Full Proposal form NWA-ORC 2020/21

Form for Impact Plan Approach

SCIN

Screen & Intervene

Neurobiological assessments in screening and individual treatment decisions in the forensic youth setting.

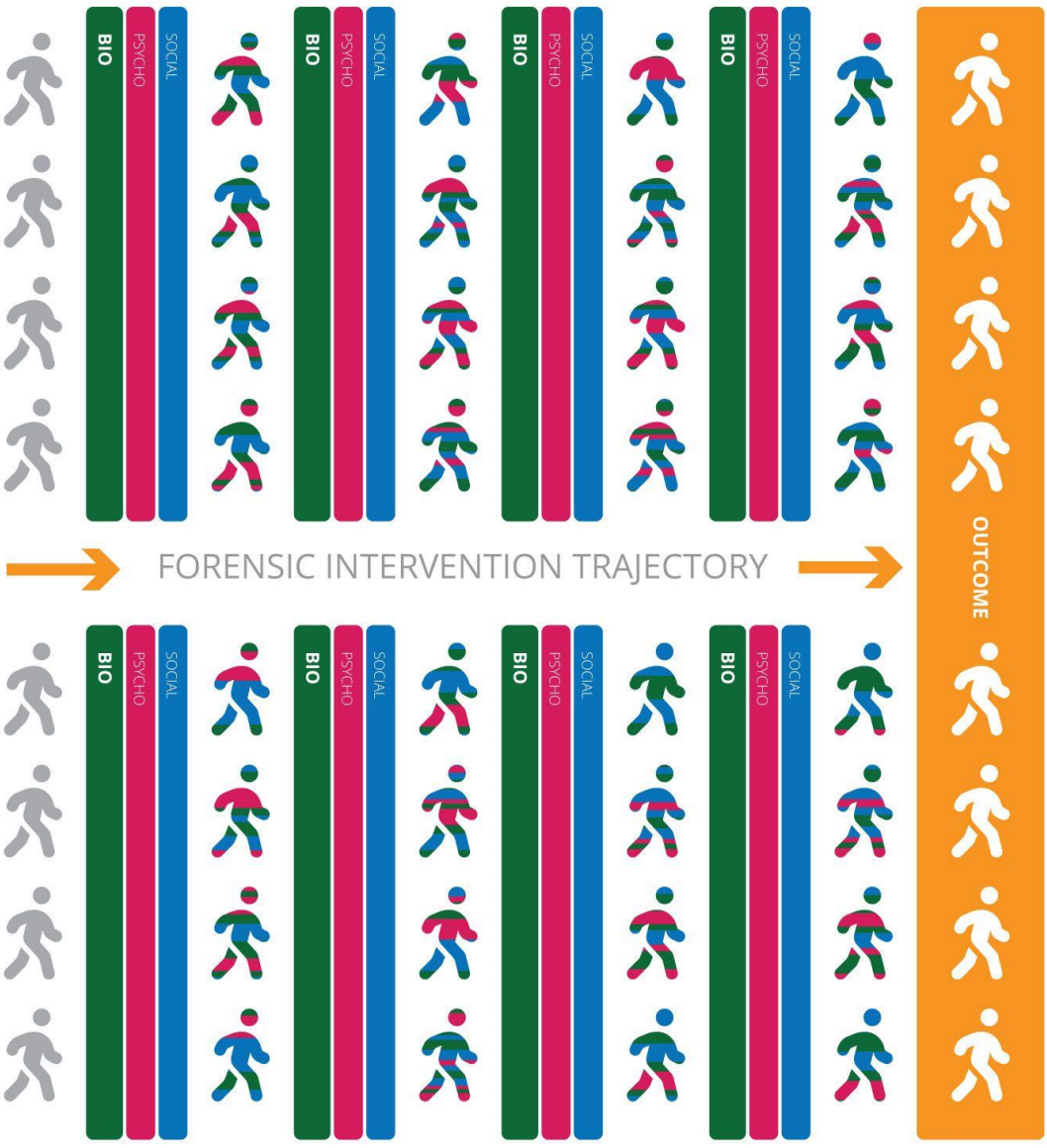


Table of Contents

1. Application overview 4
1.1. General details 4
1.2. Schematic overview of consortium 5
2. Problem statement and Impact 8
2.1 Problem statement and fit to NWA routes 8
2.1.1. Societal problem and fit to NWA route(s) 8
2.1.2 Causes 10
2.1.3 Assumptions on problem statement and causes 10
2.2 Societal impact 11
2.2.1 Societal impact 11
2.2.2 Assumptions 11
2.3 Suitability of Impact Plan approach 12
3. Consortium 13
3.1. Composition of consortium and productive interactions 13
3.2. External stakeholders 13
3.3. Diversity of the consortium 14
3.4. Involvement and development of young and mid-level researchers within the project 14
4. Impact Pathway 15
4.1. Impact Pathway 15
4.1.1. Outcomes 15
4.1.2. Assumptions 17
4.1.3 Output 18
4.1.4 Assumptions 19
4.1.5 Pathway diagram (Annex 1 on page 42) 19
4.2 Strategic activity planning 19
5. Objectives and research questions 23
5.1. Scientific objectives 23
5.2 Scientific problem 23
5.3 Scientific relevance 24
5.4 Scientific impact 24
6. Project overview 25
6.1. Project structure and coherence (also see Annex 2 at page 44) 25
6.2 Description of the work packages 27
6.3 Risk management and contingency plan 35
6.4 Project management 35
6.4.1 Project leader and consortium partners 35
6.4.2 Project advisory committee 37
6.5 Justification of project budget 37

7. Data management and ethical aspects 38
7.1 Data management 38
7.2 Ethical aspects 38
8. Statements by the main applicant 39
8.1. Other grant applications 39
8.2. By submitting this form I declare that: 39
9. List of literature references 40

1. Application overview

1.1. General details

Title of the proposal*	Screen & Intervene (SCIN) Neurobiological assessments in screening and individual treatment decision in the forensic youth setting
Main applicant**	Lucres M.C. Nauta-Jansen
Primary NWA route applicable to the research proposal**	NeuroLabNL: the ultimate living lab for brain, cognition and behavioural research
Secondary NWA route(s) applicable to the research proposal (if applicable)	Select a route *n/a*
Primary cluster question applicable to the research proposal**	058. What are the patterns and causes of crime and how can we influence them?
Secondary cluster question applicable to the research proposal (if applicable)	059. How can we help children and adolescents grow up safe and healthy?
Keywords (max. five)	Youth delinquency, individual development, neurobiology, forensic treatment, (re)mediation
Budget range requested budget**	☒ 0.5 – 2 M€ ☐ 2 – 5 M€ ☐ 5 – 10 M€

** This title should be the same as the title you enter in ISAAC.*
*** The main applicant, primary route, primary cluster question and budget range should be the same as described in your pre-proposal.*

1.2. Schematic overview of consortium

Main applicant and co-applicants

Main applicant*			
Name, title(s)	***Organisation***	***Position***	***Expertise (in key words)***
Dr. LMC Nauta-Jansen	*AmsterdamUMC - VUmc*	*Principal investigator*	*Biomedical science, translational forensic child- and adolescent psychiatry*

Co-applicant(s)			
Name, title(s)	***Organisation***	***Position***	***Expertise (in key words)***
Dr. NE Blankenstein	*AmsterdamUMC-VUmc*	*postdoc*	*Neurobiology of risk-taking behavior in youth*
Mr. dr. L van Domburgh	*AmsterdamUMC-VUmc*	*Senior researcher*	*Development and treatment of antisocial behavior in children and adolescents*
Dr. A Donker	*University of applied sciences Utrecht*	*Lector Social safety*	*Social safety, social innovation, developmental (bio)criminology*
Dr. TAM Graas	*University of applied sciences Windesheim*	*Lector Youth*	*Social educational youth care*
Dr. JM Jansen	*Leiden University, faculty of law*	*Assistant professor*	*Neurobiology in adults in penitentiary institutions (PI)*
Dr. CH de Kogel	Research and Documentation Centre Ministry of Justice and Security *(WODC)*	*Senior researcher*	*Forensic psychology, neurobiology of antisocial behavior,*
Dr. J Lokkerbol	Trimbos institute	*Data scientist*	*Data science and Machine learning*
Dr. PC de Looff	Radboud University, Behavioral Science Institute	*Medior researcher*	*Aggression, physiology & biosensors*

Prof. dr. G Meynen	*VU University* *University Utrecht*	*Professor of Ethics, in particular bioethics* *Professor of Forensic Psychiatry*	*Ethics of (neuro)technology and forensic psychiatry*
Dr. EA Mulder	*AmsterdamUMC-VUmc* *Curium-LUMC*	*Senior researcher/ Program leader Academic Workplace Youth at Risk*	*Youth at risk, risk profiles of delinquent youth*
Prof. dr. R Otten	*Radboud University*	*Professor of developmental psychology*	*Vulnerable youth and risk behavior*
Prof. dr. A Popma	*AmsterdamUMC-VUmc*	*Professor of child and adolescent psychiatry*	*Child and adolescent psychiatry, forensic psychiatry*
Prof. dr. JT Swaab	*Leiden University, faculty of Social and behavioral Sciences*	*Professor of Clinical neurodevelopmental sciences*	*Assessment and treatment, clinical neuropsychology, Initiator Preventive Intervention Team (PIT)*
Dr. A Vandenbroucke	Leiden University, psychology	*Post-doc/lecturer*	*Project coordination and involvement of youth*
Dr. M de Vries Robbé	*AmsterdamUMC-VUmc*	*Senior researcher*	*Risk assessment in forensic youth*
Prof. dr. R Didden	*Radboud University*	*Professor of learning and development*	*Intellectual disabilities, learning and development in forensic psychiatry*

Co-funders

Co-funding partner(s)				
Name, title(s)	***Organisation***	***Type***	***Sector***	***Expertise (in key words)***
Drs. C Peeters	*RJJI RijksJustitiële JeugdInrichtingen*	*Governmental organisation*	*Government*	*Juvenile forensic treatment*
Dr. K Nijhof	*Pluryn*	*Business large*	*Healthcare*	*Forensic treatment*

Dr. M Kempes	*NIFP*	*Governmental organisation*	*Government*	*Forensic assessment*
Drs. M van Baggum	*De Borg*	*Business large*	*Healthcare*	*Forensic treatment for people with intellectual disabilities*
(to be decided during the project)	*knowledge utilization management partner*	*Association*	*Healthcare*	*Knowledge utilization & entrepreneur-ship*

Cooperation partners

Cooperation partner(s)*				
Name, title(s)	***Organisation***	***Type***	***Sector***	***Expertise (in key words)***
Drs. AWM Eijken	*Ministry of justice and Security*	*Other, namely: government*	*Government and education*	*Juvenile justice*
Drs. E Overweter	*Young in prison*	*Foundation*	*Other, namely: youth organisation*	*Youth participation, delinquent youth*
Prof. mr. dr. EM Mijnarends	*Prosecution office (OM)*	*Other, namely: juvenile judicial law*	*Government and education*	*Youth law, adolescent criminal law*
Dr. C van der Zwaluw	*Freelance researcher User experience , formerly TU Eindhoven*	*Business small*	*Technology, Media and Telecommunication*	*User experience*
Mr. drs. Saskia Capello	*Dutch probation offices*	*Other, namely: juvenile judicial law*	*Government and education*	*Rehabilitation, post-detention functioning of delinquent youth*

2. Problem statement and Impact

2.1 Problem statement and fit to NWA routes

2.1.1. Societal problem and fit to NWA route(s)

The murder of Peter R de Vries, a well-known crime reporter, on July 15, 2021 had a major impact on Dutch society. One of the accused murderers was a young man, Delano G., aged 21. He was once an ambitious dancer and rapper, who ended up a criminal. He had been in regular contact with the police and four years before the murder, he was sentenced to 15 months youth detention in a Juvenile Justice Institution. Several articles in the media covered his story, all evolving around the same question: how can an adolescent that has been in youth detention and was under supervision of the probation services, still end up in serious crime?

Serious juvenile crime increases

Serious criminal offences by juvenile delinquents have a major impact on society in terms of impact on victims, and general feelings of unsafety in society**.** Although the number of juvenile delinquents in The Netherlands has decreased in the last decade (Van der Laan, Beerthuizen, & Booth, 2020), this is less so for the number of juvenile delinquents displaying serious crimes. In 2021, the prosecution office reported a worrisome trend for an **increase in seriousness of crimes among those juveniles** who are prosecuted for an offense, specifically in minors and young adults. The number of minors suspected of a serious offence had increased 17%, from 1.633 suspects in 2019 to 1.904 in 2020 (OpenbaarMinisterie, 2021). These minors were suspected of aggravated assault, theft with severe violence, extortion or serious threats. The number of young adults up to age 21 suspected of a violent crime also increased by 4%, from 1894 in 2019 to 1979 in 2020. The number of **underage (up to age 18) manslaughter suspects increased by almost 50%** to 199 suspects, while the number of **young adult manslaughter suspects (up to age 21**) **increased by 38%** to 226. Sentences for under aged suspects of serious offences can include youth detention within a Juvenile Justice Institution (JJI). In 2019, 1.175 minors were sentenced to youth detention; an increase of 17.5% compared to 2018, when 1.000 minors were sentenced to youth detention (CBS, 2021).

High juvenile reoffending rates

In addition to an overall increase in serious crimes amongst adolescents and young adults, reoffending rates in juvenile delinquents remain substantial (Van der Laan et al., 2020). Specifically, **reoffending rates of juvenile delinquents** after a stay in a JJI and of young adults after a prison sentence **remain high at 56%** (Weijters, Verweij, & Tollenaar, 2017). **The seriousness of their offences may even increase after detention,** as is illustrated by the case of Delano G. above. Moreover, these youth show **adverse outcomes in adulthood**, such as problems with mental and physical health, as well as with economic and societal functioning (Odgers et al., 2008)**.** The increase in serious crime, in combination with high reoffending rates and negative societal outcomes for juvenile delinquents, emphasize **the need for more effective forensic youth care**.

Improving assessment and interventions in Juvenile Justice Institutions

Besides protecting society, punishment and retribution, **forensic institutions have a main task in reeducation and treatment of serious juvenile delinquents**. In some cases, a PIJ (in Dutch: *Plaatsing in een Inrichting voor Jeugdigen*) measure, placement in a youth forensic treatment institution, is given, which is specifically aimed at treatment of underlying behavioral and mental health problems. However, also without a PIJ measure, forensic institutions have the task to screen for individual risks and needs and provide interventions when needed. As delinquent youth form a heterogeneous group, with various complex problems, JJIs provide a myriad of forensic interventions, varying from psychotherapy and cognitive behavioral therapy, to creative therapy, family therapy and pharmacotherapy. However, despite the wide offer in interventions, not all delinquent youth profit, as reoffending rates and psychosocial functioning outcomes are still unfavorable for many delinquent youth. **There is a need for more accurate screening and effective use of intervention programs tailored to the individual problems of adolescent perpetrators of serious offenses.** According to the current biopsychosocial model for delinquent behavior, a crucial aspect in the development of juvenile delinquent behavior is the neurobiological development (Popma & Raine, 2006). During adolescence, the brain is still fully developing. In combination with personal psychological and social (psychosocial) factors, this may cause some individuals to be more at risk for persistent criminal behavior. On the other hand, the fact that the brain is still in development, also poses opportunities for intervention, to steer development in a positive direction. However, **neurobiological developmental aspects are currently not integrated with current forensic assessments for screening and intervention.**

Inefficient application of adolescent criminal law

Adolescent criminal law has been in place since 2014. Under this law, judges can decide to apply juvenile or adult law, based on the developmental level (i.e. an 'unfinished development') of the accused. This means that young adults up to age 23 can also be sentenced to youth detention. A recent evaluation of adolescent criminal law showed that the characteristics of the group of young adults that could benefit from adolescent criminal law remain unknown, and current decision tools are insufficient to tackle this problem (Prop, Beerthuizen, & Van der Laan, 2021; Van der Laan, Zeijlmans, Beerthuizen, & Prop, 2021). Neurobiological studies, such as from Crone and Dahl (2012) show that delay of brain development is related to delinquent behavior. This knowledge lies at the basis of construction of adolescent criminal law. However, the neuropsychosocial profiles of young adults who benefit from intervention under adolescent criminal law remain unknown and current assessment methods remain inadequate, which might result in assigning a non-optimal sentence and consequently non-optimal treatment to the juvenile. As a result, **adolescent criminal law is not efficiently used, and can introduce inequality within the criminal justice system, and thus also increase the risk of reoffending.**

Fit to NWA routes

With the current project, we will contribute to the following NWA questions:

- **058. What are the patterns and causes of crime and how can we influence them?**

Within SCIN we will implement neurobiological assessments in combination with existing psychosocial assessments in screening and intervention in clinical forensic practice, in order to define specific biopsychosocial profiles that are related to reoffending risk and treatment outcomes. Our aim is to provide fundamental knowledge on how forensic treatment affects neurobiological characteristics of antisocial behavior during treatment, and how neurobiological changes relate to outcome of forensic interventions in youth. This knowledge will help us to better deploy existing interventions based on the individual needs and developmental profiles of delinquent youth to decrease reoffending. The neurobiological knowledge and interventions will be considered together and in integration with psychological and sociological knowledge and interventions

- **059. How can we help children and adolescents grow up safe and healthy?**

More effective, personalized intervention programs will also increase psychosocial functioning of delinquent youth, and help them to develop into healthy adults who contribute to, rather than harm, society. Ultimately, our project will lead to a safer society, since reoffending and the subsequent burden for society will decrease. Moreover, as antisocial behavior of an individual youth can have major impact on peers in terms of physical and psychological harm and/or negatively influencing behavior of peers, the positive effect of more effective interventions will extend to other children and adolescents in the vicinity of the delinquent youth within the study.

