The Sensory Processing Measure (SPM, SPM-P, and SPM-2)

Moving Toward Assessment Across the Lifespan

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# Sensory History

Please answer the following questions about __________________________.

**Date**

Add comments in spaces provided.

<table>
<thead>
<tr>
<th></th>
<th>Often</th>
<th>Some</th>
<th>Seldom</th>
<th>True</th>
<th>Very</th>
<th>Times</th>
<th>Or Not True</th>
</tr>
</thead>
</table>

## Auditory

1. Responds negatively to unexpected or loud noises |
2. Is distracted or has trouble functioning if there is a lot of noise around |
3. Couple of times suspected of being hard of hearing |
4. Seems to enjoy strange noises or to seek or make noise for noise’s sake |
5. Enjoys music |

## Tactile

1. Avoids getting hands in paste, finger paint, or other “messy” materials or in sand or gritty substances |
2. Does not like to have his face washed or wiped |
3. Is irritated by cloth of certain textures |
4. When an infant liked to be held or cuddled |
5. Dislikes being touched unexpectedly |
6. Irritated when someone is close to him |
7. Prefers to touch smooth, hard surfaces to rough textures |
8. At times has avoided using hands for extended periods |
9. Has banged his head on purpose |
10. Has tended to pinch, bite, hit, or otherwise injure himself or scratch himself |
11. Has tended to pinch, bite, hit, or otherwise take physically aggressive action against others |
12. Tends to examine objects by touching them thoroughly with hands |
13. Tends to examine objects by putting them in his mouth |
14. Tends not to feel pain as much as others |
15. Tends to feel pain more than others |
16. Tends to get sores on skin and heals slowly |
17. As an infant resisted solid food |
Questionnaires Have Limitations

• The information provided is subjective

• One person’s impression may be very different from another’s

• The questions can be misinterpreted

• The people who developed the questionnaire might not have thought of the best questions to ask
Why bother with sensory questionnaires?

• Provide information about the perceptions and experience of people who are important in the life of the person being assessed

• Perceptions directly affect interpersonal interactions and events

• Provide critical information not available from other assessment methods

• Provide a tool for educating key individuals about sensory influences on the person’s behavior – including the person being assessed
What Does the SPM Contribute to Assessment?

- Gathers information from persons who know the infant, child, teen, or adult well
  
  - **SPM & SPM-P**: Preschoolers & elementary school-aged children (2-5 yrs old)  
  - **SPM-2** in development: Lifespan – from 4 months to 90 years old

- Focuses on everyday behavior in familiar environments

- Examines contextual factors – can compare perceptions of different informants in different environmental settings
Designed to Support Best Practice

• Provides data for considering whether sensory or praxis difficulties affect a person’s social participation

• Promotes collaboration among significant people in the life of the infant, child, teen, or adult

• Promotes a problem solving approach

• Kerry Evetts & colleagues study comparing SPM to Sensory Profile and Sensory Experiences Questionnaire for use in South Africa
Kerry Evetts & colleagues: *Clinical Utility of Three Sensory Modulation Measures*

Compared *SPM Home Form* with *Sensory Experiences Questionnaire* and *Sensory Profile*

"SPM has the highest clinical utility and is recommended for use in the assessment of children with ASD in SA . . . "
The Original
SPM and SPM-P

**SPM (2007)**
School-aged children (5-12 yrs)

**SPM-Preschool (2011)**
Preschoolers (2-5 yrs)

**Home & School Forms**

Norm-referenced scores for sensory systems, praxis, & social participation

Norm-referenced difference score (DIF) compares parent & teacher ratings

Criterion-referenced scores for optional School Environments forms
What’s new about the SPM-2?

