Neural and psychosocial development underlying adolescent's abstract life goals

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Introduction

- Forming life goals is an important part of adolescents' development.
- Abstract life goals orient individuals toward broadly framed relationships and societal contributions, rather than toward acquiring goods and status.
- Abstract goals help adolescents connect with the world beyond themselves and build purpose[1].
- Based on core values and beliefs, abstract goals help adolescents make important decisions that will affect their future.
- Studying adolescents' ability to formulate abstract goals offers a window to examine the interaction between planning, social rewards and core values within adolescents' own frame of reasoning, both at the neural and at the psychological levels.

Abstract life goals in the lab

- **Background:** Several neural systems likely contribute to adolescents' processing of abstract life goals. Neuroimaging studies have shown that the Basal Ganglia Network (BG) processes value-driven behavior. In addition, the Default Mode Network (DMN) supports abstract understandings of one's own and others' perspectives and stories, and reasoning about values and beliefs[2]. At least one study with adolescents has shown that connectivity between the DMN and BG increases with development[3].

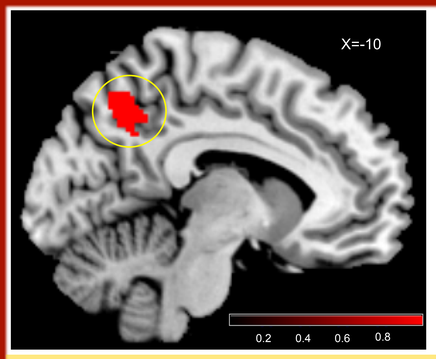
Aim: to test whether the degree of coordination between these networks during resting-state MRI may correlate with individual differences in adolescents' formulation of abstract goals assessed in a laboratory interview.

- Study 1. 25 adolescents (age=15.8(SD=1.16), 12/13 male/female, 7 East-Asian/8 Latino, SAT score= 1725.18 (SD=345.37)) underwent a resting state scan, and completed an open-ended interview about their future goals. Participants' videotaped interviews were transcribed and verified, and descriptions of goals were coded. Intentions comprising value-driven and social goals were coded as abstract.

- The Future Selves Questionnaire:[4] is an open-ended interview in which subjects are asked to imagine themselves into the future and describe their goals. Future goals were coded for the level of abstraction.

Level	Definition and examples given by participants
Abstract life goals	Goals focused on obtaining experiences, feelings, values, growth, and beliefs, as well as service to others and goals greater than the self [1, 5]. Examples: "*I want to make sure my daughter is doing well*", "*Um, uh, I think I'd still, like to help others, so organizations like Red Cross or just do some kind of volunteer work with my free time*", "*And* [I want to] *continue being a hard worker and staying humble*".
Non-abstract life goals	Goals that included acquiring goods, gaining popularity, status, social comparisons, narrowly defined tasks, personal pleasure, excitement, comfort, and hedonistic or pragmatic values[1,5]. Examples: "*I don't want to, I don't know… its just, maybe I don't wanna be homeless*", "[I want] *to have a nice car*", "*I want to have my motorcycle license*".

- Resting state fMRI acquisition and preprocessing: Participants underwent a 7-minute resting state fMRI scan (TR=2s). Images were slice timing corrected, motion corrected, normalized to the MNI space and smoothed using a 8-mm Gaussian kernel (SPM12).
- Selection of BG component: The BG was identified at the group level using independent component analysis (ICA, carried out with Infomax algorithm from GIFT toolbox) and then back reconstructed for each individual
- Data Analysis. A multiple regression model was set to regress the participants' z scores maps on the frequency of abstract future goals. A threshold was set at p<0.05 (AFNI, AlphaSim).



- Result: We found that participants who reported more abstract goals showed higher intrinsic connectivity between the inferior/posterior precuneus (a central DMN hub) (x=-10, y=-60, z=48, cluster size=181, p<.0001) and the BGN. Cluster was significant at p< 0.05 (whole brain analysis, controlling for multiple comparisons).

This study suggests that the cross-talk between brain areas important for goal processing and for reflecting about values and narratives may support building abstract goals among adolescents.

Abstract life goals in the field

- Background: Given the importance of reflecting on personal stories in the context of supportive relationships with older, wiser adults, we paired with an arts organization that teaches intergenerational storytelling to senior citizens and adolescents, *Sages and Seekers* (**www.sagesandseekers.org**). At the psychological level, adolescents' growing abilities to formulate abstract goals are thought to be supported by high quality social relationships with more experienced and trusted adults who listen and reflect with the adolescent.

Aim: to test whether the intergenerational storytelling intervention impacted adolescent participants' self-understanding and abstract goals, relative to a control movie-watching condition that involved enjoying stories in intergenerational pairs, but offered no specific support for personal storytelling.