Fit to current NWA research activities

The current project fits within the **NeurolabNL research agenda under Brain and Social Safety, theme 3: Neuroscience and antisocial behavior.** As is stated in the research agenda, a main issue in this respect is: '..how can justice be helped with insights into the causes of differences between people in aggression or behavioral control? Here too, the research field is in full swing, ready to make big strides.' Within this agenda, it is also stated that 'the integration of neuroscientific perspective on (antisocial) behavior in addition to the- within the field of justice and safety more usual - psychological and social perspective, increases knowledge and understanding. This **integration** also provides an enrichment of the 'toolbox' of assessment instruments, interventions and prevention methods.' (see NeurolabNL Onderzoeksagenda). This is exactly what SCIN aims for within the sector of youth forensic care.

The unique asset of the SCIN consortium is that it can build on its extensive experience and results obtained during the **NeurolabNL Startimpulse** project. The proposed project extends our work in project 3 of the NeuroLabNL Startimpulse on brain development in (problematic) antisocial behavior and application of this knowledge in safety measures and interventions (Deel project 3). Within this project, we have found robust and reliable **neurobiological indicators of persistent antisocial behavior/delinquency.** This stresses the need for the incorporation in treatment (Blankenstein et al., 2021).

Moreover, as for influencing the causes of crime and promoting healthy development, we have shown the effectiveness of a preventive intervention based on individual neuropsychological screening. The **addition of personalized psychosocial screening can increase the effectiveness of treatment** (Blankenstein, De Sonneville, & Swaab, in prep.; Van Zonneveld, 2019). It is unclear, however, how these biopsychosocial factors interact and how personalized screening can be utilized to tailor individualized intervention programs.

Finally, in collaboration with the Universities of Applied Sciences Windesheim and Utrecht, and with additional funding from ZonMw (grant number 729211001), we have developed **educational modules on knowledge & attitudes regarding the role of neurobiology** in the development of antisocial behavior for (future) professionals. (see http://www.bureaunauta.nl/preview/BrainstormClip04.mp4 for a filmclip example)

Due to amongst others the NeurolabNL matchmaking session, our consortium has expanded to include more societal stakeholders (RJJI, DJI, YiP,, De Borg), and essential scientific experts in several fields (i.e., neuroethics, law, data science). Within SCIN we will together expand our knowledge on the role of neurobiological factors in screening and intervention in the clinical forensic youth setting, and implement this knowledge in practice, with the ultimate goal to improve effectiveness of youth forensic interventions. As the main consortium partners from the Startimpuls are also involved in the current consortium, we have the unique opportunity to build on previous ideas, and work with the scientific and societal partners in co-designing the current SCIN project and impact plan for extending and implementing the results.

2.1.2 Causes

As a consortium, at the initiative of the societal partners, we have detected two main challenges that highly impact the effectiveness of forensic practice to reduce reoffending rates:

1. **Youth forensic treatments are insufficiently tailored to the specific individual developmental problems** and dysfunctions of delinquent youth, resulting in **high reoffending rates.** Forensic clinical practice and risk assessment can benefit from new neurobiological and neurocognitive knowledge on antisocial development, by 1) improving prediction of individual reoffending risk after forensic treatment in JJIs (de Ruigh 2020), and 2) by assessing individual neurobiological and psychosocial changes during specific interventions that are related to positive outcomes (Jambroes et al., 2019). This will help to better match currently available interventions to individual risks and needs. However, **neurodevelopmental knowledge is hardly used in forensic practice, let alone integrated with psychosocial factors.**
2. **Adolescent Criminal Law** (in Dutch: **Adolescentenstrafrecht**) for youth between 16-23 years of age **is not efficiently nor fairly used** (8)**.** Adolescent criminal law has been in place since 2014. Under this law, judges can decide to apply juvenile or adult law, based on the developmental level ('unfinished or delayed development') of the accused. This law is largely based on the current scientific knowledge that **brain development and neuropsychological functioning may not be finished until the age of 25** (Crone & Dahl, 2012; Gogtay et al., 2004; Gur, 2005). This stage of development in progress offers a window of opportunity to steer that development in a positive direction. Currently, however, science provides **insufficient objective criteria for 'unfinished development**' (Barendrecht, Beerthuizen, & Van der Laan, 2018) (Spanjaard, File, Noom, & Busse, 2020). There is an urgent need for neurobiologically informed, easy-to-use tools to help advisory bodies (such as NIFP) and courts (judges, prosecutors) assess whether a young adult is still in development, and should be tried according to juvenile criminal law.

The main underlying cause of both challenges is that **neurobiological assessments are not an integrated part of current assessments** in forensic clinical practice, nor in the assessment for adolescent criminal law**.** The current principal model for understanding development and persistence of delinquent behavior is the **biopsychosocial model.** Based on this model, it has been suggested that neurobiology should have a prominent part in forensic assessment (Popma & Raine, 2006). However, **several gaps in that knowledge hamper implementation in clinical forensic practice**.

There is a lack of fundamental knowledge on:

- **how to assess individual biopsychosocial developmental status,**
- **how biopsychosocial developmental status can be used to personalize forensic treatment programs**
- **how forensic treatment affects neurobiological development of antisocial youth,**
- **how neurobiological and psychosocial changes are related to treatment outcomes.**

This fundamental knowledge is essential to better identify the specific needs and risks of individual youth. Depending on the individual developmental status, we will be better able to determine whether there is still enough neuroplasticity to steer an initial antisocial development into a positive direction. This will also provide adolescent law with objective criteria for developmental delay.

2.1.3 Assumptions on problem statement and causes

1 **Screening and intervention in forensic clinical practice should be based on an integration of neurobiological and psychosocial factors.** The current leading model for the development of (persistent) antisocial and delinquent behavior is the **biopsychosocial model**. Therefore, individual risk prediction should be based on the integrated assessment of neurobiological and psychosocial factors. Our previous studies have provided first indications that adding neurobiological assessments to the currently used standard psychosocial assessments enhances prediction of reoffending risk and mental health outcome (de Ruigh et al., 2021; de Ruigh et al., 2019) and effective preventive intervention programs (Blankenstein et al., in prep.).

2 When adequately assessing risk, based on biopsychosocial assessments, we should also **adapt our interventions on individual risks and needs.** Delinquent youth is a heterogeneous group, with varying levels of risk of reoffending, adverse mental health and societal outcomes. Forensic treatment can be more effective by 1) improving prediction of individual reoffending risk after forensic treatment in JJIs (de Ruigh et al., 2021; Ruigh et al., 2020) and 2) by assessing individual neurobiological changes during specific interventions that are related to positive outcomes (Jambroes et al., 2019). This will help to **better match currently available interventions to individual risks and needs.**

3 There is an **urgent need for neurobiologically informed, easy-to-use tools to help advisory bodies** (such as NIFP) and courts (judges, prosecutors) assess whether a young adult is still in development, and should be tried according to juvenile criminal law. Adolescent criminal law is largely based on the current scientific knowledge that brain development and neuropsychological functioning is not finished until the age of 25 (Gogtay et al., 2004; Gur, 2005).

4 Since adolescents are still developing, there is a **window of opportunity to steer their development in a positive direction** within a youth forensic treatment setting. This is the basis for Adolescent Criminal Law. Currently, however, science provides insufficient objective criteria for 'unfinished development' (Barendrecht et al., 2018; Spanjaard et al., 2020).

5 **Forensic treatment affects neurobiological development of antisocial youth, which is related to treatment outcome.** In screening and assessment of forensic youth, we usually make a distinction between static and dynamic factors. The main assumption here is that dynamic factors can be changed by interventions, which reduces risk and promotes a positive mental health and societal outcome. As for neurobiological measures, we make a similar assumption: part of neurobiological risk factors will be dynamic and **can be influenced by our interventions**, and is related to favorable outcomes. However, although behavioral interventions also affect neurobiological functioning (Jambroes et al., 2019), current knowledge on how interventions influence neurobiological developmental changes and subsequent positive development is still limited.

2.2. Societal impact

2.2.1 Societal impact

The SCIN project aims to improve SCreening and INtervention in the youth forensic setting. We will add to accurate risk assessment and the personalization of treatment programs for adolescent perpetrators of serious offenses, by **integrating neurobiological assessments** in current application of Adolescent Criminal Law, screening of risks and needs, and treatment decisions for specific intervention programs. This will result in **a personalized deployment of forensic youth interventions**, tailored to the **individual risks and needs of delinquent youth**.
Eventually this will lead to:

- **Decrease in reoffending rates**
- **Decrease in mental health problems of juvenile offenders**
- **Increase in societal participation (self-care, relevant daily activities, social network)**

A decrease in reoffending rates will **decrease societal costs** related to juvenile delinquency, such as societal unrest, psychological damage for victims and financial costs (material as well as mental health care).
Moreover, improving treatment enhances **positive psychosocial functioning** of juveniles in terms of **mental health and societal functioning**. This will also reduce societal costs by prevention of chronic mental health problems and associated medical costs. Additionally, it will improve societal functioning, such as having a job and thereby preventing costs associated with societal non-participation.

2.2.2 Assumptions

Personalized programs increase effectiveness of screening and intervention in forensic clinical practice

1. **Neurobiology should have a prominent part in forensic assessment and treatment.** By integration of neurobiological psychological and social factors in screening and intervention of severe antisocial youth we can personalize programs on the basis of developmental needs and increase effectiveness of forensic treatment (Popma & Raine, 2006).
2. **Neurobiology should have a prominent role in assessment for Adolescent Criminal Law.** Although adolescent criminal law is largely based on neurodevelopmental knowledge, there are currently no objective criteria for developmental delay (Van der Laan et al., 2021). Neurobiology will add to objective

criteria for fair allocation to juvenile law and subsequent effective treatment (see assumption 1) for those with a developmental delay.

3. **Effective treatment based on profiles using a combination of neurobiological and psychosocial information will decrease reoffending risk and subsequently decrease reoffending rates**
4. **Effective treatment will improve mental health and prevent development of chronic mental health problems in delinquent youth.**
5. **By reducing reoffending and improving mental health, societal functioning will also improve,** because youth will be better able to care for themselves as well as for people in their social network, by finishing their education, holding a job or exploring other relevant daily activities, and contributing positively to society.

2.3 Suitability of Impact Plan approach

The Impact Plan approach is most suitable for this project and the foreseen breakthroughs.
Within SCIN we apply an integral, multidisciplinary design where we first develop a concept **neurobiological test battery** in collaboration with clinical practice, then integrate this into **standard clinical assessments.** This generates longitudinal data that will be used to develop **prediction models** and gain knowledge on the changeability of neurobiological measures during treatment. In turn, this information will be used to improve the assessment battery, but also to develop decision tools for personalized, effective interventions within the institutions as well as for Adolescent Criminal Law. Crucial in the SCIN project is that this will be a **continuous iterative process of implementation, data collection and further development of screening and intervention tools**, all in direct collaboration with clinical practice: **professionals *and* youth**. Working together in a multidisciplinary setting, covering the complete juvenile justice chain, and collecting data within clinical practice, is crucial for achieving a scientific breakthrough in translating neurobiological knowledge at group level to the individual level, as well as for direct implementation of this knowledge in effective screening and personalized interventions in youth forensic clinical practice. As such, the project will have a direct impact on clinical practice through increased effectiveness of forensic youth care. Effective youth forensic interventions will reduce reoffending risk, increase mental health and stimulate positive societal functioning of (former) juvenile offenders. Eventually, society will benefit because this will reduce criminality. Moreover, former juvenile delinquents will develop into healthy adults that positively contribute to, rather than harm, society.

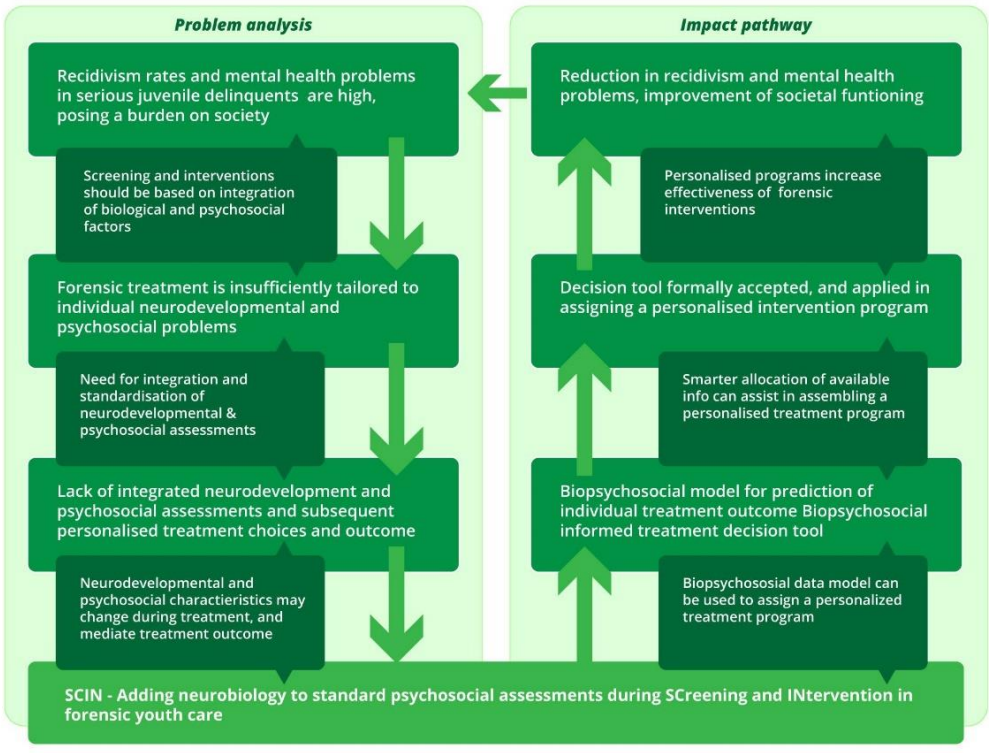


Figure 1: SCIN impact plan - Theory of change diagram

3. Consortium

3.1. Composition of consortium and productive interactions

The SCIN consortium consists of a strong mix of scientific and societal partners that are already partly involved in the NeurolabNL Startimpuls deelproject 3 and have co-designed the current project proposal.
The consortium consists of scientific partners from **three different universities**: From **AmsterdamUMC- VUmc**, *dr. L. Nauta-Jansen (project leader), prof. dr. A. Popma, dr. N. Blankenstein, dr. E. Mulder, dr. M. de Vries Robbé, and mr. dr. L. van Domburgh* are part of the research line Risk at Youth, and will provide their expertise on the (neuro)developmental factors involved in the development and persistence, as well as treatment of antisocial behavior in youth. *Prof. dr. Gerben Meynen*, also from **VU university as well as Utrecht University**, will provide expertise on ethics of (neuro)technology and forensics psychiatry. From **Leiden University***, prof. dr. H. Swaab*, is the founder of the Preventive Intervention Team (PIT) project. She will provide her expertise on development of personalized preventive interventions based on neurocognitive profiles.d*Dr. A. Vandenbroucke* is involved as coordinator of the Startimpulse and for her expertise in academic-youth collaboration (NeurolabNLYoung). From the faculty of Law, *dr. J. Jansen* and *prof. dr. I. Mijnarends* contribute to the judicial aspects of the project, specifically regarding adolescent criminal law. From the Radboud University, prof. dr. Otten, prof. dr. Didden and dr. De Looff will be involved based on their expertise on innovative longitudinal designs and methods (including wearables) for data sampling in daily clinical practice. Together with *Dr. J. Lokkerbol* from **Trimbos institute,** they will provide expertise on innovative data analysis and machine learning techniques. From the **universities of applied sciences** (resp. **Hogeschool Windesheim, Hogeschool Utrecht**) *dr. D. Graas* and *dr. A. Donker* are involved for their expertise in translating scientific knowledge to clinical forensic practice, in co-creation with professionals and youth, as well as translating scientific knowledge to the education of forensic professionals.
The **societal partners** that are involved are *dr. K. de Kogel*, senior researcher in forensic psychology at the **WODC**, with specific expertise on the role of neurobiology in the judicial system; *dr. K. Nijhof*, from the innovation and research department of **Pluryn**, a youthcare organisation with several services including a juvenile justice institution, for her expertise on assessment and treatment in forensic practice; *dr. M. Kempes*, head of the department of research & education at the **Netherlands Institute of Forensic Psychiatry & Psychology**. This institute is involved in forensic psychiatric/psychological assessment of young adults and advises the judge about application of adolescent criminal law; *drs. C. Peeters*, managing director of the **State Juvenile Justice Institutions (RJJI)**. The RJJI were involved in establishing the initial need for neurobiological assessments in clinical practice, and they will play an important role in ensuring the practical feasibility of this project; *drs. M van Baggum*, director of **expertise center de Borg**, a cooperation of four mental health organizations for her expertise on assessment and treatment of forensic juveniles with intellectual disabilities. Experience expert youth will be involved through Young in Prison, to co-create the different phases of the research and implementation.
In addition, **cooperation partners** such as the ministry of Justice and safety, adult penitentiary institutions, prosecution office and probation services will have an advisory role throughout the project (see 6.4.2. Project Advisory Committee).
Together, the consortium **covers the complete juvenile justice chain**, and the **full chain from science to clinical practice to education** of forensic professionals, to ensure that the project will be performed in co-creation with all stakeholders and is poised to have a significant impact on clinical youth forensic practice.