• Extends age range down to infancy

• Extends age range up through adulthood

• Some items replaced in preschool & school-age forms

• Adds new forms for comparison of raters or settings
Five Sets of Age Ranges in the SPM-2

- Infant and toddler (4 – 9 months, and 10 - 30 months)
- Preschooler (2 - 5 years)
- School-age child (5 - 12 years)
- Teen (12- 21 years, if in school)
- Adult (up to 90 years; includes 16-21 years if no longer in school)
SPM-2 Infant-Toddler Forms

- **Younger infant:** 4-9 months
- **Older Infant or Toddler:** 10-30 months
- **Caregiver:** Adult self-report
My baby goes limp when picked up by an adult. (Younger infant)

My baby cries or pushes away when held. (Older infant/toddler)

I diaper my child too loosely or too tightly. (Caregiver self-rating)
SPM-2 Preschool and School- Age Forms

**Preschool**
- Home 2-5 years
- School 2-5 years

**Elementary School**
- Home 5-12 years
- School 5-12 years
- School Environments: Recess, PE, Music, Art, Bus, Cafeteria
SPM-2 Preschool / School Sample Items

- Twirls or spins excessively on playground equipment (Preschool)
- Grasps objects such as a pencil or spoon too loosely or tightly to use easily (School-age)
- Fails to gather belongings or otherwise take notice of approaching bus stop (School environment)
SPM-2 Teen Forms

- Parent/caregiver report
- Teacher/other adult report
- Self-report
- Driving forms for licensed drivers (parent report and self-report)
SPM-2 Teen Sample Items

- Loses balance when bending (Parent/caregiver)
- Runs hands against the wall when walking down a hallway (Teacher/other adult)
- I dislike tasting unfamiliar food (Self-report)
- I have trouble knowing how hard to press on the gas pedal or brake. (Driving)
SPM-2 Adult Forms

- Self-report
- Informant report
- Driving form for licensed drivers
SPM-2 Adult Sample Items

- I have trouble noticing street signs or traffic signals when I am in a new place. (Self-report)

- I need to be in a very quiet place in order to work or fall asleep. (Self-report)

- I dislike eating in restaurants because of the different smells and tastes. (Self-report)
Unique Features of the SPM and SPM-2

- Measures functioning within each sensory system
- Measures praxis (ideation & motor planning)
- Measures social participation as distinct from sensory processing
- Created to support teamwork and collaboration
- Considers multiple environments and perspectives
Value of SPM and SPM-2 Questionnaires

- Helps to answer the question "Why is the problem occurring?"
- Gathers information from parents, teachers, and others
- Allows for comparisons to norms
Norm-Referenced Tests

• Measure how far from average the person is performing

• Score represents distance from the mean (higher or lower)

• Type of score is usually based on standard deviations from the mean (z-scores, T-scores)
SPM and SPM-2 provide $T$-scores

- For each sensory scale
- For total sensory score
- For praxis
- For social participation
SPM and SPM-2 Sensory Scales

- Touch (TOU)
- Proprioception (BOD)
- Vestibular (BAL)
- Auditory (HEA)
- Visual (VIS)
- And perhaps Taste/Smell (TS) on SPM-2
SPM and SPM-2 Scoring

• Home & School (Main Classroom) forms

• Norm-referenced scores for sensory systems, praxis, & social participation

• Norm-referenced difference score (DIF) compares parent & teacher ratings
What is a $T$-score?

Mean = 50
SD = 10
Interpretation of SPM $T$-scores

- Typical range ($T$-score range of $40-59$)
- Moderate Difficulties* range ($T$-score range of $60-69$)
- Severe Difficulties* range ($T$-score range of $70-80$)

*Note change in wording between SPM and SPM-2
SPM score form – Main Classroom

- **Social** – typical
- **Vision** – moderate difficulties
- **Touch** – moderate difficulties
- **Proprioception** – severe difficulties
- **Vestibular** – severe difficulties
- **Praxis** – moderate difficulties
- **Total Sensory** – severe difficulties
Normative Samples

• Must know the composition & size of the normative sample, as you are comparing your patient/client to the average for this group.

• How is the person you are assessing similar to or different from the normative sample?