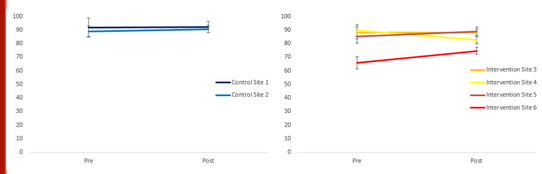
- Study 2. We examined the effects of an intergenerational storytelling intervention in a sample of 47 adolescents, compared with a 18-person control group who completed a movie-watching activity of equivalent length. Participants completed open-ended questions regarding their future goals and surveys about their psychosocial development.

- The intergenerational storytelling intervention: consisted of an eight-week program focused on meaningful conversations about life stories, along with systematic opportunities for reflection.

- Sampling (Convenience): Participants for Control Sites 1 and 2 were recruited from a Christian community and a after school program in LA. For Intervention Sites 3, 4, and 5 recruitment took place at after school programs in LA and Pasadena. Intervention Site 6 took place in an non-regular High School at Inglewood. Site 6 showed lower scores at baseline for every outcome.

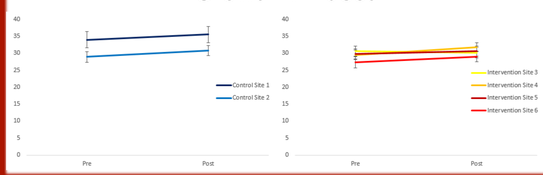
After the intervention, participants increased the frequency of abstract goals, as well as they exhibited higher wellbeing and purpose in life, compared to the control group.

Psychological Wellbeing[6]



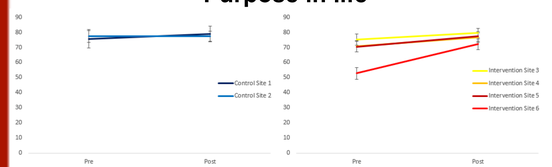
- Differences in **Wellbeing** across Sites: $F_{(5,46)}$=5.4, p=.001, η^2=.3
- Trend for improvement in **Wellbeing** for Intervention Sites across Time: $F_{(1,5)}$=2.2, p=.06, η^2=.2

Growth Mindset[7]



- An increased in **Growth Mindset** scores across Time was observed: $F_{(1,5)}$=5.3, p=.02, η^2=.09

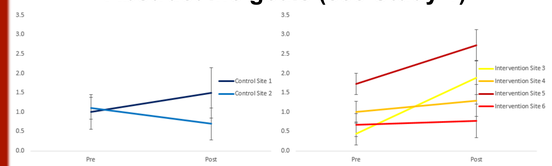
Purpose in life[8]



- Increased **Purpose in life** across Time: $F_{(1,5)}$=15.8, p<.001, η^2=.24. Differences across Sites: $F_{(5,49)}$= 3.1, p=.01, η^2=.24

- Intervention Sites increased in **Purpose in life** (Time * Sites: $F_{(5,49)}$=3, p=.01, η^2=.23)

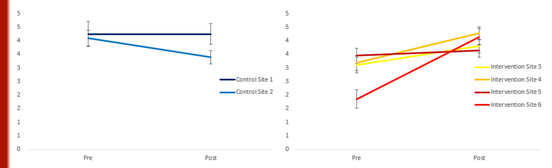
Abstract life goals (see Study 1)



- Coded **Abstract life goals** increased with Time: $F_{(1,5)}$=7, p=.01, η^2=.13. Differences across Sites: $F_{(5,47)}$, p=.01, η^2=.27.

- Intervention Sites improved across Time: $F_{(5,47)}$=2.5, p=.04. η^2=.2

Actions for social change[9]



-A main effect of Time was observed $F_{(1,5)}$=12.8, p=.001, η^2=.2, Intervention Sites improved scores about **Actions for Social change** $F_{(5,47)}$=4.3, p<.001, η^2=.4

What can you do to solve problems you see in the world?
Answers were coded:
1= I do not know
2= There is nothing I can do to help
3= I can help
4= I can involve others in helping
5= I can convince and organize others to help

Conclusions

- Integrating findings from social-affective neuroscience research on goal processing with the results from an established educational storytelling program: this research offers insights into the neurobiology of fostering social goals and the value of offering adolescents with opportunities for reflecting on their communities in relation to their future goals, in order to promote thoughtful citizenship.
- Demonstrating the effectiveness of an established arts-based educational program in promoting healthy development of adolescents: we can inform practitioners and school administrators about the benefits of intergenerational storytelling. Storytelling could expand the repertoire of educational practices that promote social-emotional learning, contributing to transforming classroom climates. Finally, it illustrates for policy-makers the benefits the promoting equal access to the arts and of systematically providing adolescents with spaces for personal reflection in schools.

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