3.2. External stakeholders

Youth with experience in forensic youth settings will be involved in development from day one of the project. Their involvement is ensured via Young in prison, but additionally youth from ExpEx could be involved as well, as we have already done for other projects. Moreover, some institutions within the consortium have close collaborations with specific youth ambassadors. They will be involved in the co-creation of biopsychosocial assessments, decision support tools and educational material for youth.
Other Juvenile Justice Institutions (JJIs) and board of directors of the JJIs (Inhoudelijk Directeuren Overleg, IDO).
The SCIN data collection will start within the RJJIs and JJI Lelystad, but there are more JJIs in The Netherlands that could be involved later on in the project (f.i. to increase the inclusion rate). The IDO is the board of directors of the JJIs and will be consulted for this.

Penitentiary Institutions (PIs) for adults are currently not part of the SCIN project, but will be consulted during the project. They will also be involved to recruit additional 18-23 year-olds that are convicted under adult law.
Judges are responsible for actually applying adolescent criminal law. The SCIN project will consult both juvenile and adult judges, specifically in the development of the Adolescent Criminal Law screening and decision support tools.
Probation services and child protection boards, together with juvenile justice institutions are jointly responsible for the diagnostic process and intervention of delinquent youth. They are responsible for supervision, as well as in planning and implementation of forensic care. Moreover, they have an important role in the assessments for Adolescent Criminal Law and will be involved in the development of the screening and decision support tools regarding developmental delay.
Ministry of Justice & Security A large-scale development process is currently underway at the ministry to work towards more personalized diagnostics and intervention (VOM-Vrijheidsbeneming Op Maat). The desire to better implement neurobiological assessments is explicitly mentioned as part of the process. From the perspective of the ministry, this is both a clinical (design and further diagnostics and treatment) and a technical process (developing better ICT support).
Dienst Justitiële Inrichtingen (DJI) The Ministry of Justice and Security is responsible for the enforcement of that sentence or measure. This duty has been delegated to the Custodial Institutions Agency (DJI). DJI's most important task is to realise the detention of convicted individuals in order to ensure that justice is served in order to ensure a safer society. In addition, DJI is responsible for the day-to-day care of the detainees and their rehabilitation. DJI will be involved in the implementation process and eventually dissemination to other forensic institutes.

3.3. Diversity of the consortium

The consortium consists of 9 female and 5 male co-applicants, age range 30 - 58 years old.
In the appointment of new staff, specific attention will be paid to diversity, conform diversity policy at the knowledge institutions. The youth and professional advisory board will be carefully selected to achieve an accurate representation (e.g. ethnicity, SES, intellectual functioning) of the populations within the forensic youth settings.

3.4. Involvement and development of young and mid-level researchers within the project

Co-applicants already vary from **early career researchers to senior staff**. The consortium forms a **multi-disciplinary team, with backgrounds in philosophy, econometry, law & management, ethics, artificial intelligence, biomedical sciences, neurophysiology, psychology,** and related disciplines. In addition, we will appoint a post-doc/project coordinator, 3 PhD students and 2 post-doctoral researchers to run the project.
SCIN will invest in the development of both PhD students and post-doctoral researchers, to eventually become senior researchers or achieve assistant professor status. Besides training programs for PhD from the universities involved, SCIN will provide scientific training elements, such as mentoring and intervision and specific seminars related to forensic research and practice. Unique for SCIN is that we will provide training for our researchers to become **science practitioners**. Researchers will perform their research project *within* the juvenile justice institutions, take part in the daily screening and assessment and help to develop new guidelines and procedures for screening and intervention programs. This formula has been **proven successful** as former PhD students from Amsterdam UMC are currently employed at forensic youth settings, combining clinical and research tasks, even at the management level (f.i. Van Domburgh). In turn, our researchers will train professionals in practice to incorporate science in their daily job. We will involve these professionals in all phases of the project, and they will closely work together with the researchers. This will provide a unique opportunity to provide provide with general skills regarding the implementation and evaluation of new screening and intervention methods within clinical practice.
A particularly difficult step in career development is the **step from postdoc into a tenure track position**. This will be given particular attention in SCIN, in line with the Dutch program **"Erkennen en Waarderen"**. They include: a) publications as first or last author; b) coaching in writing high-quality and competitive grant proposals (Veni); c) opportunities to speak at (inter)national conferences, workshops or seminars; d) acquisition of mentoring and teaching skills; e) contribution to science communication; f) opportunity to be directly involved in the supervision of PhD students as co-supervisors; g) developing management skills through large scale project management. This initiative will contribute to their career development. However, the university makes the final decision about whether someone can be promoted from postdoc to assistant professor.

4. Impact Pathway

4.1. Impact Pathway

The SCIN project aims to **integrate neurobiological and neuropsychological assessments with standard psychosocial assessments** currently used within the youth forensic institutions. These biopsychosocial assessments will form a comprehensive biopsychosocial screening & assessment battery that will be used to assess all juveniles on a regular basis throughout the intervention trajectory.
The data collected from the repeated biopsychosocial screening & assessment battery will in turn provide input for **a longitudinal biopsychosocial database and model** development. This will provide the opportunity to gain fundamental scientific knowledge on biopsychosocial mechanisms underlying behavioral and neurobiological change, treatment outcome and the relation between treatment initiatives and the observed behavioral and neurobiological development.
Based on the model, a **decision support tool** will be developed to assign individual adolescents to a treatment program based on their individual profile of risks, strengths, and needs. A comparable decision support tool will be designed for youth in the 16-23 age range within the Adolescent Criminal Law system. To safeguard future use beyond this project, learning modules on biopsychosocial factors in delinquent behavior and training on how to use the screening & assessment toolkit, and the decision support toolbox will be developed for both professionals and youth themselves. (outputs)

Both the assessment battery and decision support tools will be **developed and tested together with youth and professionals** at the management and treatment level. This ensures maximal integration between existing psychosocial assessment and innovative neurobiological screening in one comprehensive assessment toolkit. The SCIN project will follow an **iterative process**. The use of the biopsychosocial assessment battery and decision tools in practice will continuously provide additional data to improve the model, and dynamically adjust the concept assessment battery and decision tool. Eventually, this will lead to **more effective, personalized screening, assessment and interventions.** This applies also to the process leading up to sentencing under Adolescent criminal law. More knowledge about which young adults would benefit from Adolescent criminal law sentencing will result in an increase of young adults being sentenced under juvenile law. In addition, subsequent interventions within the JJIs will be tailored to these profiles. (outcome)

Together, more effective interventions for seriously delinquent youth and effective use of Adolescent criminal law will lead to a **decrease in reoffending rates and better individual and societal functioning** of the (previously) delinquent youth themselves, both in terms of mental health and positive participation in society. (societal impact)

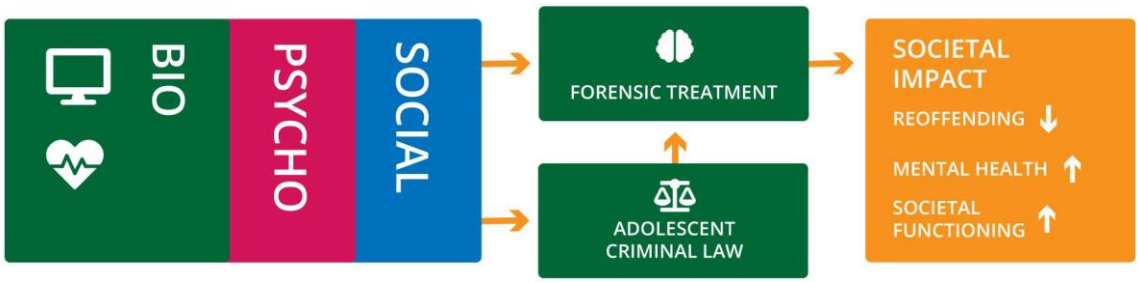


Figure 2: *Schematic model of the impact pathway of the SCIN project*

4.1.1. Outcomes

1. **Biopsychosocial assessment batteries are accepted and used for screening and intervention monitoring in youth forensic clinical practice and adolescent criminal law.**

During year 1,we will work in co-creation with professionals and youth within the forensic institutions (RJJI - De Hartelborgt Spijkenisse, Den Hey-Acker Breda, Pluryn -JJI Lelystad, De Borg - Trajectum, Boschoord, Fivoor, Den Dolder, Ipse de Bruggen, Zwammerdam en Stevig Dichterbij, Oostrum) and the NIFP on the practical usability and acceptance of an integrated biopsychosocial assessment battery for use in clinical forensic practice and institutions (probation services and NIFP) involved in adolescent criminal law. Two toolkits will be developed: one for assessment and treatment monitoring in forensic interventions and a comparable battery for assessment in adolescent criminal law. The integrated biopsychosocial toolkit will be developed in collaboration between the *researchers form WP1 (AmsterdamUMC and University leiden) and professionals and youth from*

the forensic institutions in an attractive and user-friendly format, including a dashboard for individual profiles and monitoring purposes. Researchers from WP2 will also be directly involved in the development of the toolkit to ensure that the data collection is properly aligned with the data analysis.
Subsequently, the concept batteries will be piloted within the JJI's and institutions involved in adolescent criminal law for 6 months.
During this period, we will regularly (at least monthly) collect feedback on the actual use as well as experienced relevance and practical usability within the institutions, and adjust the concept battery where necessary.
After the 6-month pilot phase, in year 2, the assessment battery will be finalized and implemented broadly within the participating forensic institutions to be used for standard screening and monitoring during intervention in the JJIs:

- ***Management of the institutions*** *(RJJI, Pluryn, De Borg, NIFP)* has to support the use in screening and monitoring, and provide for resources in terms of personnel and infrastructure (ICT, equipment, assessment facilities).
- **Professionals *within the institutions*** will participate in scientific research, collaborate with researchers from WP1 in design and implementation of biopsychosocial screening and monitoring.
- ***Universities of applied sciences (HU - Donker, Windesheim - Graas)*** will provide training in the use of the toolkit by means of a train-the-trainer model in order to create local 'champions' running and monitoring the implementation process.
- ***Researchers from Radboud university (de Looff, Otten) and Trimbos (Lokkerbol)*** will develop and train researchers and (ICT) professionals to transfer biopsychosocial assessment data for analyses and model building.

After implementation, in year 2-5,

- ***Professionals*** are using the toolkit, and can integrate neurobiological assessments and knowledge in their interactions with youth. This includes professionals at all levels, not only forensic psychologists and psychiatrists, involved in advising on interventions and adolescent criminal law, but group leaders are specifically important, as they have a major role in incorporating intervention in the daily routine and observation and monitoring of behavior of youth during their stay within the institutions.
- ***Youth*** are willing to participate in the assessments, assessments are attractive and outcomes are understandable and relevant for youth themselves.
- ***Feedback from professionals and youth*** regarding relevance and usability will be collected at specific time points throughout the SCIN project (see strategic activities). In turn, they will be provided with the latest knowledge from the data analyses and the model by the researchers. Based on that, the assessment battery will be further developed. This will be a continuous process throughout the complete project.

Indicator: In year 5, standard biopsychosocial screening should be performed in 80% of youth within the JJIs and adolescent criminal law and for 20% of the population within the JJIs longitudinal biopsychosocial assessments should be available.

2. **Biopsychosocial support tool for assigning personalized intervention programs is proven effective?, accepted and used in youth forensic clinical practice**.

After initial data collection and model building, in year 4, we will start with the development of the decision support tools for personalized interventions in clinical forensic practice.
We will work in co-creation with professionals and youth within the forensic institutions (RJJI - De Hartelborgt Spijkenisse, Den Hey-Acker Breda, Pluryn -JJI Lelystad, De Borg - Trajectum, Boschoord, Fivoor, Den Dolder, Ipse de Bruggen, Zwammerdam en Stevig Dichterbij, Oostrum) on the content, form and practical usability of a treatment decision support tool. This should lead to an attractive and user-friendly format, including a dashboard for individual treatment trajectories, highlighting changes and opportunities for specific intervention.
After a pilot phase of 6 months, the treatment decision support tool will be implemented by professionals and used for supporting treatment decisions in the forensic institutions **.**

- The decision support tool is considered a helpful instrument to decide on individual treatment programs.
- Biopsychosocial assessment results and the use of the decision support tool are specifically mentioned in the perspective plans (*perspectiefplannen*) for youth.
- Youth are involved in the treatment decision and have control over their intervention program. Youth are motivated for treatment.

Indicator: At the end of the project, the decision tool should be used for 80 % of long-stay youth within the JJIs for selecting a personalized intervention program, biopsychosocial information is mentioned in the intervention plans ('perspective plans').

3. **Biopsychosocial decision support tool is accepted and used by professionals involved in Adolescent Criminal Law.**

Also in year 4, we will start development and implementation of the biopsychosocial assessment and decision support tool for adolescent criminal law.
After the pilot phase of 6 months, the treatment decision tool should be accepted and ready for use by forensic psychiatrists and psychologists from the NIFP in supporting decisions within Adolescent Criminal Law.

- Forensic psychologists and psychiatrists will be able to make well-informed decisions, based on objective criteria regarding the use of Adolescent criminal law for those individuals that are most likely to benefit.
- Youth are willing to participate in the necessary assessments and are involved in the decision process.
- The decision support tool is seen as a helpful instrument by forensic psychologists and psychiatrists from NIFP to give advice about adolescent criminal law to the judge.
- Biopsychosocial assessment results and the use of the decision support tool are specifically mentioned in forensic assessment reports.
- Adolescents who are advised and or receive judgement under adolescent criminal law have profiles that relate to models indicating delayed development. Adolescents who are advised and receive judgement under adult criminal law have profiles that resemble models indicating no significant development during stay in JJI.

Indicator: At the end of the project, the use of the decision support tool and the role of biopsychosocial factors in assessing developmental delay is mentioned in 80% of advice within Adolescent Criminal Law, of youth between 16 and 23 years of age.
(see also Annex 2, project overview, for specific planning of outputs)

4.1.2. Assumptions

1. **Although the biopsychosocial model is generally accepted as the model for development of persistent antisocial behavior, there is still a pressing need in clinical forensic practice to translate this model to standard biopsychosocial assessment throughout the forensic screening and intervention trajectory.** There is currently a lack of practical assessment methods and knowledge regarding the translation of neurobiological measures to assess biopsychosocial profiles that are related to individual risks and needs. Moreover, biological assessment should be integrated with current standard psychosocial assessments to be acceptable for clinical practice (Horstkötter & Snoek, 2020). The biopsychosocial profiles can be used to develop a decision support tool to help professionals allocate personalized treatment programs for individual youth.
2. **Objective assessment of delayed development will lead to a more effective and fair use of Adolescent Criminal Law.** Youth have the right to be judged fairly, according to their developmental status, based on objective criteria. Integration of biological and psychosocial measures will provide objective neurodevelopmental profiles that are indicative of a delayed development. Youth with such a profile will benefit from judgement and subsequent interventions under Adolescent criminal law.
3. **Professionals and youth should be actively involved in the selection and testing of the screening, assessment and decision tools and development of education material.** Implementation and effect fully depend on the willingness and ability of both professionals and youth themselves within the institutions to use the biopsychosocial assessments and decision tools.
   a. **Professionals in forensic clinical practice are eager to use the latest neurobiological knowledge, but lack the knowledge and practical abilities to do so.** Effective use of the biopsychosocial assessment battery is dependent on good integration of neurobiology with current psychosocial assessments (Horstkötter & Snoek, 2020) In addition, knowledge, attitude and practical skills of professionals, as well as availability, practical usability and support from management within the institutions. The biopsychosocial decision tool, and accompanying educational modules will facilitate professionals in the field to decide on effective, personalized intervention programs for individual youth.
   b. **Delinquent youth are interested in knowledge about their own behavior and how their behavior relates to the processes in the brain and body.** They are eager to gain more insight in their behavior and the progression during treatment, which provides them with more control over their behavior during the intervention programs(Horstkotter, Berghmans, de Ruiter, Krumeich, & de Wert, 2012). This will also increase their motivation for taking part in the intervention programs. Youth are interested in understanding their own behavior, and have a right to know on what basis they are judged. This will eventually help in verdict acceptance and increase their motivation for subsequent intervention programs.