• Consider representativeness of your community: language, ethnicity/race, geographic location, educational level, rural vs urban.
Original SPM Normative Data

- Normed on 1,051 children across the U.S.
- Approximately equal proportions of boys & girls
- Age range: 5 to 12 years (K-6th grade)
- Ethnicity: 76% White, 12% Hispanic/Latino, 10% Black/African American, 0.3% Other
- Parent education: 13.5% less than high school graduation
SPM-P Normative Data

- Normed on 651 children across the U.S.
- Approximately equal proportions boys & girls
- Age range: 2 to 5 years
- Ethnicity: 78% white, 10% Hispanic, 7% African American, 2% Asian, 2% American Indian, 2% other
- Parent Education: 12% less than high school graduation
Normative Samples for SPM-2

• Targets for SPM-2: English & Spanish norms

• Representative of US Census data as closely as possible for ethnicity/race, geographic location, educational level, rural vs urban

• Normative data will be used to create T scores on sensory, praxis, and social scales, as well as DIF scores
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We seek examiners with access to typically developing and clinical populations, from infants to individuals up to 90 years of age. Your role as a data collector will be to recruit teachers, parents and their children, adults and their spouses, and caretakers to complete the online forms.

How to Get Started

To be considered for participation, please visit www.wpspublish.com/SPM2Survey and complete a 5-minute survey.
Translations

• Must receive permission from WPS (copyright owner) to create a translation

• Rigorous back-translation process used

• Portuguese, Danish, Swedish, & Finnish are published outside the U.S.

• Available in paper or electronic format for administration & scoring

• Currently scores are derived from U.S. normative data using English forms

• With SPM-2, we expect to have U.S. normative data for Spanish forms
Interpretation of T scores

• Identify which scales have T scores that are elevated (60 or higher)

• For each elevated T score, identify the specific items that contributed to the high score

• What do these items indicate?
  • Use knowledge of SI theory to interpret SPM
  • Integrate SPM with other assessment data (triangulation)
Sensory Vulnerabilities

• Within each sensory system scale, items cover diverse types of vulnerabilities:
  – Under-reactivity
  – Over-reactivity
  – Sensory seeking (explore possible reasons for the type of seeking)
  – Perception
  – Postural control and/or balance
  – Ocular control

• However, overall there are more items that address modulation than perception or motor control.

*SPM-P Manual pp. 73-76; SPM Manual pp 21-23
Interpreting DIF Scores

• The original SPM and SPM-P gather information about the *perceptions* of adults who know the child well.

• **DIF score is the difference between Home and School Forms** for the *Total Sensory* scores.

• A DIF score greater than 1 SD from mean DIF score for normative sample indicates an unusually large difference in perceptions of different raters.

• Practitioners need to consider what in the home or school *contexts* might account for the large DIF score.

• DIF scores will be available on SPM-2 forms.
Qualitatively Interpreting T-Score Differences

- Very different T-scores from two or more forms evaluating the same person
  - Different raters on the same form (two parents, or parent & nanny)
  - Different raters on comparable forms (Teen parent & Teen self-report)
  - Same rater at two points at time to measure change

- Very different T-scores on Infant-Toddler behavior ratings vs Caregiver self-reports
  - Identify noteworthy differences in infant vs caregiver sensory and motor responses
  - Explore how these differences may influence co-occupations

- Identification of scores that fall beyond cutoff points on optional environmental forms
  - School environments forms (art, music, PE, cafeteria, recess, bus)
  - Driving forms
Psychometrics of the SPM

• Items are developed and then selected to create reliable & valid scales

• Reliability = consistency or stability of scores

• Validity = whether scores measure what they are supposed to measure
Reliability and Validity: *Why Do We Care?*

- In SI assessment, we use evaluation instruments to identify individuals with sensory integration and praxis difficulties, and to choose the most appropriate interventions for these individuals.

- If the instrument we are using is not reliable and valid we cannot trust the scores we are using to make decisions.

- Therefore we need to know their strengths and weaknesses before using them – *to avoid making intervention decisions based on faulty data.*
Item Selection

• For both the original SPM and SPM-P, all items selected for the questionnaire forms were powerful discriminators (large effect sizes) between children with clinical problems and typical children.

