected the different types of mental behavior defects in children with different autisms, and the important problem of different intervention methods is needed [27]. Therefore, in future apps, it is necessary to pay attention to personal preference settings.

Mentioned in many studies there is a clear correlation between the parental efficacy and the recovery of the child. High parental efficacy is one of the necessary conditions for the rehabilitation of autistic children [28]. As a personal cognitive system, the parental education concept is an important component of the quality of parents and plays an important role in the development of children's adaptive behavior [29]. In the relationship between parenting concept and adaptive behavior of autistic children, the study found that parental education has a significant predictive effect on the adaptive behavior of autistic children. Parental self-efficacy has significant independent functions for autistic children. Predictive effects, parental achievement expectations have a significant predictive effect on the social/homemade function of autistic children [30]. Perhaps, in design of apps of education for children with autism, designers should consider more parental factors, set up parents use ports, let parents use apps together, and improve the learning effect of children with autism.

Assessing the quality of an app is an essential step before evaluating its efficacy. The 13 apps provided for children with autism reviewed in this study had a median objective quality MARS score of 3.3. This suggests the apps had an overall acceptable level of quality. However, the low median engagement



and moderate median aesthetics and information subscale scores highlight potential target areas for improvement.

## **Strengths and Limitations**

This study is one of the first to review educational mobile apps for autistic children and evaluate their quality using a new multidimensional expert rating scale. The MARS provides a reliable measure of app quality on four objective subscales (engagement, functionality, visual aesthetics, information quality) and one subjective scale. Only the objective quality scales are included in the total app quality score. Expert ratings on 50% of the reviewed apps had a high level interrater reliability in the current study. However, while the MARS can be used to provide an evaluation of the quality of existing apps, this cannot replace the use of rigorous user-centered design and evidence-based practice in the design of educational apps for autistic children.

The current review was limited to iPhone iOS apps, indicating future research is required to review and rate the quality of educational apps for autistic children developed for other app platforms. Future research is also required to assess the quality of relevant part of the education contained in the other categories apps, as there is currently no gold standard for how education for children with autism is best conceptualized or practiced.

## **Future Research**

While an increasing number of educational apps for autistic children are being developed, the current evidence base is extremely lacking. Future research is needed to determine and compare the efficacy of education apps for children with autism in randomized controlled trials.

## **Conclusions**

Only 2% of the 750 apps identified in our search meeting the needs of education for children with autism. Though many apps claimed to be educational apps developed for children with autism, most of them were not. While the reviewed apps scored an acceptable median MARS score, very few scored high, indicating that the quality of the apps can be improved. The lack of evidence for the effectiveness of education apps for children with autism needs to be addressed.

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## appendix

Yazmin's Rating

Apps/Scores	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.
1.Otsimo	5	5	4	4	4	4	5	5	4	4	4	4	4	4	4	4	4	2	3	5	5	3	5
2.Socky for Autism	4	4	4	3	4	4	5	4	4	4	4	4	4	4	4	4	4	2	0	4	4	3	4
3.Sand Draw	4	4	2	3	4	4	5	4	4	4	3	4	4	4	4	3	4	2	0	4	4	1	4
4.Visual Schedule& Social stories	4	4	2	4	4	4	4	4	4	4	4	4	4	4	4	3	3	2	0	4	4	1	3
5.Autism Parenting Magazine	3	3	3	4	4	4	4	4	4	4	4	3	4	4	4	4	4	3	0	3	3	3	3
6.Autism iHelp-WH Question	4	4	4	3	4	3	4	4	4	4	3	3	4	4	4	4	4	2	0	4	4	1	3
7.Autism iHelp-Play	4	4	3	3	4	3	5	4	4	3	3	3	4	4	4	3	4	2	0	4	4	1	3
8.Autism Speech Sequencing Zapps	4	4	3	4	4	4	4	3	4	4	3	3	3	3	3	3	4	2	0	4	3	1	3
9.Lower Case S	3	3	1	3	4	3	4	3	4	3	3	4	4	4	3	3	4	2	0	4	4	1	3
10.Niki Talk	3	3	3	3	4	4	4	3	3	3	3	3	3	3	3	3	3	2	0	3	3	1	3
11.NAS	2	2	1	2	4	3	4	4	4	3	2	3	4	4	4	4	3	3	0	4	3	1	3
12.Autism Neighborhood	3	3	1	2	4	3	4	4	3	3	3	4	3	3	3	3	3	2	0	3	2	1	3
13.Autism Speaks Assessment	2	2	1	1	4	1	1	2	1	2	3	3	1	1	1	1	2	2	3	1	2	1	1