4.1.3 Output

The SCIN project aims to provide **fundamental knowledge on individual biopsychosocial profiles**, how forensic treatment affects neurobiological development (neuroplasticity) of antisocial youth, and how changes in neurobiology are related to treatment outcome. This knowledge will be subsequently lead to the following outputs:

A set of practical neurobiological assessments will be developed and integrated with psychosocial assessment tools within youth forensic clinical practice (WP1).

1. A **concept biopsychosocial assessment battery** for screening and monitoring within the clinical forensic setting and adolescent criminal law will be ready after year 1. Based on existing neurobiological knowledge from a.o. the NeurolabNL Startimpulse project a set of initial measures will be selected that are related to stress and emotion regulation (WP1.1), cognition and self-regulation (WP 1.2), and delayed development (WP1.3). Next, the neurobiological assessment battery will be integrated with standard psychosocial assessments within the institutions**.** Specific attention will be paid to the usability and attractive design of both the assessments and the results thereof (dashboard).
2. Moreover, **educational modules** for practical use of the assessment battery for professionals, as well as information for youth will be developed by the universities of applied sciences in collaboration with professionals and youth (WP3.3).
3. The concept battery will be piloted during 6 months, and based on the results of the pilot, the **definitive biopsychosocial assessment battery** will be finalized and implemented in year 2 of the project**.** The concept biopsychosocial assessment battery will subsequently be implemented within the institutions. This will provide fundamental knowledge about how to implement neurobiological assessments in clinical forensic practice and what conditions should be taken into account. This knowledge will be disseminated in scientific reports as well as practical information for the forensic clinical sector.

The biopsychosocial assessment battery will be used to collect longitudinal data for developing individual profiles related to risk evaluation, delayed development and treatment outcome (WP2).

4. **A longitudinal biopsychosocial database** for first analyses will be ready at the end of year 3. After implementation, biopsychosocial assessments performed in clinical practice will continuously feed the database. By using growth mixture modeling, network analysis and machine learning. **A** model will be developed for the **prediction of reoffending risk, delayed development and treatment outcome** at the group level and later on the individual level**,** which forms the input for the development of the concept decision support tools and educational material.
5. The **longitudinal database** will be ready for analyzing the longitudinal data throughout the intervention trajectory at the end of year 5**.**

Final prediction models and models regarding biopsychosocial changes during treatment can be developed starting from year 5. This knowledge is important to identify which neurobiological factors can be influenced by forensic interventions and how this is related to outcome in terms of reoffending, mental health and eventually societal functioning. These models form the input for the definitive decision support tools.

The knowledge from WP1 and WP2 will be integrated to develop practical decision support tools and educational programs (WP3) .

6. In year 5, we will develop a **concept decision support tool** to allocate youth to personalized intervention programs that are deemed most effective (WP3.1) Based on data from the biopsychosocial assessments from WP1 and the model developed in WP2, individual profiles will be linked to outcomes on specific interventions. This concept model will be implemented and further developed through an iterative process, in which results from the assessments during these personalized programs also feed back to the model.
7. The **final decision support tool** will be ready in year 7.
8. Similarly, a **concept decision support tool for forensic psychologists and psychiatrists within adolescent criminal law** will be developed in year 5, to advise about assigning youth to either the juvenile or adult justice system (WP3.2).In addition, through the outline of developmental profiles. By linking the developmental profiles to treatment outcome, we will gain additional data in the next two years on which individuals with developmental delay will benefit from the interventions within juvenile justice, and should therefore be judged under adolescent criminal law.
9. The **final decision support tool** will be ready in year 7.
10. Based on the knowledge gained in the SCIN project, **final educational modules** on the use of decision support tools will be developed for both professionals and youth in year 7 (WP 3.3).

(see also Annex 2, project overview, for specific planning of outputs)

4.1.4 Assumptions

1. **According to the current biopsychosocial model for antisocial behavior, neurobiological measures should be included in screening and monitoring assessment in youth forensic clinical practice.** Neuroendocrinological, neurophysiological and neuropsychological factors are related to emotion and stress regulation (WP 1.1), executive functioning and self-regulation (WP 1.2), delayed development (WP 1.3), and persistent delinquent behavior and should be assessed in clinical forensic practice. In order to do so, neurobiological assessments should be integrated with current standard psychosocial risk assessment / risk screening
2. **Using integrated biopsychosocial longitudinal data will allow us to define biopsychosocial profiles that predict reoffending risk, and/or treatment outcome for individual youth** (WP2)**.** We have shown the value of this approach in a smaller sample of youth in JJIs in a previous study (de Ruigh et al., 2021). Currently, we are working on a similar approach using the larger NeurolabNL startimpuls database (Blankenstein et al., in prep.).
3. **Developmental delay is characterized by specific biopsychosocial profiles.** Moreover, based on the longitudinal biopsychosocial models that will be developed in WP2, we will be able to define profiles of youth that are most likely to benefit from youth forensic interventions, i.e. interventions stimulate neurodevelopment.
4. **Neurobiological measures will change during intervention, which is related to behavioural changes and treatment effect.** (WP2) Previous work of our group has shown effects of intervention on neuroendocrinological as well as cognitive functioning in antisocial adolescents during intervention (Jambroes et al., 2019; Oostermeijer et al., 2017). The longitudinal data and models that we develop in this project, will provide further knowledge on individual change profiles and how these are related to treatment effects.
5. **Based on the biopsychosocial profiles we will be able to develop a decision support tool to allocate personalized intervention programs.** Initial biopsychosocial screening will be translated to an individual profile and subsequently we can allocate a personalized intervention program that is most likely to be effective for that profile. Moreover, neurobiological assessments during interventions will provide objective indicators of treatment effect, thereby providing the opportunity to adapt the treatment program when necessary. (WP3.1)
6. **Based on biopsychosocial profiles of developmental delay, we can develop an objective screening and decision support tool for Adolescent Criminal Law.** Specific profiles of delayed development can be identified for youth in the age range from 18-23, who will benefit from youth forensic interventions and should therefore be judged according to juvenile, rather than adult law (WP3.2)
7. **The use of neurobiological assessments in screening and interventions in youth forensic clinical practice is possible, provided that professionals and youth have sufficient knowledge about biopsychosocial interactions, and practical skills and conditions are provided for.** educational modules that we will develop, are needed for both professionals and youth, to provide them with essential information, in which attitudes and ethical issues regarding neurobiological assessments are also taken into account (WP3.3)

4.1.5 Pathway diagram (Annex 1 on page 42)

4.2 Strategic activity planning

a) Stakeholder engagement

Objective
The main objective for the engagement of the stakeholders is the integration and implementation of biological assessments in standard screening and intervention in clinical forensic youth care and ASR, in order to make forensic interventions for youth more personalized and more effective.

Youth
At the start of the project , we will form an **expert board of 5-10 adolescents** that will advise us throughout the project (see also 6.4 project management). These adolescents will be recruited through our cooperation with Youth in Prison (YiP).
Throughout the project, **youth will play an important role in the design (year 1-2), data collection (year 2-4), interpretation and implementation (year 5-7) of the research.** Youth who have experience with the criminal

justice system themselves will advise on the different stages of the research. Their involvement ensures that the newly proposed biopsychosocial model and the forthcoming screening & intervention decision support toolbox are accepted by youth and feasible to implement in judicial and forensic practice.
Lastly, youth will be involved in the several broad **dissemination projects** that will take place throughout the project (see communication, year 1-7).

Forensic care professionals
In each institution, **two dedicated professionals** will be appointed for 0,1fte of their time for this project. They will also join the forensic professional advisory board.
Professionals within the institutions will be involved from the beginning of the project in development and implementation of the screening battery (year 1-2) in data collection and interpretation of the models in (year 2-4), and subsequently the development and implementation of the decision support tools (year 5-7).
Throughout the project, **educational modules** regarding biopsychosocial knowledge, attitudes and practical skills will be used to further educate all professionals (WP3.3), from psychiatrist and psychologists to group workers, within the juvenile justice institutions as well as for forensic psychologists and psychiatrists from the NIFP involved in Adolescent criminal law.

Forensic institutions and management
In addition, **managers** of the forensic institutions will be involved throughout the project, and will also take a seat in the Professional advisory board (see 6.4 project management). They are essential for providing **support for the eventual implementation** of the biopsychosocial screening and intervention support tools.
Management from the institutions will appoint professionals within the institutions that will work within the project on development and implementation of the biopsychosocial screening and intervention tools (see above). They are important for providing **practical facilities**, such as testing rooms, equipment and ICT structure.
ICT departments of the institutions will be included to co-design the assessment battery. This is crucial as the setting within forensic institutions asks for specific conditions regarding security and privacy.
Adult detention centers (*penitentiaire Instellingen*, PIs) will also be involved after development of the biopsychosocial assessment tool for adolescent criminal law, in order to also collect data on 18-23 year old delinquent youth who are judged under adult law.

<u>Co-creation and co-design</u>
Stakeholders, in specific **youth and professionals** will be engaged throughout the project in the co-creation and co-design of:

1. **Integrated biopsychosocial screening and assessment battery.** Together, we will design an assessment battery that is deemed both relevant and practical in clinical practice. This will also involve selecting those assessment forms that are most practical or appealing, and re-designing assessments that are deemed impractical or unappealing by professionals and youth. Moreover, we will design how the feedback from the assessments (dashboards) should be presented, also taking into account privacy and ethical considerations of biopsychosocial assessments in practice. Also, practical conditions such as ICT and data security will be taken into account.
2. **Intervention and ASR decision support tools.** To start, we will ask professionals and youth which problems they face in the current screening & intervention processes, and how we can match these problems with our assessment and decision tools. The universities of applied sciences have ample experience in conducting focus groups with (future) professionals regarding their thoughts and attitudes towards the use of biopsychosocial knowledge in practice. For youth, we will collect narratives of experienced experts through creative methods, such as raps. Young in Prison has extensive experience in collecting these types of data. Moreover, we will account for privacy and ethical considerations of the use of biopsychosocial decision tools in practice (Meynen).
3. **Educational modules** As a start, the already developed educational modules regarding knowledge and attitudes will be used and adapted for the current project where necessary, together with youth and professionals. In the following years, the modules will be further developed, based on new knowledge from the project. In addition, educational modules for use of the biopsychosocial screening and intervention tools will be developed in co-creation with professionals, while specific information for youth will be developed in co-creation with youth.

For professional's and youth's involvement in all these different stages, we will use **human centered design principles** (Sanders & Stappers, 2014). Human centered design focuses on the different users of a product, and uses qualitative research methods to define their needs and the context in which the product is used. Through an iterative process, a prototype product is improved until it is ready to be used in practice. The approach follows the human-centered and holistic design that characterizes this project throughout (Melles, Albayrak, & Goossens, 2020), for which co-creation with stakeholders is crucial. This means that the ***values* of**

stakeholders are central to the development of new techniques and technological tools. New technologies should protect and foster human values of those involved - e.g., autonomy - which requires a process of co-creation.

(Forensic) Youth care at large

Screening and Intervention decision support tools as well as ***educational material*** will be made available for use in other forensic institutions. This may in due time also be extended to closed youth care and ambulant forensic youth care. The decision support tools will be placed for management at a suitable partner. Some institutions already work with existing partners for management of tools (f.i. Stichting 180 and SAPROF international). A plan will be made to guarantee training, quality assurance and further development in the long term. In this phase, we will also develop a business model to ensure the sustainability of the tool (i.e., adequate management and updates, training and manual).

In addition, we will share our ***knowledge*** outside the participating practice institutions via existing channels such as NJI, Kenniscentrum KJP, AW Risicojeugd, and NeurolabNL. Youth will also play a key role to shape communication products that explain the research results to society and youth. By involving youth that have experience in the criminal justice system and treatment themselves, science communication will be more effective and tailored to groups that benefit from this knowledge, such as (potentially) delinquent youth, their parents and professionals working with youth.

Scientific community

To reach the broad scientific and professional community, ***scientific articles*** will be written in peer-reviewed open access journals, as well as trade journals. Peer-reviewed articles will be submitted once the first research projects are finished (from year 3 onwards, see also the GANT chart in annex 2), while articles for trade journals can also encompass an overview of the ongoing research, ideas for implementation, and ethics, such as Nauta-Jansen (Nauta-Jansen, 2020) and Horstkötter (Horstkotter, Donker, de Kogel, & Nauta-Jansen, 2017).

Open Science will be an integral part of this project. As we did for the NeurolabNL Startimpuls project Neurobiological correlates of antisocial behavior across adolescence: A multi-sample, multi-method study, we will make all code for data analysis available. Within the project, we will also work with pre-registration of specific (sub)projects and scientific papers in OSF.io. Scientific papers will be published in open access journals. Considering the sensitivity of our data with regard to delinquent youth, data cannot be made publicly available. However, anonymous data will be made available for specific research projects outside the consortium on request to the EB.

b) Communication

Consortium partners

As described in 6.1.4., the **Executive Board (EB)** and **Supervisory Board (SB)** will have regular meetings (EB: monthly, SB: bi-annual, see 6.4.) to discuss progress and collaboration. For the EB, a slack environment will be created for continuous communication on project activities and individual interaction between partners.

Also, the EB and SB will plan communication activities to the wider audience, and contribute to a clear and coherent communication strategy.

A separate **Youth and Professional Expert Boar**d will be formed (see also 6.4). To make their time investment feasible and purposeful, we will involve them in discussion on specific parts of the project, in setting up the research design, and specifically the assessment battery, data collection itself, and of course the implementation of the research and decision support toolbox in practice.

Stakeholders

Most stakeholders are either part of the EB, AB and/or PAC and will be **regularly updated** through their meetings (see 6.4). In addition, all consortium members and stakeholders affiliated with the project will receive a **bi-annual newsletter,** keeping them up to date about meetings, relevant symposia, research output and dissemination activities. In addition, we will create an active **LinkedIn profile and Twitter account**, as well as connect with existing accounts from consortium partners, to post messages regarding events and published results to both stakeholders and the broader forensic community as well as initiate discussion on specific topics or findings that are related to the project.

For **youth** specifically, media such as instagram, NOS stories and/or podcasts will be used, also as outreach to their more direct social relations, such as their peers, parents and teachers.

External stakeholders

External stakeholders such as the Ministry of Justice, DJI, the board of directors of the JJIs *(IDO),* OM, and probation services are important cooperation partners, and will be (and have been) **consulted** at the start of the project, in the final stage of development of the biopsychosocial screening tools and at the final stage of the development of the decision support tools. Specific meetings will be organized for this purpose. In addition, they will have access to the newsletters, Linked-In profile and Twitter feeds.

Wider audience

Scientific symposia - Scientific results will be disseminated yearly to an audience of scientists and societal stakeholders, by organizing a symposia. At the start of the project, we will present at the ESOF congress, also for the wider audience. At least once a year, we will submit a proposal for a meeting or dedicated workshop at a relevant conference for professionals and researchers, such as "Jeugd in Onderzoek", EFCAP, or other forensic and youth care conferences. In addition, we will organize an invited symposium for which we will invite international forensic researchers with a focus on neurobiology to discuss our research design, progress and implementation (Year 7).

Lectures - The consortium will actively engage in giving lectures. For the scientific community, we will visit conferences on forensic care (f.i. EFCAP) or neurodevelopment (f.i., Flux, VNOP). For stakeholders, we will seek opportunities to give lectures at organizations and institutes of the consortium partners and external stakeholders such as the Ministry of Justice and Safety, probation services, OM, etc. For the wider audience, lectures will be organized that are targeted at the social environment of youth with severe antisocial behavior, for example in cooperation with community centers in neighborhoods with a lot of youth crime. On February 4th, there is a public event in Leiden where we will present SCIN. During the project, lectures will be organized annually for the scientific community once the first results are analyzed (after year 2), and for the stakeholders and wider audience once the implications are more clear (after year 4).

Media products - Throughout the project, the consortium will proactively seek media attention, such as articles and interviews for newspapers, radio or tv-shows. In addition, for the interested public, we will make a **podcast series** based on the process and journey that we will take with the youth and stakeholders who are involved in this project. Youth themselves will be involved to co-create podcasts, events for peers, parents , teachers and the wider public. In the NeurolabNL Startimpuls project, we already have experience in creating podcast-audioclips for educational purposes, together with YiP.

(A detailed communication plan will be worked out in year 1 of the project.)

c) Monitoring & Evaluation

The Executive Board (EB) is responsible for the daily monitoring of the project (see 6.4. project management). They will meet at least twice a year to discuss the progress of the project and the specific work packages according to planning. They will monitor the achievement of outputs and outcomes, assumptions, and the strategic activities needed to achieve impact (see Annex 2, project overview, for specific planning). If necessary, the project coordinator can call on extra meetings or separate consultation with responsible work package leaders.