• SPM clinical sample N = 345; SPM-P: N = 242

• Examples of clinical samples:
  - Learning disability
  - SI dysfunction
  - Autism spectrum
  - ADHD
  - Unspecified emotional/behavioral problems
  - Speech/language impairment
  - Visual impairment
  - Intellectual or developmental disorder
  - Cerebral palsy/other motor disorder
Item selection also is influenced by:

• Rasch analysis

• Contribution of each item to reliable and valid scales

• Clinically useful questions

• Does not gather the same information as other items selected
SPM and SPM-2 Reliability

- Test-Retest
- Interrater
- Internal Consistency
## Reliability for Original SPM & SPM-P

<table>
<thead>
<tr>
<th></th>
<th>SPM Home</th>
<th>SPM Main School</th>
<th>SPM-P Home</th>
<th>SPM-P School</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Internal consistency</strong></td>
<td>.77 -.95</td>
<td>.75 -.95</td>
<td>.75 -.93</td>
<td>.72 -.94</td>
</tr>
<tr>
<td><strong>(coefficient alpha)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Test-retest reliability</strong></td>
<td>.94 -.98</td>
<td>.95 -.98</td>
<td>.90 -.98</td>
<td>.90 -.96</td>
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</tbody>
</table>
# SPM-2 Adult Initial Reliability Data

(N=600/750)

<table>
<thead>
<tr>
<th>Scale</th>
<th># of items</th>
<th>alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Participation</td>
<td>10</td>
<td>.81</td>
</tr>
<tr>
<td>Vision (VIS)</td>
<td>10</td>
<td>.82</td>
</tr>
<tr>
<td>Hearing (HEA)</td>
<td>10</td>
<td>.85</td>
</tr>
<tr>
<td>Touch (TOU)</td>
<td>10</td>
<td>.70</td>
</tr>
<tr>
<td>Body Awareness (BOD)</td>
<td>10</td>
<td>.79</td>
</tr>
<tr>
<td>Balance and Motion (BAL)</td>
<td>10</td>
<td>.75</td>
</tr>
<tr>
<td>Planning and Ideas (PLA)</td>
<td>10</td>
<td>.86</td>
</tr>
<tr>
<td>Taste and Smell (TS)</td>
<td>10</td>
<td>.83</td>
</tr>
<tr>
<td>Driving (DRV)</td>
<td>15</td>
<td>.86</td>
</tr>
</tbody>
</table>
SPM and SPM-2 Validity

- Expert review of content validity for original SPM items
- Expert review of content validity & appropriateness of wording for SPM-2 Teen Self-Report items
- Focus Groups for original SPM
- Convergent validity (correlations with other tests)
- Discriminant validity
- Factor Analysis
Convergent Validity

- SPM Home & Sensory Profile sensory & social domains:
  \[ r_s = -.27 \text{ to } -.58 \] (Dugas, Simard, Fombonne, & Couture, 2018)
  SPM Home identified more children with ASD who have sensory features in every domain

- SPM Home & Sensory Profile Total scores:
  \[ r = .86 \] (Brown, Morrison & Stagnitti, 2010)

- SPM Home & Short Sensory Profile Total:
  \[ r = .72 \] (Parham et al., 2007)

- SPM Main Classroom & SP School Companion Total:
  \[ r = .74 \] (Brown, Morrison & Stagnitti, 2010)

- SPM-P Home & Short Sensory Profile Total scores:
  \[ r = .62 \] (Miller Kuhaneck et al., 2010)
Factor Analysis

• Analyzes scores to identify groupings of items into categories (factors) that seem to fall or belong together

• Someone who scores high on one item in a factor is likely to score high on the rest of the items in the factor (they vary together)

• Used to examine the validity of the ideas regarding the items and how they should be grouped and summed for scores
**SPM Factors** fell out according to sensory systems (proprioception etc) as well as praxis and social participation.
Confirmatory Factor Analysis

• Used to test whether items group together in factors that are consistent with an existing theory.

• Does confirmatory factor analysis identify factors that conform to ASI theory?