Table9 MARS Rating of the Author on Each Question

Alice's Rating

Apps/Scores	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.
1.Otsimo	5	5	5	5	5	5	4	4	4	4	4	5	4	4	4	4	4	2	0	4	4	3	4
3.Sand Draw	4	4	3	5	4	4	3	4	4	4	4	4	4	4	4	3	4	2	0	4	3	3	4
4.Visual Schedule& Social stories	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	3	4	2	0	3	4	3	4
6.Autism iHelp-WH Question	3	3	3	4	3	4	4	4	4	3	3	4	4	3	4	4	2	0	3	4	3	3	3
7.Autism iHelp-Play	3	3	1	4	3	5	4	4	4	3	3	4	4	4	3	4	2	0	3	3	3	3	3
8.Autism Speech Sequencing Zapps	4	4	1	5	4	4	3	3	3	3	4	4	4	4	5	3	4	2	0	4	3	1	3
13.Lower Case S	3	3	1	5	4	3	5	4	5	3	4	3	4	4	4	3	4	2	0	3	3	1	2

Table10 MARS Rating of the Second Expert on Each Question

App	Star Rating	Number of Rating	Number of Comments	MARS's Rating
1.Otsimo	4.1	204	0	4.16
2.Socky for Autism	4.6	31	0	3.8
3.Sand Draw	4.3	75649	42	3.54
4.Visual Schedule& Social stories	3.9	14	0	3.5
5.Autism Parenting Magazine	4.0	91	0	3.48
6.Autism iHelp-WH Question	None	None	0	3.4
7.Autism iHelp-Play	4.0	41	0	3.3
8.Autism Speech Sequencing Zapps	4.5	13	0	3.26
9.Lower Case S	None	None	0	3.1
10.Niki Talk	3.9	200	0	2.92
11.NAS	5	2	0	2.92
12.Autism Neighborhood	None	None	0	2.8
13.Autism Speaks Assessment	1	2	0	2.04

Table11 Double Check

**Correlations**

	Yazmin	Alice
Correlation Coefficient	1.000	.929**
Sig. (2-tailed)	.	.003
N	7	7
Correlation Coefficient	.929**	1.000
Sig. (2-tailed)	.003	.
N	7	7

\*\* . Correlation is significant at the 0.01 level (2-tailed).

### 7.3 MARS 量表

# Mobile Application Rating Scale (MARS)

## App Classification

The Classification section is used to collect descriptive and technical information about the app. Please review the app description in iTunes / Google Play to access this information.

**AppName:**

\_\_\_\_\_ **Rating this version:** \_\_\_\_\_

**Rating all versions:** \_\_\_\_\_ **Developer:**

\_\_\_\_\_ **N ratings this version:** \_\_\_\_\_

**N ratings all versions:** \_\_\_\_\_ **Version:**

\_\_\_\_\_ **Last update:**

\_\_\_\_\_ **Cost - basic**

**version:** \_\_\_\_\_ **Cost - upgrade version:**

\_\_\_\_\_ **Platform:**   iPhone   iPad

Android

**Brief description:**

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Focus: what the app targets (select all that apply)**

Increase

Happiness/Well-being<sup>[SEP]</sup>   Mindfulness/Meditation/Relaxation<sup>[SEP]</sup>   Reduce  
negative

emotions<sup>[SEP]</sup>   Depression<sup>[SEP]</sup>   Anxiety/Stress<sup>[SEP]</sup>   Anger<sup>[SEP]</sup>   Behavi  
our Change<sup>[SEP]</sup>   Alcohol /Substance Use<sup>[SEP]</sup>   Goal



Setting  Entertainment  Relationships  Physical health  Other \_\_\_\_\_

### Affiliations:

- Unknown  Commercial **Age group (all that apply)**
- Children (under 12)  Adolescents (13-17)  Young Adults (18-25)  
 Adults
- General

### Theoretical background/Strategies (all that apply)

- Assessment  Feedback  Information/Education  Monitoring/Tracking  Goal setting  Advice /Tips /Strategies /Skills training  CBT - Behavioural (positive events)  CBT – Cognitive (thought challenging)  ACT - Acceptance commitment therapy  Mindfulness/Meditation  Relaxation  Gratitude  Strengths based  Other \_\_\_\_\_

### Government Technical aspects of app (all that apply)

- Allows sharing (Facebook, Twitter, etc.)  Has an app community  Allows password-protection  Requires login
- Sends reminders  Needs web access to function
- NGO  University

## App Quality Ratings

The Rating scale assesses app quality on four dimensions. All items are rated on a 5-point scale from “1.Inadequate” to “5.Excellent”. Circle the number that most accurately represents the quality of the app component you are rating. Please use the descriptors provided for each response category.