In addition, there will be **bi-annual meetings of the SB** (see 6.4. project management). During these meetings the progress of the specific work packages within the project will be discussed, as well as the progress regarding the general Impact Pathway. If necessary, adaptations will be made on advice of the supervisory board, and will be discussed with the PAC as well.

As for the **professional and youth advisory boards**, to make their time investment feasible, and keep motivation high, we will ask them to give advice on specific parts of the research, rather than on the research outcomes, or the progress of the research as a whole. In addition, to motivate them to continue to participate, we will feed back the results of the advice that they gave, and how this was incorporated in the research.

Finally, progress of the project, regarding output, outcomes and impact will be reported yearly to **NWO**.

d) Capacity strengthening

Capacity strengthening is an inherent part of the SCIN project WP3.3, as the main outcome of the project is to implement neurobiological knowledge in the screening and intervention process within youth forensic clinical practice.

Scope and design

We have established in the Startimpuls project that

- Professionals are generally interested in neurobiological knowledge, but stress the importance of integration of neurobiological knowledge within current psychosocial screening and intervention (Horstkötter & Snoek, 2020) (Cornet, Bootsman, Alberda, & De Kogel, 2016).
- There is a need for extra education regarding knowledge and attitudes towards the role of neurobiological factors in the development and treatment of delinquent behavior in youth.
- Institutions need professionals with general skills for implementing and monitoring new screening and intervention methods.

Therefore, we will design an educational module for professionals

Plan

- involve professionals from the beginning in the development of the biopsychosocial assessment battery as well as the decision support tools.

- develop specific educational modules on knowledge, attitudes and practical skills for professionals

Activities

- Recently developed educational material on general neuropsychological themes (Breinstorm kennisclips / modules) form the starting point in the development of the materials required to enhance the level of knowledge and attitude towards biopsychosocial integration for the different groups of professionals involved in this project.
- Materials will be updated by using (quasi) experimental designs among those (future) professionals involved in assessment and treatment of juvenile delinquents, NIFP forensic experts, probation officers. Theoretical and practical developments will be implemented in educational materials for professionals that will work with the decision support toolbox. (see 6.2 WP3)
- In addition, an extra asset of the SCIN project is that two staff members per participating institution will be assigned to supervise the development and implementation, and keep in close contact with both the researchers, the professionals and youth within the institution. This will provide a unique opportunity to involve professionals within the institutions in research and provide them with general skills regarding the implementation and evaluation of new screening and intervention methods within clinical practice.

Evaluation

- Initial material will be evaluated during the pilot phase of the integrated biopsychosocial assessment battery in year 2, by actively collecting feedback from professionals and youth via focus groups, and adapt material where necessary based on the feedback. After year 4, when the initial data will be analyzed and the first predictive models are built, educational material will be updated with new fundamental knowledge
- Professionals will be involved in the development of the decision support tools for clinical forensic intervention as well as Adolescent Criminal law and additional educational material regarding the use of these tools for both sectors will be developed and piloted in year 5. Based on the pilot, material will be evaluated and adjusted if necessary. The final material will be implemented in standard training for biopsychosocial screening and intervention decision making.

5. Objectives and research questions

5.1. Scientific objectives

The SCIN project aims to provide fundamental knowledge on individual biopsychosocial profiles, how forensic treatment has an effect on neurobiological development of antisocial youth, and how changes in neurobiology are related to treatment outcome.

The *main scientific objectives* of the SCIN project are to:

1 *Provide fundamental knowledge on individual biopsychosocial profiles, how forensic treatment affects neurobiological characteristics of antisocial youth, and how neurobiological changes are related to treatment outcome.*

2 *Translate this fundamental knowledge to neurobiologically informed screening and intervention decision support tools for forensic treatment and adolescent criminal law.*

5.2 Scientific problem

The current scientific model of development and persistence of delinquent behavior is the biopsychosocial model. Based on this model, it has been argued that neurobiology should have a prominent part in forensic assessment (Popma & Raine, 2006). However, neurodevelopmental knowledge is not currently used in clinical forensic practice.

The main problem is that, although there is an increasing amount of knowledge on neurobiological correlates of delinquent behavior, there are several gaps in that knowledge that hamper implementation in clinical forensic practice.

There is **a lack of fundamental knowledge** on:

1 how to translate current knowledge on group level to **individual biopsychosocial risk profiles** and individual neurodevelopmental status

2 how forensic treatment affects neurobiological development of antisocial youth - which **neurobiological characteristics are dynamic** and which are stable.

3 how neurobiological changes during intervention are **related to treatment outcomes**.

This fundamental knowledge is essential to better identify the specific needs and risks of individual youth. Depending on the individual developmental status, we will be better able to determine whether there is still enough neuroplasticity to steer an initial antisocial development into a positive direction. This will also provide adolescent law with objective criteria for developmental delay.

5.3 Scientific relevance

Neurobiological knowledge and expertise in relation to criminal and antisocial behavior has grown enormously in the last decade (in the Netherlands partly due to HCMI and Startimpulse NeurolabNL). It has been shown that severe antisocial behavior is associated with dysfunctions in the subcortical, limbic brain areas that are related to stress and emotional functioning, as well as dysfunctions in prefrontal areas that are related to self-control (Blair, 2013; Figueiredo et al., 2020; Kohls et al., 2020; Oldenhof et al., 2019). Moreover, neuroscientific studies also illustrated that delinquent behavior is linked to the development of brain functions that is not completed until 25 years of age (Gogtay et al., 2004; Gur, 2005). This implies that **adolescence is a window of opportunity, with enough neuroplasticity to be able to steer an initial antisocial development into a positive direction.** This is the basis for the strong focus on treatment in juvenile forensic settings. It was also one of the reasons why the Dutch government passed a law in 2014 raising the age limit for applying juvenile criminal law from 21 to 23 years old. Moreover, based on the currently leading biopsychosocial model of development and persistence of antisocial and delinquent behavior, it has already been suggested that neurobiology should have a prominent part in forensic assessment and treatment (Popma & Raine, 2006). However, current forensic screening and interventions are predominantly based on psychosocial factors. One of the main reasons for this is a **lack of fundamental knowledge on individual biopsychosocial development, how forensic treatment affects neurobiological development of antisocial youth, and how neurobiological changes are related to treatment outcome.** For instance, there is an abundance of literature on neurobiological characteristics that are related to antisocial development at the group level (Cornet, 2015; Cornet et al., 2016; Raine, 2002; van der Gronde, Kempes, van El, Rinne, & Pieters, 2014), but specific screeners or instruments aimed at assessing delayed neurobiological development at the individual level are lacking. Moreover, although we have knowledge on specific neurobiological factors that have significant predictive value for reoffending as well as treatment outcome (de Ruigh et al., 2021; de Ruigh et al., 2019), there is only limited knowledge on how treatment affects neurobiological correlates of antisocial behavior. There are some first indications that specific interventions focusing on emotion regulation and aggression regulation do result in changes in neurobiological characteristics, such as an increase in cortisol levels in youth with psychopathic traits and initially low cortisol (Jambroes et al., 2019; Nyklicek, Mommersteeg, Van Beugen, Ramakers, & Van Boxtel, 2013; Stadler, Konrad, Popma, Kirchner, & Freitag, 2019). The SCIN project will increase this knowledge by structurally investigating individual biopsychosocial development and different possible trajectories thereof.

5.4 Scientific impact

The SCIN project will lead to the following scientific breakthroughs:

- We will provide fundamental knowledge on **how to translate biopsychosocial knowledge to Individual biopsychosocial developmental profiles** and how they are related to treatment outcome.
- Moreover, we will provide knowledge on **changeability of neurobiological risk factors for youth delinquent behavior,** by collecting data on how forensic treatment affects neurobiological development (neuroplasticity) of antisocial youth and how changes in neurobiology are related to treatment outcome.

As discussed previously, one of the main problems within the **field of research on the neurobiology of delinquent behavior** (or neurocriminology) is the fact that most findings are on group level and are difficult to translate to the individual level. This is one of the main reasons that the picture of the future that is depicted in the paper “Will future forensic assessment be neurobiological?“ by Popma & Raine (2006) is still not reality. This was discussed in the WODC report by (Cornet et al., 2016) and was also one of the main topics that was discussed in the related Akademie Colloquium: Bridging the gap between neuroscience and the criminal justice practice — KNAW, where key researchers in the field were present (including prof. Raine). Within the present study we aim to make this translation to the individual and clinical level, which will be a major breakthrough within the field.
Secondly, the integration of neurobiological factors within psychosocial assessment will move the **field of biopsychosocial interaction model research** significantly forward, as most research focuses on either neurobiological or psychosocial factors, or sometimes on the interaction of one biological and one social factor. Our previous work has shown that an approach where all factors are included, does have enormous power in improving the prediction of reoffending (de Ruigh et al., 2021; Ruigh et al., 2020). With the current project we

create a state-of-the art integrated biopsychosocial assessment battery based on the latest scientific insights. The longitudinal data that becomes available is used to create open source models and algorithms that can be utilized by the wider scientific research community. The development of diagnostic, predictive, and prognostic models is thought to be transformative for the future of forensic psychiatry and psychology, and the addition of scientifically based models democratizes treatment as clients and professionals can use the data to directly impact treatment. The models that are created are tested in practice and implemented in a randomized study that provides essential information on the effectiveness of the models to prescribe treatment.
Finally, although the **field of developmental neuropsychology** as well as the biopsychosocial model all imply that neurobiological factors are changeable, specifically during adolescent, when the brain is still plastic, there is not much research focusing on the change of neurobiological factors during interventions and how this predicts outcome. Most studies including neurobiological factors rely on single neurobiological assessments predicting outcome. Also, our biopsychosocial assessments in relation to developmental delay, will have significant impact on the field of developmental psychology, as we will increase knowledge on objective assessment of developmental delay.

6. Project overview

6.1. Project structure and coherence (also see Annex 2 at page 44)

The SCIN project is divided into three main work packages:
Work package 1 will focus on developing a practical neurobiological assessment toolkit in co-creation with forensic clinical practice and youth, that can be integrated with standard psychosocial assessments in forensic practice, and implementing them for data collection in forensic settings for 12-23 year old offenders.

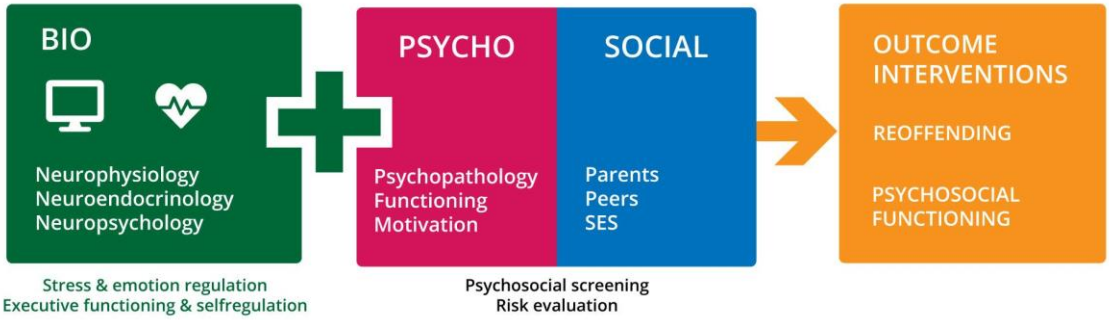


Figure 3: Adding biological measures to psychosocial screening and outcome assessments

The NeurolabNL Startimpuls projects has resulted in a basic set of relevant neurobiological measures that are related to antisocial development, as well as intervention effects throughout adolescence. This will be used to develop an **initial neurobiological toolkit, which will be further developed and combined with the standard clinical psychosocial assessments to form an integrated biopsychosocial assessment battery for longitudinal data collection in practice.** The biopsychosocial toolkit will be developed in co-creation with professionals and youth and implemented in practice. Subsequently, the screening toolkit will be used for regular assessments throughout the forensic intervention trajectory within the institutions **(figure 4)**. The resulting data form the basis for the individual profiles and predictive models that will be developed in WP2.

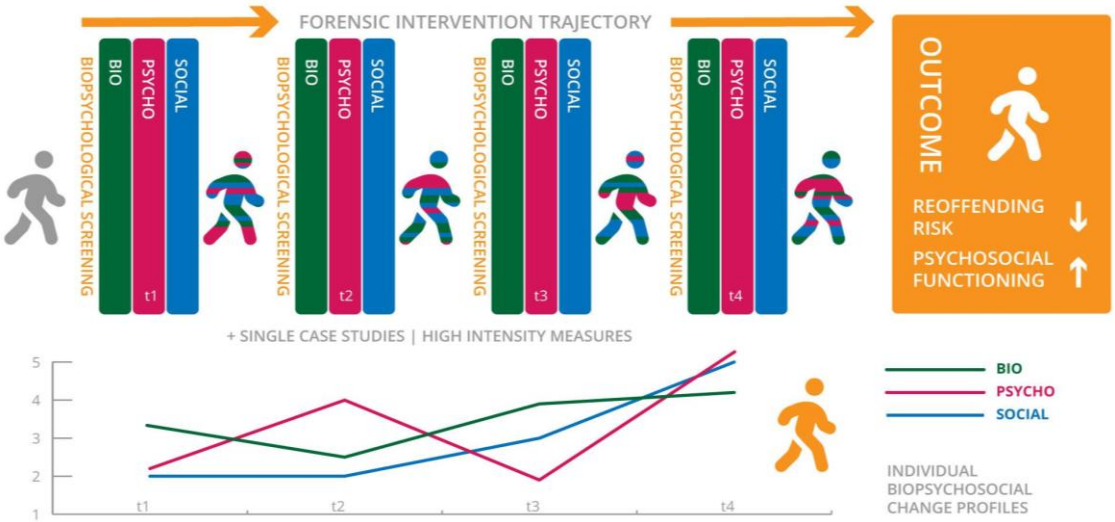


Figure 4: Biopsychosocial longitudinal data collection during intervention in forensic settings.

Work package 2 will focus on building neurobiological and psychosocial informed diagnostic, prognostic and predictive models to increase treatment success and decrease risk for reoffending in delinquent youth, using state-of–the art data analytics. We hypothesize that improving biological, psychological and social functioning will increase treatment success, and that improving treatment success will decrease the risk for reoffending. The main problem is that it is currently unclear what contributes most to treatment success and decreasing reoffending risk in individual patients. We assume that we can identify biopsychosocial developmental patterns over a treatment period, and that the transitions on biological, psychological and social outcomes will differ for each individual patient. We will use this information to identify developmental profiles that serve to support decisions about personalized intervention programs and the application of Adolescent Criminal Law (WP3).

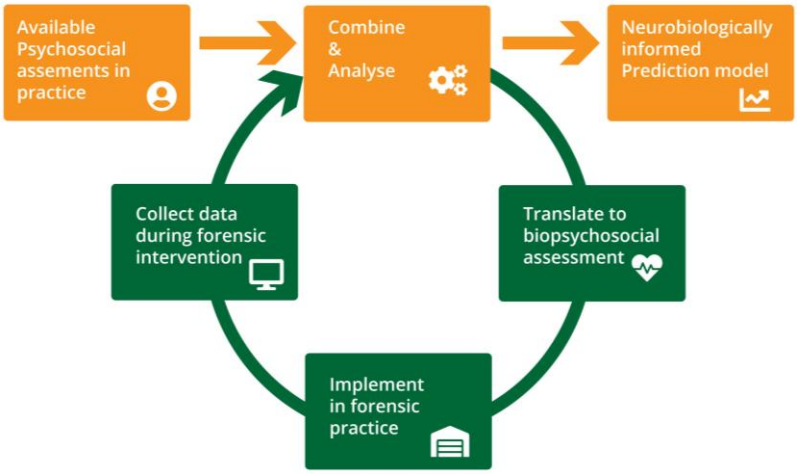


Figure 5: Research cycle of model development (orange) based on continuous data input from the integrated biopsychosocial assessments from WP1 in clinical practice (green)

Work package 3 will focus on translating the prediction model into a neurobiologically informed **decision support tool for use in forensic clinical practice and by institutions involved in advice and sentencing within adolescent criminal law.** In WP3 the prediction model of WP2 will be translated for use in treatment and decision making in clinical practice. Here, the involvement of the societal stakeholders will be further intensified and we will constantly test whether user needs are met in the best possible way by means of an iterative process. Based on the prediction model, we will develop a decision support tool in co-creation with clinical partners (Barda, Horvat, & Hochheiser, 2020). As the design highly depends on the context, separate tools will be developed for use in forensic treatment and adolescent criminal law:
WP 3.1 Forensic treatment - In forensic treatment, the main focus will be on the use of the decision support tool for personalizing intervention programs within the institution and reoffending risk after release. The tool

will mainly be used by healthcare professionals that work with the adolescents on a daily basis within the institutions. Moreover, the closed setting will pose specific ICT challenges in terms of limited facilities and extra attention to data safety. Based on these conditions, in co-creation with the forensic institutional managers and staff, an optimal tool and implementation plan will be developed.