• Su and Parham (2014) tested this hypothesis using a large data base of children’s scores on the ESP (precursor to the SPM Home Form).
Confirmatory Factor Analysis

Tactile System (F1)

Vestibular-Proprioceptive System (F2)

Auditory System (F3)

Visual System (F4)

Source: Su & Parham (2014)
Detection of Clinical Cases

• **Sensitivity** = detection of **true** positives
  • So you **won’t miss** children who actually have sensory problems

• **Specificity** = exclusion of **false** positives
  • So you **won’t mistakenly identify** children as having sensory problems when really they don’t
Clinical Detection of Children with SI Problems

• Are SPM Total sensory scores powerful in detecting children with SI problems when mixed in with the normative sample?

• Conditional probability analysis

• At what cutoff score does the Total sensory score have the best sensitivity and specificity?
# Sensitivity & Specificity

**SPM Home TOTAL Score**

*(n = 33 identified SI disorders, N = 1,051 normative)*

<table>
<thead>
<tr>
<th>T-score cutoff</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>55</td>
<td>.94</td>
<td>.70</td>
</tr>
<tr>
<td>60</td>
<td>.85</td>
<td>.85</td>
</tr>
<tr>
<td>65</td>
<td>.46</td>
<td>.94</td>
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<tr>
<td>70</td>
<td>.18</td>
<td>.98</td>
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<tr>
<td>75</td>
<td>.06</td>
<td>.99</td>
</tr>
</tbody>
</table>
### Sensitivity & Specificity
**SPM Main Classroom TOTAL Score**

<table>
<thead>
<tr>
<th>T-score cutoff</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>55</td>
<td>.84</td>
<td>.72</td>
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<td>60</td>
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<tr>
<td>65</td>
<td>.34</td>
<td>.94</td>
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<tr>
<td>70</td>
<td>.16</td>
<td>.98</td>
</tr>
<tr>
<td>75</td>
<td>.01</td>
<td>.99</td>
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</tbody>
</table>
SPM and SPM-2 Quick Tips

Help identify appropriate interventions to assist individuals with challenges in sensory integration at home, school, and in the community
SPM-2 Case Study: José
45 yr old adult with Asperger Disorder

Presenting challenges:

• Sensory difficulties, including over-reactivity, impacting his relationship with his fiancée, Anita. José would like to “work things out before they get hitched.” Though reluctant to participate in “therapy,” José agreed to meet with Anita and the OT to discuss strategies.

• José is a proud supervisor who is able to organize products in large stores using his “photographic” memory.

• He does not like change and embraces “sameness” in his daily schedule.

• José likes that he does not have to deal with customers as he prefers animals. They “appear to be comfortable in the space I create.”

• José says he has a good life by himself, except that he has fallen in love with Anita who José says “has her own issues.” For example, he “does not like to be touched that much” which causes Anita to complain that she would like to be hugged “at least once a day.”
<table>
<thead>
<tr>
<th><strong>José and Anita</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Self Report (José)</strong></td>
</tr>
<tr>
<td>1. I need predictable routines/schedules.</td>
</tr>
<tr>
<td>2. I am bothered by ceiling lighting.</td>
</tr>
<tr>
<td>3. I have difficulty focusing when I hear sounds such as crunching on popcorn.</td>
</tr>
<tr>
<td>4. I dislike when people touch me or are too close to me.</td>
</tr>
<tr>
<td><strong>Informant (José re Anita)</strong></td>
</tr>
<tr>
<td>1. Anita tends to change plans.</td>
</tr>
<tr>
<td>2. Anita needs overhead lighting.</td>
</tr>
<tr>
<td>3. Anita makes a lot of noise when snacking on crunchy foods, especially at night in front of TV.</td>
</tr>
<tr>
<td>4. Anita needs daily hugs and snuggling.</td>
</tr>
<tr>
<td>SPM-2 items SOC Scale</td>
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<tr>
<td>-----------------------</td>
</tr>
<tr>
<td>I need predictable routines and schedules.</td>
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<tr>
<td>SPM-2 items TOU</td>
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<tr>
<td>-----------------</td>
</tr>
<tr>
<td>I dislike when people touch me or are too close to me</td>
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<tr>
<td></td>
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<td></td>
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<tr>
<td></td>
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<tr>
<td>I like wearing snug-fitting clothes</td>
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