### SECTION A

**Engagement – fun, interesting, customisable, interactive (e.g. sends alerts, messages, reminders, feedback, enables sharing), well-targeted to audience**

**1. Entertainment: Is the app fun/entertaining to use? Does it use any strategies to increase engagement through entertainment (e.g. through gamification)?**

- . **1 Dull, not fun or entertaining at all** [L] [SEP]
- . **2 Mostly boring** [L] [SEP]
- . **3 OK, fun enough to entertain user for a brief time (< 5 minutes)** [L] [SEP]
- . **4 Moderately fun and entertaining, would entertain user for some time (5-10 minutes total)** [L] [SEP]
- . **5 Highly entertaining and fun, would stimulate repeat use** [L] [SEP]

**2. Interest: Is the app interesting to use? Does it use any strategies to increase engagement by presenting its content in an interesting way?**

- . **1 Not interesting at all** [L] [SEP]
- . **2 Mostly uninteresting** [L] [SEP]
- . **3 OK, neither interesting nor uninteresting; would engage user for a brief time (< 5 minutes)** [L] [SEP]
- . **4 Moderately interesting; would engage user for some time (5-10 minutes total)** [L] [SEP]
- . **5 Very interesting, would engage user in repeat use** [L] [SEP]

**3. Customisation: Does it provide/retain all necessary settings/preferences for apps features (e.g. sound, content, notifications, etc.)?**

- . **1 Does not allow any customisation or requires setting to be input every time** [L] [SEP]
- . **2 Allows insufficient customisation limiting functions** [L] [SEP]
- . **3 Allows basic customisation to function adequately** [L] [SEP]
- . **4 Allows numerous options for customisation** [L] [SEP]
- . **5 Allows complete tailoring to the individual's characteristics/preferences, retains all settings** [L] [SEP]

**4.Interactivity: Does it allow user input, provide feedback, contain prompts (reminders, sharing options, notifications, etc.)? Note: these functions need to be customisable and not overwhelming in order to be perfect.**

- . **1 No interactive features and/or no response to user interaction** [L] [SEP]
- . **2 Insufficient interactivity, or feedback, or user input options, limiting functions** [L] [SEP]
- . **3 Basic interactive features to function adequately** [L] [SEP]
- . **4 Offers a variety of interactive features/feedback/user input options** [L] [SEP]
- . **5 Very high level of responsiveness through interactive features/feedback/user input options** [L] [SEP]

**5.Target group: Is the app content (visual information, language, design) appropriate for your target audience?**

- . **1 Completely inappropriate/unclear/confusing** [L] [SEP]
- . **2 Mostly inappropriate/unclear/confusing** [L] [SEP]
- . **3 Acceptable but not targeted. May be inappropriate/unclear/confusing** [L] [SEP]
- . **4 Well-targeted, with negligible issues** [L] [SEP]
- . **5 Perfectly targeted, no issues found** [L] [SEP]

**A. Engagement mean score =**

## **SECTION B**

**Functionality – app functioning, easy to learn, navigation, flow logic, and gestural design of app**

**6.Performance: How accurately/fast do the app features (functions) and components (buttons/menus) work?**

- . **1 App is broken; no/insufficient/inaccurate response (e.g. crashes/bugs/broken features, etc.)** [L] [SEP]

- . **2 Some functions work, but lagging or contains major technical problems** [L] [SEP]
- . **3 App works overall. Some technical problems need fixing/Slow at times** [L] [SEP]
- . **4 Mostly functional with minor/negligible problems** [L] [SEP]
- . **5 Perfect/timely response; no technical bugs found/contains a 'loading time left' indicator** [L] [SEP]

**7.Ease of use: How easy is it to learn how to use the app; how clear are the menu labels/icons and instructions?**

- . **1 No/limited instructions; menu labels/icons are confusing; complicated** [L] [SEP]
- . **2 Useable after a lot of time/effort** [L] [SEP]
- . **3 Useable after some time/effort** [L] [SEP]
- . **4 Easy to learn how to use the app (or has clear instructions)** [L] [SEP]
- . **5 Able to use app immediately; intuitive; simple** [L] [SEP]

**8.Navigation: Is moving between screens logical/accurate/appropriate/uninterrupted; are all necessary screen links present?**