WP 3.2 Adolescent criminal law - In adolescent criminal law, the main focus is on the assessment of a person's 'unfinished development', consisting of their developmental status and prediction of changeability of neurodevelopmental characteristics during intervention. Based on the fundamental knowledge from SCIN, a decision support tool will be developed with forensic assessors to decide whether a specific young adult is better off with judgement under juvenile or adult criminal law.

WP 3.3 Educational modules & knowledge utilization - In the Startimpulse project, we have already investigated the attitude of both professionals and youth towards neurobiological assessment. Both groups saw considerable additional value in combining neurobiological and psychosocial screening and assessment during interventions (Horstkötter 2020). Moreover, in collaboration with the Universities of Applied Sciences Windesheim and Utrecht, and with additional funding from ZonMw (grant number 729211001), we have developed **educational modules on the neurobiology of antisocial behavior for (future) professionals.** The modules consist of knowledge clips (figure 8) and accompanying in-depth study assignments. The modules are available for the bachelor and master level, as well as for in-company education of (future) professionals within forensic youth care and allied disciplines. These educational modules will be used to inform professionals involved in the current project. Subsequently, these educational modules will be **further updated and developed based on new knowledge from the SCIN project, in co-creation with professionals.** This will facilitate knowledge transfer and implementation of the biopsychosocial model and neurobiological assessments in screening and intervention decisions. In addition, training modules for the specific decision support tools, both in the JJI's and for the application of Adolescent Criminal Law, will be developed, such that professionals are able to use the assessment and tools without supervision. **This solidifies the use of the to-be-developed tools in practice.**

Figure 6:
Brainstorm: an educational module for (future) professionals on the role of neurobiology in the development of antisocial and delinquent behavior
http://www.bureaunauta.nl/preview/BrainstormClip04.mp4

6.2 Description of the work packages

Work package number	**1**
Work package title	**Biopsychosocial screening toolkits**
Work package leader	Lucres Nauta-Jansen (WP1.1), Hanna Swaab (WP1.2), Maaike Kempes (WP1.3)
Involved partners	Amsterdam UMC, Leiden University Hogeschool Utrecht, Hogeschool Windesheim co-funders: RJJI, Pluryn, NIFP, De Borg cooperation partners: YiP, WODC, Ministry J&V, OM
Start date	Year 1
End date	Year 5

Objectives

The main objective of WP 1 is to develop an integrated biopsychosocial assessment toolkit, by integrating neurobiological and neuropsychological factors into currently standard screening protocols within the JJIs.

- WP 1.1 will specifically focus on stress and emotion regulation
- WP 1.2 will specifically focus on executive functioning and self-regulation
- WP 1.3 will specifically focus on delayed development

Methodology

WP1.1 Based on the Startimpulse project (figure 1) and international literature (Cornet, 2015), we define **neurophysiological** (Heart rate, heart rate variability/RSA, skin conductance/PEP) and **neuroendocrinological** (cortisol, testosterone) measures that are related to stress and emotion processing, as the most promising to differentiate within the domain of antisocial behavioral profiles.

Earlier research of our group shows that adding neurobiological measures (basal and in response to emotional challenge) to initial psychosocial and cognitive screening in JJIs helps to predict outcome (reoffending) (de Ruigh et al., 2021; Ruigh et al., 2020). Moreover, a practical calculation was created to estimate the risk for reoffending for individual youth (https://architecta.shinyapps.io/PredictingYouthReoffending/). WP1.1 will further develop the neurobiological assessment toolkit regarding stress and emotion regulation that can be easily used for *longitudinal* assessments in clinical practice (f.i. using wearables for heart rate and skin conductance and non-invasive assessment of hormones in saliva and/or hair samples).

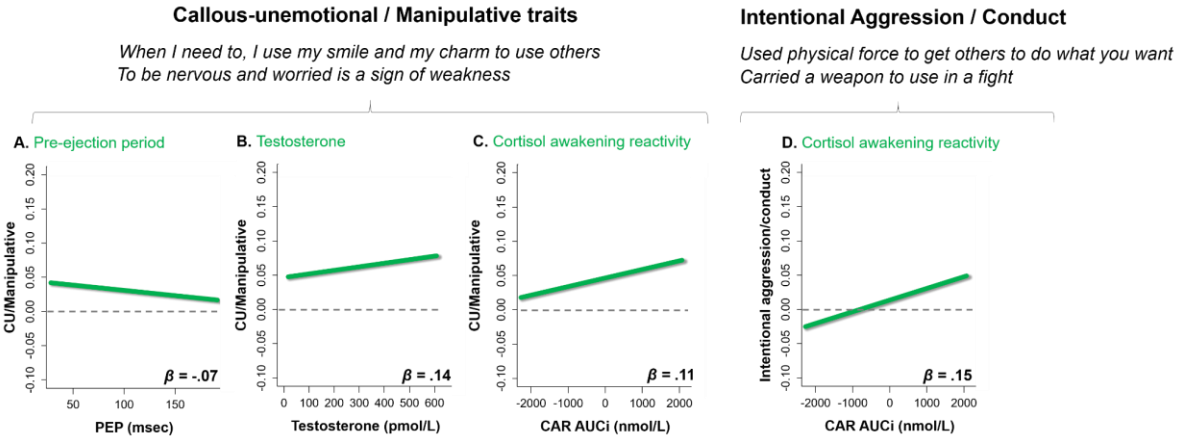


Figure 1: First results from the NeuroLabNL Startimpulse multi-sample, multi-method study on neurobiological correlates of antisocial behavior across adolescence.

Combined neurobiological data from 1489 participants (9-27 years, 67% male), from six heterogeneous antisocial and control samples. A-C Significant associations between callous-unemotional/manipulative traits component score (y-axis) and neurophysiological measures. D intentional aggression/conduct component score (y-axis) was related to neuroendocrinological measures.
PEP – pre-ejection period, sympathetic nervous system activity, RR- respiration rate, AUCi – area under the curve, cortisol response to awakening. (Blankenstein et al., Psychological Medicine 2021 (Blankenstein et al., 2021))

WP 1.2 Disruptions in neurocognitive functioning contribute to a great extent to the development and persistence of antisocial behavior in children and adolescents (Cornet et al., 2016; Ogilvie, Stewart, Chan, & Shum, 2011). Important neuropsychological functions predictive of antisocial behavior in youth and young adults include (social)attention and cognitive flexibility, working memory, social planning, empathy and emotion recognition (Van Zonneveld, Platje, De Sonneville, Van Goozen, & Swaab, 2017), specifically under emotional conditions (De Brito, Viding, Kumari, Blackwood, & Hodgins, 2013; Euler, Sterzer, & Stadler, 2014). Moreover, neurocognitive screening has shown to be helpful in providing tailor-made preventive intervention for high-risk children and adolescents (Blankenstein et al., in prep.; Van Zonneveld, 2019), figure 2. WP 1.2 will develop a neurocognitive toolkit out of existing and new, practically feasible and validated instruments that cover constructs related to executive functioning and self-regulation which are robustly predictive of antisocial behavior.

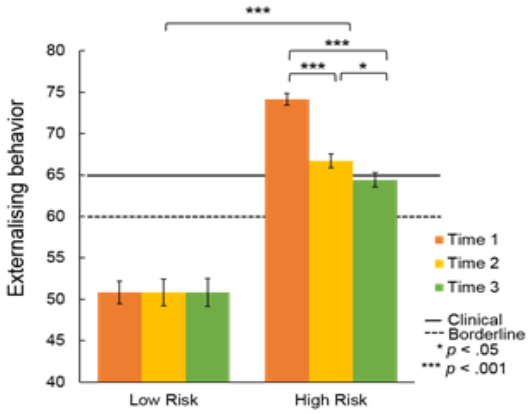


Figure 2:First results of the (PIT) preventive intervention program based on individual neuropsychological screening profiles in 6-18 year old high-risk children and adolescents at risk of developing a criminal career (N = 440, 336 boys), and comparison participants from the same high-risk environment (N = 108, 64 boys). Time 1 - pre-intervention, time 2 – post intervention, time 3 – follow-up. (Blankenstein et al. in prep.)

WP1.3 Besides chronological age as a legal marker, the concept of maturity has the potential to become an important consideration in legal decision-making related to young adult offenders in the Netherlands. In WP 1.3 we will mainly focus on the triad of cognitive regulation (prefrontal cortex), reward and approach (striatum) and emotional intensity (amygdala). These neural systems are thought to change drastically during adolescence and early adulthood and are also thought to be involved in delinquent behavior (Ernst, 2014). Since it is hard to assess the direct influence of these systems on direct individual behavior we will mainly focus on behavioral markers of these systems, i.e. hot and cold executive functions and reward sensitivity. WP 1.3 will develop a neurocognitive toolkit out of existing and new, practically feasible and validated instruments that are able to assess the above-mentioned abilities viewed as indicators of immaturity. Instruments selected in WP 1.3 will probably overlap with instruments selected in WP1.1 and 1.2.

The neurobiological assessments developed in the first phase of WP1, will subsequently be integrated with standard psychosocial assessments within clinical practice, to form a biopsychosocial screening toolkit.
Currently, **psychosocial assessments** are performed at admission and at 3-monthly intervals within the institutions in order to decide on and monitor intervention programs. The basic set of assessments consists of:
A diagnostic tool for assessing mental health problems, the Massachusetts Youth Screening Instrument, Version 2 (MAYSI-2) (Ford, Chapman, Pearson, Borum, & Wolpaw, 2008).
A short self-report instrument to assess mental health and behavior is used: the Strengths & Difficulties Questionnaire (SDQ) (Muris, Meesters, & van den Berg, 2003)
An questionnaire for cognitive distortions, How I Think (HIT) (Nas, Brugman, & Koops, 2008)
Psychosocial factors related to risk evaluation are regularly assessed using the Structured Assessment of Violence Risk in Youth for risk factors (SAVRY) (Lodewijks, Doreleijers, & De Ruiter, 2008) and the Structured Assessment of Protective Factors for violence risk – Youth Version for protective factors (SAPROF-YV) (de Vries Robbé, Vogel, & Douglas, 2013; Kleeven, de Vries Robbé, Mulder, & Popma, 2020). For the short-stay delinquents and short-term repeated assessments we will join a current study by De Vries Robbé (*co-applicant*) in which a short risk evaluation screener for youth is developed and implemented (Risk Screener – Youth).
The integration with neurobiological assessments, will be developed in co-creation with the professionals and management within the institution during the first year of the project and subsequently piloted before implementation and data collection.
Interventions received during the stay in the institutions are registered in JVS (*Jongeren Volg Systeem*) within the institutions.
Outcome of interventions during stay in institutions and after release will be assessed based on aggressive incidents within the institution, reoffending and self-report of psychosocial functioning (SDQ), and quality of life and self-sufficiency (de Ruigh et al., 2019). We will also explore the use of Patient Reported Outcome Measures (PROMs; (Stover, Haverman, Van Oers, Greenhalgh, & Potter)). Outcome will be assessed immediately after release and a year after release from the institution.

Description of research activities
The combined neurophysiological/neuroendocrinological and neurocognitive assessments will be incorporated in the standard psychosocial assessments in clinical forensic practice that are typically performed with 3-month intervals, to create a longitudinal database (WP2). We expect to include about 800 adolescents in the age range between 12 and 23 years of age in clinical forensic settings for juvenile delinquents (mainly juvenile justice institutions – JJIs). In 2019, 18% were long- stay (>12 wks) and 82% short-stay, with 27% between 2 and 12 weeks, 35% less than 2 weeks in the institution at release.

Data will be collected for all juveniles at least four times I. For short-stay, this will consist of 1 full biopsychosocial screening within the institutions and three online outcome assessments after release. For long-stay, biopsychosocial assessments will be performed as many as possible with a 3-month interval, following up online if release is earlier than after 12 months. This will enable us to investigate changes in biopsychosocial profiles during their forensic intervention trajectory and beyond. In collaboration with WP2, single case studies with high intensity measures during the subsequent phases of intervention will be performed in order to achieve the full personalized medicine potential (Hekler et al., 2019).

Productive interactions (co-design and co-creation)
Professionals and youth will be involved in the co-creation of the integrated biopsychosocial assessment battery. Together, we will design an assessment battery that is deemed both relevant and practical in clinical practice. This will also involve selecting those assessment forms that are most practical or appealing, and re-designing assessments that are deemed impractical or unappealing by professionals and youth. Moreover, we will design how the feedback from the assessments should be presented, also taking into account privacy and ethical considerations of biopsychosocial assessments in practice. Also, practical conditions such as ICT and data security will be taken into account. By using **human centered design principles**, we will incorporate input from all co-creation partners on the assessments via a creative and iterative process. The concept biopsychosocial assessment battery will subsequently be implemented within the institutions and used for screening and monitoring during intervention programs within the institutions. Throughout the project professionals and youth will regularly provide feedback on the assessments and assessments will be adapted according to their feedback.
Two PhD students will be appointed for WP1.1 and 1.2. These PhD students will develop the neurobiological assessment batteries, and integrate them into a biopsychosocial assessment toolkit. The PhD students will also assist in data collection and preparation to develop the individual profiles and prediction modules for WP2.
Within each institution, two professionals (in-kind co-funding) **will be appointed to assist the implementation of the biopsychosocial assessments.** These professionals will closely collaborate with the PhDs in the implementation and practical use of the assessment battery.
In addition, a separate PhD student will be appointed for WP1.3 at the NIFP (in-kind co-funding) will be appointed to specifically collect data on **biopsychosocial measures in delinquents between 18-23 years of age, in order to determine specific profiles that are indicative of a delayed development,**.

Contribution to project
The biopsychosocial screening toolkit will be used for **longitudinal data collection** within the institutions, as well as for more intensive assessments in the single case studies that form the **input for the individual profiles and prediction models that will be developed in WP2.**
The development and implementation of the biopsychosocial assessment developed in WP1 will provide **fundamental knowledge about how to implement neurobiological assessments in clinical forensic practice and what conditions should be taken into account.** This knowledge will be disseminated in scientific reports as well as practical information for the forensic clinical sector. Moreover, **educational modules for practical use of the assessment battery for professionals, as well as information for youth** will be developed by the universities of applied sciences in collaboration with professionals and youth in WP3.
Initially, we will develop the biopsychosocial assessment battery for use in the Juvenile Justice Institutions, but in due time, we may extend to other residential (closed youth care) and/or ambulant forensic settings.

Work package number	**2**
Work package title	**Biopsychosocially informed diagnostic, prognostic and prescriptive models.**
Work package leader	Roy Otten, Peter de Looff
Involved partners	Radboud University, AmsterdamUMC-VUmc Universities of Applied Sciences Windesheim and HU Trimbos Institute co-funders: RJJI, Pluryn, De Borg, NIFP
Start date	Year 2
End date	Year 7

Objectives.
The main objective of WP2 is to build neurobiological and psychosocial informed diagnostic, predictive, prognostic and prescriptive models to assess neurodevelopmental status, increase treatment success and decrease risk for reoffending.

Methodology
Predicting the risk of reoffending is paramount to keep communities safe (Garb & Wood, 2019). The prediction of (violent) reoffending has traditionally been conducted by clinicians, followed by the addition of structured assessments, statistical predictions and, more recently, machine learning (Tortora, Meynen, Bijlsma, Tronci, & Ferracuti, 2020). Recent studies using very large samples from biobanks showed that the most accurate models arise from longitudinal machine learning models in comparison with standard models that are traditionally used for clinical prediction (Zhao et al., 2019)
In psychiatry, mixed models and machine learning are used to study both outcomes and transitions(Janssen, Mourão-Miranda, & Schnack, 2018) and have primarily been used for diagnostic and prognostic modeling of clinical, cognitive, social and biological data (Sanfelici, Dwyer, Antonucci, & Koutsouleris, 2020) in depression and psychosis (Gong, Simon, & Liu, 2019; Janssen et al., 2018; Sanfelici et al., 2020). A diagnostic model assesses a current state while a prognostic model makes predictions about the future. The prognosis is affected by a plethora of factors that longitudinally affect the outcome (Janssen et al., 2018), making it a high dimensional data problem. Machine learning is especially useful in instances where multifaceted and complex associations lead to an increased risk for aversive outcomes, as is arguably the case in forensic psychiatry (Sanfelici et al., 2020). In detecting effects it is important to adopt a multivariate approach as single variables are typically not useful to detect (small) differences between groups or individuals, and heterogeneity should be incorporated into the assessment of the accuracy (Schnack, 2019).

Description of research activities
In WP2 we use three necessary steps to develop and test the models using three innovative data analysis approaches:
1. Description and diagnosis of homogenous biopsychosocial group (transition) trajectories - to integrate existing psychosocial information with newly acquired biological information, a database infrastructure is created following the principles of FAIR data ecosystems (Koers et al., 2020). This database - containing relevant psychosocial predictors- (El Aboudi & Benhlima, 2018) will allow us to integrate descriptive, diagnostic, predictive, and prognostic analytics necessary to combine biological and psychosocial predictors to use for prescriptive personalized treatment.
In a first step, we will use Growth Mixture Modeling, a semi-parametric clustering technique, to identify homogeneous groups of participating juveniles during treatment based on similarities in the biopsychosocial assessment at the start of treatment (intercept) and the progression of these measures throughout the course of treatment (slopes).
In addition to GMM, network analysis allows the conceptualization of disorders and psychological phenomena as dynamic structures of interacting and mutually reinforcing biopsychosocial factors. In this case, we will look at patterns of biopsychosocial factors that fluctuate across the four measurements and link these to treatment outcomes and reoffending. In particular, network analysis enables investigation of the organization and strength of the associations between the different biopsychosocial factors (i.e., network connectivity), and allows their differential importance, or factor centrality, to be assessed (Armour, Fried, Deserno, Tsai, & Pietrzak, 2017). Eventually, networks of biopsychosocial factors will be compared for participating juveniles who show different treatment outcomes and reoffending.
To explore the latent structure of transitions of biopsychosocial predictors and investigate how these are correlated with treatment outcome and reoffending we will first apply a Gaussian process regression, cross-correlation function and a neural network to discover subtypes of trajectories (Gong et al., 2019), which will help gain insight in the temporal correlations between biological, psychological, and social factors that are associated with treatment success and reoffending. One of the biggest challenges is the reliability of the outcome (or targets) and predictor (or features) measures, and it is therefore essential to gather high quality prognostic data (Janssen et al., 2018). Another challenge is overfitting of the data, therefore we will construct a train dataset and a test dataset (80% vs 20%) and use a k-fold cross-validation strategy (Acion et al., 2017; Gong et al., 2019; van Mens et al., 2020) with an external site cross-validation, the latter being paramount for accurate (generalizability) estimates(Janssen et al., 2018; Sanfelici et al., 2020). The composition of the SCIN proposal with its multi-site partners is especially suited for addressing these challenges.
2. Prognosis of individual transition trajectories using innovative machine learning analyses The biopsychosocial information and profiles obtained in step 1 will serve as the start for the prognostic models for individual patients. A unique activation function can be constructed for each patient that represents the similarity to the profile (Gong et al., 2019), and provides an individual prognosis. Artificial neural networks are often difficult to interpret and the combination of Gaussian process regression, cross correlations and neural networks with individual activation functions allows clinicians to intuitively interpret temporal transitions on a group and individual level.

3. Prescription of individualized treatment tested with Single case studies using Single Case Experimental Design (SCED) analyses- Based on the individual prognostic models we will conduct a series of at least 20 single case studies using a randomized non-concurrent multiple baseline design. Ten juveniles will receive treatment as usual, while the remaining ten juveniles will be prescribed a treatment procedure that should optimize their outcomes based on the analyses. We will work very closely with the juvenile and practitioner to carefully implement the information. We will use daily diary measurements (ecological momentary assessments) to assess changes in physiological measures as well as behavioral measures over time (Kuntsche, Otten, & Labhart, 2015; Serre et al., 2012). It will be investigated whether the groups differ on their predicted outcomes and if the experimental group significantly enhances treatment and reoffending outcome.

Productive interactions (co-design and co-creation)
The data are collected by the co-funding partners. Together with the researchers, they are responsible for the systematic and standardized collection of the data. Based on these data, the analyses will be conducted in collaboration with Radboud University, Vrije University and Trimbos. Together with the partners from WP1 and WP3, the models are poured into applications that are understandable and intuitive for youth and professionals. In step 2, in consultation with professionals and youth, an initial individual prognosis can be given for new patients admitted to the institutions. When the model has been optimized in step 2, step 3 will start with the design of SCEDs involving all partners to determine the most optimal treatment for and with the adolescent. During the treatment, there will be close cooperation with all partners to carefully monitor treatment progress and reoffending risk.

Contribution to project
By providing insight into the complex interactions that play a role during treatment and the delivery of practically usable models and applications, WP2 contributes to the practical tools that professionals and juveniles to direly need to increase treatment efficacy. The models and applications will contribute to a solid scientific basis for optimal treatment choices. This leads to an improvement in the mental health of clients, reducing reoffending and ultimately increasing the social participation of our clients.

Work package number	**3**
Work package title	**Implementation of the biopsychosocial models**
Work package leader	Eva Mulder (WP3.1), Maaike Kempes (WP3.2), Andrea Donker (WP3.3)
Involved partners	Leiden University, VU University, Curium-LUMC, Amsterdam UMC-VUmc Universities of Applied Sciences Utrecht and Windesheim Co-funders: RJJI, Pluryn, de Borg, NIFP, Cooperation partners: Dutch Probation Organisations, OM, Ministery J&V, WODC, YiP
Start date	Year 1
End date	Year 7

Objectives
The main objective of WP3 is to develop and implement decision support tools for personalized intervention programs and Adolescent criminal law

- WP 3.1 - Implementation of the biopsychosocial decision support toolbox that will guide experts within JJI's in their design for a personalized intervention program and treatment evaluation in forensic juvenile justice.
- WP 3.2 - Implementation of the biopsychosocial decision support toolbox that will guide experts within the criminal justice system in their decision to apply or advise on the application of juvenile or adult criminal law.
- WP 3.3 - Generally enhancing the knowledge base of the integrated biopsychosocial model of (future) professionals - Specifically training professionals on the new biopsychosocial decision support toolbox.

Methodology

A crucial aspect for successful implementation of scientific results in practice, is that stakeholders are involved in the research from the start of the project. Therefore, the implementation of the decision support toolbox will effectively start in year 1, together with WP 1 and 2. In these WP's, they will be involved in co-creation of the assessment battery and defining the developmental profiles that will be used as input for the toolbox.
We will design the tool with a basic set of functions such that it can be used to both support decisions to personalize intervention programs in JJI's and for application of juvenile criminal law. Therefore, professionals from NIFP, the parole board and forensic institutions take seat in the co-creation sessions for the assessment battery and toolbox together. Crucially, apart from health care professionals and parole officers, management of these institutions are included in these sessions as well, since implementation depends on their carrying capacity. However, since the context of using the decision support tool differs between the applicability of ASR and personalized intervention programs, we will also host sub sessions to investigate how the decision support tools are used in these different contexts, and design it with flexibility to do so.
As an implementation method, we will use action research loops. This allows us to monitor use of the tool in practice, while at the same time adjusting the process to improve usability and further implementation of the tool in treatment and evaluation. To optimally guide these processes, we have divided supervision and implementation in two separate pathways: WP3.1 for treatment in forensic institutions (lead by AmsterdamUmc, LUMC Curium, Pluryn, Leiden University) and WP3.2 for application of adolescent criminal law (lead by NIFP, Parole board, Leiden University). Importantly, implementation and future use of the biopsychosocial decision support tool is safeguarded through the development of a training module that allows management and staff to keep using this toolbox without scientific supervision (WP3.3, led by HU, Windesheim).
To optimally involve professionals and youth in the design of the decision support tool and training module, we will use human centered design methods. Human centered design works with creative tools to design a product based on the user's needs. The product is optimized by iteratively going through four steps. The four steps of this process are: a) Research about the context in which the tool is used, b) defining the need of the stakeholders, c) designing a prototype tool and d) evaluation by the stakeholders of the prototype. If adjustments need to be made to the prototype, one can go back to step c, or even step a, depending on the feedback. After a series of these steps, the product is ready to be used in practice.

Description of research activities

WP 3.1 & 3.2

1. Professionals from NIFP (n=4), the parole board (n=4) and forensic institutions (n=4) will participate in *co-creation sessions* in WP1 to develop an assessment battery. In this first step, they will discuss the design of the working method including materials / instructions on how to use the assessments + t0-measure moment (year 1) on competence in professionals, time spent + description of regular process of treatment planning and evaluation, use of biopsychosocial arguments in treatment planning and evaluation/adaptation. In a parallel process, the Expert Youth Board will participate in co-creation sessions on the working methods and assessments used in the research.
2. Professionals from NIFP (n=4), the parole board (n=4) and forensic institutions (n=4) will participate in *co-creation sessions* in WP2 to help define the developmental profiles and how they can be used to determine application of adolescent criminal law and designing personalized treatment programs.
3. Professionals from the NIFP (n=10), parole board (n=10) and forensic institutions (n=10) will use a beta-version of the assessment toolbox (year 4). They will provide feedback to researchers in WP2 regarding the extent to which biopsychosocial information from the assessment instrument can be used in practice (iterative development). This is accompanied by implementation monitoring on the actual use and feasibility. At the same time, experts will be trained in use of the toolbox by using education tools (see WP3.3). Youth for which the toolbox is used will give feedback on its usability and their motivation to cooperate with the associated assessments.
4. At t1 (year 5), a PhD student will score forensic reports (n=100) and reports of probation services (n=100) to reveal whether (1) the decision toolkit is mentioned, if (2) profiles of adolescent who are sentenced under juvenile criminal law differ from those sentenced under adult criminal law, and if (3) profiles of adolescent who are sentenced under juvenile criminal law resemble profiles in the model (WP2) that shows groups of adolescents with delayed development. Similarly, competence and motivation to use the tool in professionals working at JJI's and youth are measured. File research will be conducted on how biopsychosocial factors were used in treatment planning and evaluation/adaptation, + improvement of instructions/treatment planning process based on the lessons learned.
5. The monitoring loop for both the application of adolescent criminal law and personalizing intervention programs using the biopsychosocial decision support tool is repeated, and a second measurement (year 6) in usage, motivation and competence in all stakeholders, including youth.

6. After a final round of adaptation, when the juvenile criminal law is indeed successfully applied to adolescents with a profile of delayed development, all probation services and forensic experts will be trained in using the decision support tool and it will be implemented across the whole of the Netherlands. Similarly, when the biopsychosocial decision support tool has been shown to help professionals design a personalized intervention program that is more effective than previously used methods, professionals at other juvenile institutions will be trained in using the toolbox, and it will be implemented in these institutions as well.

WP3.3

1. Recently developed educational material on general neuropsychological themes (Breinstorm kennisclips / modules) form the starting point in the development of the materials required for enhancing the level of knowledge and attitude towards biopsychosocial integration for the different groups of professionals involved in this project. Materials will be updated in co-creation with those professionals involved in assessment and treatment of juvenile delinquents, NIFP forensic experts, probation officers. In addition, educational material will be designed for youth that will help them to understand the biopsychosocial model and how it can support their treatment outcomes.

2. Parallel to WP 3.1 and 3.2, theoretical and practical developments will be implemented in training materials for professionals that will work with the decision support toolbox. This educational material will also be co-created with forensic experts in the juvenile institutions, experts from the NIFP and probation services.

Productive interactions (co-design and co-creation)

1. Co-creation sessions with researchers in WP1 and forensic experts NIFP, probation services from parole board, health care professionals and management, to design the assessment battery in WP1.

2. Co-creation sessions with researchers in WP1 and experienced expert youth to design the assessment battery in WP1.

3. Co-creation sessions with researchers in WP2 and forensic experts NIFP, probation services from parole board, health care professionals and management, to design the decision support toolbox for use in practice.

4. Co-creation sessions with researchers in WP2 and experienced expert youth to design the decision support toolbox for use in practice.

5. Co-creation sessions with researchers and teachers from Applied Universities and forensic experts NIFP, probation services from parole board, health care professionals and management to develop education material for professionals on the basic knowledge of the biopsychosocial model and how it can improve treatment.

6. Co-creation sessions with researchers and teachers from Applied Universities and experienced expert youth to develop education material on the basic knowledge of the biopsychosocial model and how it can help their treatment.

7. Co-creation sessions with researchers and teachers from Applied Universities and forensic experts NIFP, probation services from parole board, health care professionals and management from JJI's to develop training material for professionals to be able to use the biopsychosocial decision support toolbox without supervision.

NIFP will provide a PhD in kind and forensic experts for co-creation sessions and testing in practice.
Parole board will provide probation services for co-creation sessions and testing in practice.
JJI's will provide health care professionals and management for co-creation sessions and testing in practice.
Applied Universities will provide teachers for co-creation sessions about the educational material.
YiP will help to recruit juvenile experience experts for co-creation sessions

Contribution to project

Please describe how this work package will contribute to the impact pathway of the whole project.

The initiatives in this work package will make sure the assessment instruments and biopsychosocial integrated decision support toolbox will be suited to be used in practice. This will during the project already lead to better redirection of adolescents under adolescent criminal law, and enhanced personalized treatment due to the use of integrated biopsychosocial information. In addition, the work package will ensure that adolescents themselves are motivated to perform the assessments, and have a better understanding of how these assessments can help them, due to their direct involvement, and educational modules designed for them. Last, implementation and future use of the biopsychosocial decision support tool is safeguarded through the development of a training that allows management and staff to keep using this toolbox without scientific supervision. This work package will therefore contribute lower reoffending levels and improved psychosocial functioning.

6.3 Risk management and contingency plan

Societal

The forensic institutions are under pressure because of the increase in youth sentenced to Juvenile justice institutions. This is related to the increase in serious offences by youth and subsequent increase in sentences to youth detention. However, there are also plans to open an extra RJJI (personal communication CP).

Also, a new lockdown due to a new COVID-19 outbreak may increase strain on management and professionals. This may delay data collection, as professionals and group workers within the institutions are mainly responsible for collecting data, as part of the implementation within the clinical practice.

If necessary, we can include additional institutions, as we cover the complete forensic chain within the consortium and also have an extensive network within the forensic field via the Academic workplace Youth at Risk.

Another development that puts strain on the sector is that the ministry works towards more personalized diagnostics and intervention (VOM-Vrijheidsbeneming Op Maat). The desire to better implement neurobiological assessments is explicitly mentioned as part of the process. From the perspective of the ministry, this is both a clinical (design and further diagnostics and treatment) and a technical process (developing better ICT support). However, our project perfectly fits within this development, and the ministry is involved as a cooperation partner and we will closely collaborate to

A final societal issue might be ethical. From an ethical perspective it is important to communicate the 3 basic – interrelated – ideas that characterize this project: 1) a *human-centered* approach that aims to do justice to people regarding their bio, psycho, and social existence; 2) all three – bio, psycho and social – are considered as *changeable*. In principle, neither a person's psychology, social position, or neurobiology are 'fixed'. The repeated measurements of the bio-psycho-social parameters makes this very clear: they are all open to modification and, in fact, improvement. 3) The three components should be considered together, from a holistic perspective (Melles et al., 2020). Development of the tool as well as the interpretation of its results should reflect these components in order to do justice to the biopsychosocial model and, therefore, to the adolescents it concerns. This will, for instance, be achieved by making the process of co-creation with adolescents explicit.

Scientific

At the scientific levels, main risks involve the assumptions regarding the predictive value as well as the changeability of biopsychosocial factors, specifically the role of neurobiological factors therein. However, based on the results of the Startimpulse 2021 (Blankenstein et al., 2021; Blankenstein et al., in prep.) as well as our previous work on the added value of neurobiology in risk evaluation (Ruigh et al., 2020), in using state-of-the-art statistic models to create biopsychosocial profiles related to recidivism risk (de Ruigh et al., 2021) and our initial finding regarding changeability of neurobiological factors (Jambroes), it is expected that we will be able to improve our predictive models within this project. Moreover, the samples will be larger and techniques more advanced. Moreover, the integration with already known psychosocial factors increases the predictive value way beyond using single predictive factors.

Financial

We do not foresee any significant financial hazards: personnel and material costs that are based on previous experience with comparable projects. The co-funders all have committed to the deployment of personnel. The only risk will be in the development of the interfaces for the biopsychosocial assessment, decision support tools and educational material. As these will be based on findings from the project, and co-creation with youth and professionals, it is impossible to completely oversee what will be needed. However, we do have experience with the development of previous materials within the start impulse. If needed, we will include additional technical and/or innovation partners within the project.

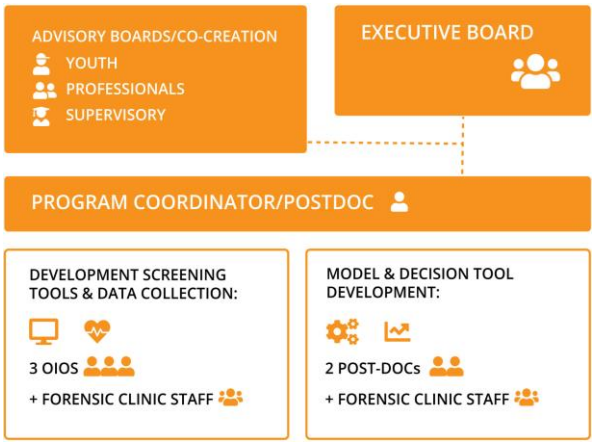
In **general,** risks and assumptions will be regularly discussed within the EB, SB, professional and youth advisory boards and the PAC (see project management). If any violations of assumptions occur, this will be discussed and assumptions and strategic activities will be adjusted accordingly.