- . **1 Different sections within the app seem logically disconnected and random/confusing/navigation is difficult** [L] [SEP]
- . **2 Usable after a lot of time/effort** [L] [SEP]
- . **3 Usable after some time/effort** [L] [SEP]
- . **4 Easy to use or missing a negligible link** [L] [SEP]
- . **5 Perfectly logical, easy, clear and intuitive screen flow throughout, or offers shortcuts** [L] [SEP]

**9.Gestural design: Are interactions (taps/swipes/pinches/scrolls) consistent and intuitive across all components/screens?**

- . **1 Completely inconsistent/confusing** [L] [SEP]
- . **2 Often inconsistent/confusing** [L] [SEP]
- . **3 OK with some inconsistencies/confusing elements** [L] [SEP]

- . **4 Mostly consistent/intuitive with negligible problems** [L] [SEP]
- . **5 Perfectly consistent and intuitive** [L] [SEP]

**B. Functionality mean score = \_\_\_\_\_**

## **SECTION C** [L] [SEP]

**Aesthetics – graphic design, overall visual appeal, colour scheme, and stylistic consistency**

**10. Layout: Is arrangement and size of buttons/icons/menus/content on the screen appropriate or zoomable if needed?**

- . 1 Very bad design, cluttered, some options impossible to select/locate/see/read device display not optimised
- . 2 Bad design, random, unclear, some options difficult to select/locate/see/read
- . 3 Satisfactory, few problems with selecting/locating/seeing/reading items or with minor screen- size problems
- . 4 Mostly clear, able to select/locate/see/read items
- . 5 Professional, simple, clear, orderly, logically organised, device display optimised. Every design

**11. Graphics: How high is the quality/resolution of graphics used for buttons/icons/menus/content?**

- . 1 Graphics appear amateur, very poor visual design - disproportionate, completely stylistically inconsistent
- . 2 Low quality/low resolution graphics; low quality visual design – disproportionate, stylistically inconsistent
- . 3 Moderate quality graphics and visual design (generally consistent in style)

- . 4 High quality/resolution graphics and visual design – mostly proportionate, stylistically consistent
- . 5 Very high quality/resolution graphics and visual design - proportionate, stylistically consistent throughout

**12. Visual appeal: How good does the app look?**

- . 1 No visual appeal, unpleasant to look at, poorly designed, clashing/mismatched colours
- . 2 Little visual appeal – poorly designed, bad use of colour, visually boring
- . 3 Some visual appeal – average, neither pleasant, nor unpleasant
- . 4 High level of visual appeal – seamless graphics – consistent and professionally designed
- . 5 As above + very attractive, memorable, stands out; use of colour enhances app features/menus

**C. Aesthetics mean score = \_\_\_\_\_**

**SECTION D**

**Information – Contains high quality information (e.g. text, feedback, measures, references) from a credible source. Select N/A if the app component is irrelevant.**

**13. Accuracy of app description (in app store): Does app contain what is described?**

- . **1 Misleading. App does not contain the described components/functions. Or has no description** [L] [SEP]
- . **2 Inaccurate. App contains very few of the described components/functions** [L] [SEP]

- . **3 OK. App contains some of the described components/functions**
- . **4 Accurate. App contains most of the described components/functions**
- . **5 Highly accurate description of the app components/functions**

**14. Goals: Does app have specific, measurable and achievable goals (specified in app store description or within the app itself)?**

N/A Description does not list goals, or app goals are irrelevant to research goal (e.g. using a game for educational purposes)

- . 1 App has no chance of achieving its stated goals
- . 2 Description lists some goals, but app has very little chance of achieving them
- . 3 OK. App has clear goals, which may be achievable.
- . 4 App has clearly specified goals, which are measurable and achievable
- . 5 App has specific and measurable goals, which are highly likely to be achieved

**15. Quality of information: Is app content correct, well written, and relevant to the goal/topic of the app?**

N/A There is no information within the app

- . 1 Irrelevant/inappropriate/incoherent/incorrect
- . 2 Poor. Barely relevant/appropriate/coherent/may be incorrect
- . 3 Moderately relevant/appropriate/coherent/and appears correct
- . 4 Relevant/appropriate/coherent/correct

- . 5 Highly relevant, appropriate, coherent, and correct

**16. Quantity of information: Is the extent coverage within the scope of the app; and comprehensive but concise?**

N/A There is no information within the app

- . 1 Minimal or overwhelming
- . 2 Insufficient or possibly overwhelming
- . 3 OK but not comprehensive or concise
- . 4 Offers a broad range of information, has some gaps or unnecessary detail; or has no links to more information and resources
- . 5 Comprehensive and concise; contains links to more information and resources

**17. Visual information: Is visual explanation of concepts – through charts/graphs/images/videos, etc. – clear, logical, correct?**

N/A There is no visual information within the app (e.g. it only contains audio, or text)

- . 1 Completely unclear/confusing/wrong or necessary but missing
- . 2 Mostly unclear/confusing/wrong
- . 3 OK but often unclear/confusing/wrong
- . 4 Mostly clear/logical/correct with negligible issues
- . 5 Perfectly clear/logical/correct

**18. Credibility: Does the app come from a legitimate source (specified in app store description or within the app itself)?**



- . **1 Source identified but legitimacy/trustworthiness of source is questionable (e.g. commercial business with vested interest)**
  - . **2 Appears to come from a legitimate source, but it cannot be verified (e.g. has no webpage)**
  - . **3 Developed by small NGO/institution (hospital/centre, etc.) /specialised commercial business,  funding body**
  - . **4 Developed by government, university or as above but larger in scale**
  - . **5 Developed using nationally competitive government or research funding (e.g. Australian  Research Council, NHMRC)**
- 19. Evidence base: Has the app been trialled/tested; must be verified by evidence (in published scientific literature)?**

N/A The app has not been trialled/tested

- . 1 The evidence suggests the app does not work
- . 2 App has been trialled (e.g., acceptability, usability, satisfaction ratings) and has partially positive outcomes in studies that are not randomised controlled trials (RCTs), or there is little or no contradictory evidence.
- . 3 App has been trialled (e.g., acceptability, usability, satisfaction ratings) and has positive outcomes in studies that are not RCTs, and there is no contradictory evidence.
- . 4 App has been trialled and outcome tested in 1-2 RCTs indicating positive results
- . 5 App has been trialled and outcome tested in > 3 high quality RCTs indicating positive results

**D. Information mean score = \_\_\_\_\_** \*<sup>[1]</sup><sub>[SEP]</sub> Exclude questions rated as "N/A" from the mean score calculation.

## **App subjective quality SECTION E**

**20. Would you recommend this app to people who might benefit from it?**

---

**1 Not at all**

2

<sup>[1]</sup><sub>[SEP]</sub> **3 Maybe**

<sup>[1]</sup><sub>[SEP]</sub> **4**

**5 Definitely**<sup>[1]</sup><sub>[SEP]</sub>

**21. How many times do you think you would use this app in the next 12 months if it was relevant to you?**

. **1 None**

. **2 1-2**

. **3 3-10**

. **4 10-50**

. **5 >50**

**22. Would you pay for this app?**

1 No<sup>[1]</sup><sub>[SEP]</sub>

3 Maybe

5 Yes

**23. What is your overall star rating of the app?**

. **1 ★★**

. 2 ★★★★★

. 3 ★★★★★★

. 4 ★★★★★★★

. 5 ★★★★★★★★★

# Scoring

## App quality scores for

OneoftheworstappsI'veused Average OneofthebestappsI'veused

SECTION <sup>[1]</sup><sub>SEP</sub> A: Engagement Mean Score = \_\_\_\_\_ B:  
 Functionality Mean Score = \_\_\_\_\_ C: Aesthetics  
 Mean Score = \_\_\_\_\_ D: Information Mean Score =  
 \_\_\_\_\_ **App quality mean Score =**  
 \_\_\_\_\_ **App subjective quality Score =**  
 \_\_\_\_\_

# App-specific

These added items can be adjusted and used to assess the perceived impact of the app on the user's knowledge, attitudes, intentions to change as well as the likelihood of actual change in the target health behaviour.

## SECTION F

**1. Awareness: This app is likely to increase awareness of the importance of addressing [insert target health behaviour] <sup>[1]</sup><sub>SEP</sub> Strongly disagree  
 Strongly Agree 12345 <sup>[1]</sup><sub>SEP</sub>**

**2. Knowledge: This app is likely to increase knowledge/understanding of [insert target health behaviour] Strongly disagree Strongly Agree**  
12345

**3. Attitudes: This app is likely to change attitudes toward improving [insert target health behaviour] Strongly disagree Strongly Agree**  
12345

**4. Intention to change: This app is likely to increase intentions/motivation to address [insert target health behaviour] Strongly disagree Strongly Agree**  
12345

**5. Help seeking: Use of this app is likely to encourage further help seeking for [insert target health behaviour] (if it's required) Strongly disagree Strongly Agree**  
12345

**6. Behaviour change: Use of this app is likely increase/decrease [insert target health behaviour] Strongly disagree Strongly Agree**  
12345