6.4 Project management

6.4.1 Project leader and consortium partners

The success of SCIN and its anticipated achievements will depend, to a large extent, on the management of the project and the structure and procedures to enable this. The consortium has its roots within the NeuroLabNL Startimpuls, where the main applicant and most co-applicants have already formed the basis to manage the SCIN consortium. In addition, main applicant and co-applicant A Popma also have experience within the European FemNAT-CD

consortium. Within Amsterdam UMC, there is ample experience on hosting the coordination and management of interdisciplinary consortium projects. From this experience, an extensive set of structures and procedures have been put in place to ensure the successful management and delivery of the scientific quality of the research, and effective dissemination and communication of the results.



The SCIN consortium consists of a management team, supported by a supervisory board, a professional and youth advisory board that together will plan the research strategy within the project.

The **Executive Board** (EB) consists of the WP leaders: *Dr. L. Nauta-Jansen* (main applicant, chair), *Prof. dr. H. Swaab*, *Prof. dr. R. Otten*, *dr. Peter de Looff, dr. E. Mulder*, *dr. M. Kempes*, *and dr. A. Donker*. The EB will be completed by the to-be assigned project coordinator/post-doc. The coordinating post-doc will, together with the main applicant, oversee and integrate the content of the work packages, organize meetings and streamline the implementation and dissemination process.

The EB will meet monthly; one of these meetings will be in person, whereas the other is optionally an online conference. Additional meetings can be convened at any time following a written request by any member of the EB to the chairperson. The EB acts as the central management team of SCIN, and is responsible for overall monitoring of the scientific and financial progress of the project activities towards the main objectives of the project. Specific tasks include drafting reports and associated documents and forms for NWO and monitoring inter-WP alignment and progress of the activities and output. In case contingencies occur, the EB will advise the SB on any corrective measures to be taken.

The **Supervisory Board** (SB) will consist of co-applicants and co-funders. This supervisory board is chaired by the main applicant (Nauta-Jansen). The advisory board will meet twice a year. Extraordinary meetings can be convened upon written request by any member to the coordinator. Primary responsibility is to oversee the quality of the program and review the progress of SCIN in terms of research, supervision, dissemination and exploitation, specifically ensuring that the impact goals are to be met. The SB will enable continuous and close communication among SCIN partners, promoting an exchange of best practices and maximizing the long-term benefits of the partnership. The SB is the internal advisory body in case of any contingencies, disruptions or disputes, and is responsible for adjusting the work plan if necessary. The SB will formulate a strategy on scientific misconduct, detailing notification, confidentiality and assessment of any allegation of such misconduct as well as consequences of scientific misconduct for researchers and institutions. In addition, the SB has specific decision-making responsibilities with regards to alterations in WP-related activities, the allocation of financial resources, formal agreement on progress reporting to NWO, and any other decisions affecting the Consortium Agreement. In principle, decisions are made by consensus. If no consensus can be reached, decisions will be made by simple majority vote of SB members.

In the design of the project, involvement of youth and professionals is paramount. Therefore, **Advisory Boards of professionals and youth** will be appointed. These advisory boards have partly been formed during the Startimpulse project. Primary responsibility is to oversee the feasibility and the implications of the SCIN project for youth themselves and professionals. The professional advisory board will meet twice a year, chaired by the project coordinator and HBO representatives. Extraordinary meetings can be convened upon request by any member to the coordinator, or by the EB or SB when additional advice from youth or professionals is deemed necessary. As for the Youth advisory board, previous experiences show that, to keep youth committed, they should be consulted for specific goals within the project. Therefore, we will consult the youth advisory boards at key-points within the project (i.e. developing the concept battery and decision support tools, evaluation of the usability of the assessment battery and decision support tool, development of educational material etc.). This is further described under strategic activities and WP3.

The **Project Office** (PO) consisting of the main applicant, a project manager (0.2fte), and a financial controller/administrator is housed at the organization of the main applicant. Under the responsibility of the main applicant, the project manager will execute all daily administrative, legal and financial issues concerning the project, preparation and organization of management meetings, keep in touch with the SB members, and will be in direct contact with NWO. The financial controller will assist the project manager in monitoring the budget and financial reporting to NWO and is available to the consortium partners for financial or budgetary questions. The PO ensures financial management and distribution of budget as agreed in the Consortium Agreement. Furthermore, the PO has dedicated support offices at its disposal to provide expert legal, administrative, financial and project management advice and support. These services include a Technology Transfer Office (IXA), Research Grant Support, Legal Research Support and the Project Control and Administration Office, all available within Amsterdam UMC.

6.4.2 Project advisory committee

The Project Advisory Committee (PAC) will meet once a year (preferably after one of the SB meetings, as there is overlap in members). The PAC will monitor the progress of the project, based on progress of outputs and outcomes. Moreover, when assumptions are disproven, this will be discussed in the PAC as well and solutions or alternative strategies from the EB and SB will be discussed.
Members of the PAC have been selected for (i) their experience in training, research and project management, (ii) their prominent role in their respective communities, (iii) their network. The PAC will consist of all co-applicants, co-funders and cooperation partners and representatives of the professional advisory board. In addition, an independent scientist as well as an independent societal partner will take seat in the PAC The following persons and/or organisations have committed to take seat in the PAC:

Name	Organisation	Role / Function
Drs. C. Peeters Dr. K.. Nijhof Dr. M. Kempes Drs. M van Baggum	RJJI Pluryn NIFP De Borg	Representatives from co-funder(s) *obligatory*
Drs. AWM Eijken Drs. E Overweter Prof. dr. EM Mijnarends Dr. C van der Zwaluw	Ministry J&V Young in prison Prosecution office (OM) Freelance researcher User experience	Representative from cooperation partners(s); *if applicable, obligatory*
Tinca Polderman	VU university, clinical developmental psychology	Independent Scientific Member; *at least one obligatory*
Eva Becking Jantine Homan	Garage 2020 VWS, policy officer youth for the Caribbean areas	Independent Societal Member; *at least one obligatory*
All co-applicants		see table 1.2 Overview of the consortium, co-applicants

6.5 Justification of project budget

Personnel Within the first 5 years, 2 PhD students will be appointed for 0.8fte for WP1 and 2. One Phd student will focus on developing, integrating and analyzing the emotion and stress regulation assessments. The other PhD student will focus on executive functioning and self-regulation. In addition, NIFP will provide for a PhD student for 4.5 years, 0,8 fte to specifically focus on developmental delay (in kind). At the second phase of the project, year 5-7, 2 Post-docs will be appointed for developing the decision support tools. During the full 7 years of the project, a coordinating post-doc will be appointed. WP leaders will supervise the project and the PhDs and Postdocs (in kind). All co-funding partners will invest two professionals (0.01fte each) for implementation for the full duration of the project within the institutions.
Material Within institutions, reimbursements for participants will consist of about 5€ on the JJI accounts (which is the maximum allowed), for assessments after release, participants will be reimbursed for filling out online outcome questionnaires (10€ per online assessment)
Laboratory assessments will consist of cortisol & testosterone in saliva (a 15€). Equipment for physiological (VUams) assessments is available, but innovations such as wearables are part of the budget. In addition, costs for developing new interfaces (f.i. gamification) and software for both the assessment tools and decision support tools, is part of the investment budget. Based on first experiences and together with potential users we will decide whether adjustments are needed. In addition, costs for data-management and storage are included in the budget (see 7.4)
Knowledge utilization For knowledge utilization, there is a budget for professional and youth advisory boards, for the development of educational material and co-creation, and organization of focus groups, symposia, etc.
Project management A project manager will be appointed for the full duration of the project. The project management will be completed with the main applicant, the coordinating postdoc (see personnel) and financial administration support from AmsterdamUMC-VUmc.

7. Data management and ethical aspects

7.1 Data management

Please complete the questions below. For more information, we refer you to our website: https://www.nwo.nl/en/research-data-management

1. Will this project involve re-using existing research data?
   - ✓ **Yes:** Are there any constraints on its re-use?
   - ☐ No: Have you considered re-using existing data but discarded the possibility? Why?

   If no, please briefly explain why; if yes, state any constraints on re-use of existing data if there are any.

2. Will data be collected or generated that are suitable for reuse?
   - ✓ **Yes:** Please answer questions 3 and 4.
   - ☐ No: Please explain why the research will not result in reusable data or in data that cannot be stored or data that for other reasons are not relevant for reuse.

3. After the project has been completed, how will the data be stored for the long-term and made available for the use by third parties? Are there possible restrictions to data sharing or embargo reasons? Please state these here.

We are strong proponents of open science practices. It is therefore our strong intention to make data openly available through an easily accessed data store.
We will follow the strict conditions for the management of research data. Specifically we will use a detailed protocol for the safe and secure storage of data during research and the sharing of data at time of publication. Before the start of the project, all issues related to data management will be addressed in a fully-fledged Data Management Plan, including data management roles; types of data, the choice of software, and the size and possible growth of the dataset; ownership, privacy and security issues; short-term storage solutions, data-sharing solutions and prevention of data loss; long-term storage solutions, documentation and giving access to data.
After the project has been completed, data will be archived for at least 10 years, together with their accompanying metadata and documentation necessary to understand the data. The consortium strives to publish results, as well as supporting data in its raw, processed and analyzed states, in a long-term data archive to which access may be open, or restricted, or both (depending on the data), in accordance with the FAIR data principles.

4. Will any costs (financial and time) related to data management and sharing/preservation be incurred?
   - ✓ **Yes:** Then please be sure to specify the associated expenses in the budget table of this proposal.
   - ☐ No: All the necessary resources (financial and time) to store and prepare data for sharing/preservation are or will be available at no extra cost.

7.2 Ethical aspects

	Not applicable	Not yet applied for	Applied for	Received
Approval from a recognised (medical) ethics review committee	☐	V*	☐	☐
Approval from an animal experiments committee	V	☐	☐	☐
Permission for research with the population screening Act	V	☐	☐	☐

*If applicable, proof of approval will need to be sent to NWO before the start of your project. * For previous comparable studies in forensic populations, ethical approval has been received. We expect no specific problems in this respect.*

8. Statements by the main applicant

8.1. Other grant applications

Title proposal:	Growing Up Together in Society (GUTS)
Applicant(s):	*EA Crone, L Krabbendam, R. Veenstra, B Guroglu, L Nauta-Jansen, H Hulshoff Pol (main applicants)*
Funding agency and call:	NWO, Zwaartekracht
Budget applied for:	*25M*
Date of submission:	*19 January 2021*
Estimated date of decision:	*January 2022*
Difference with this proposal (percentage):	*99% different*
Describe difference:	*My work package within this proposal also concerns delinquent youth. However, it concerns a much younger cohort (below age 12), and a different research question. However, some of the biological concepts and assessments are similar*

8.2. By submitting this form I declare that:

- ✓ the main applicant is appointed at their host institute for the duration of the application process and for the project that is applied for.
- ✓ I and all individuals involved in this proposal satisfy the nationally and internationally accepted standards for scientific conduct as stated in the *Netherlands Code of Conduct for Scientific Practice 2014* (Association of Universities in the Netherlands)
- ✓ I have discussed the final version of this proposal with all individuals mentioned in this proposal as (intended) consortium partners. All such individuals mentioned are aware of and agree with their role and intended contribution to the project, should this be awarded funding.
- ✓ all consortium partners mentioned in this proposal, especially the co-funders, have taken notice of the rules for this call for proposals on Intellectual Property and publication (see section 3.5 of the call for proposals), including the conclusion of a project agreement between all consortium partners before the start of the project.
- ✓ I follow the NWO policy on data management.
- ✓ I have completed this application form truthfully.

Name: Lucres Nauta-Jansen

Place: Amsterdam

Date: October 5th, 2021

Before you submit the full proposal in ISAAC you will be asked to confirm again that you have completed the form truthfully.

Please submit the application to NWO (pdf format is required!) via the online application system ISAAC, which can be accessed via the NWO website. The application must be submitted from the account of the main applicant. For any technical questions regarding submission, please contact the ISAAC helpdesk (isaac.helpdesk@nwo.nl).

Please note: NWO requests that you, as the main applicant, can make three suggestions for foreign referees whom we might consult. The suggested referees may not include persons you have worked with during the past three years, are currently working with you or are expected to be working with. The suggested referees should not be working in the Netherlands.
In addition, you have the option to list three people who you prefer not to be asked as referees. Suggestions for referees and names of preferred non-referees can be inserted in ISAAC when you submit your proposal.

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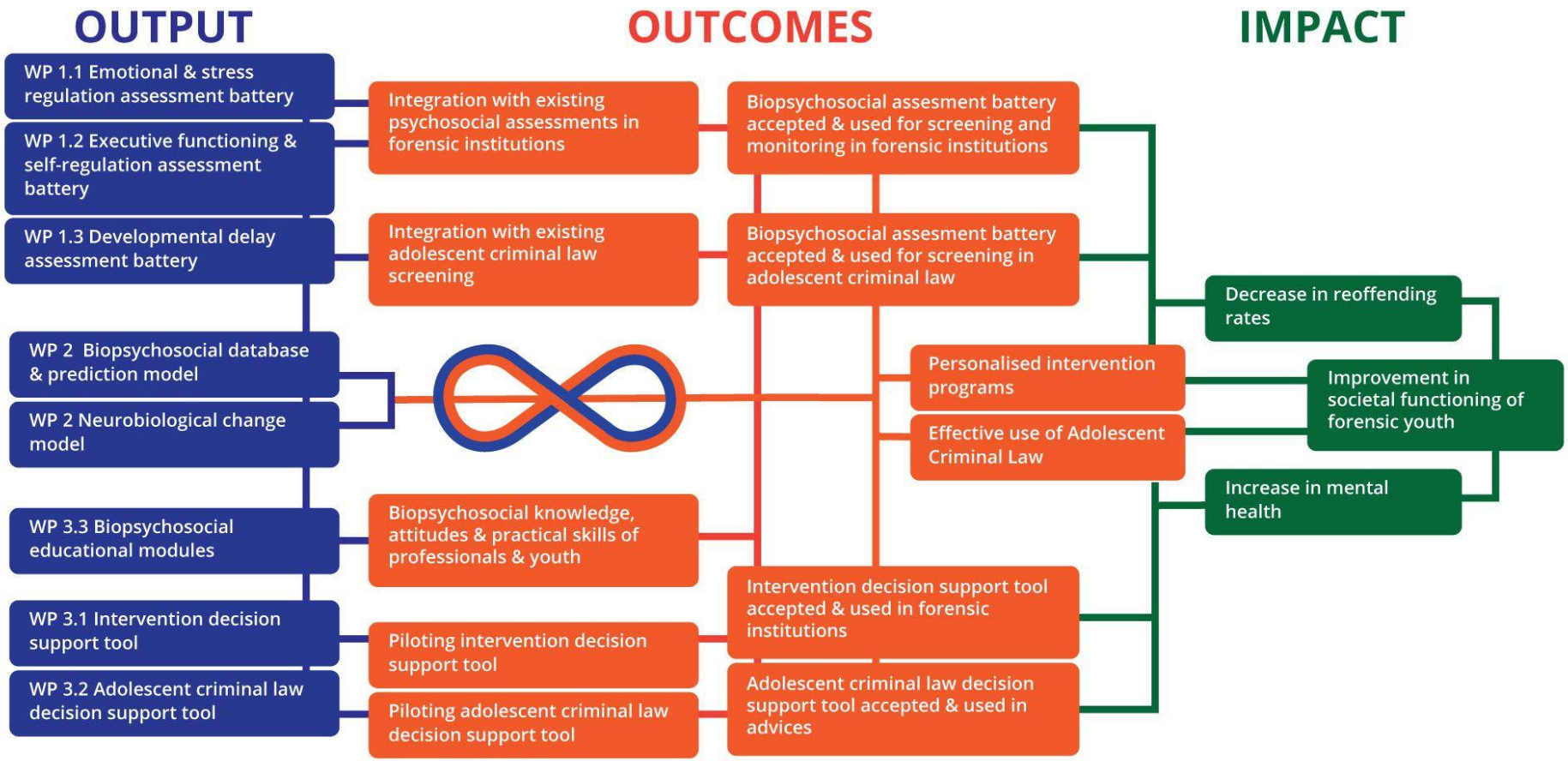
Annex 1A: Pathway Diagram

Pathway diagram of the SCIN project.



Note that lines represent two-way directions - the development of biopsychosocial batteries and decision support tools are based on iterative processes that continue after implementation. Data will continuously be collected and keep feeding the models throughout the project (and thereafter). The infinity sign represents this principle.

Annex 1B: Impact Pathway indicators

Outcome	Indicator
Biopsychosocial assessment batteries accepted and used in forensic institutions and Adolescent criminal law	Biopsychosocial assessment is performed in 80% of youth in participating institutions 20% of youth take part in longitudinal biopsychosocial assessments Biopsychosocial screening is performed in 80% of youth between 18-13 years of age for Adolescent criminal law advice
Biopsychosocial profiles can be used to predict treatment outcome	Neurobiological factors have statistically? significant additional value in prediction models for treatment outcome. Changes in neurobiological factors have additional value in predicting treatment outcome
Outcome Screening & decision support tools is implemented and accepted in practice	Decision tool is used in 80% of cases in JJIs; biopsychosocial factors are mentioned in 80%? of the treatment programs and 'perspective plans' Adolescent criminal law decision tool is used in 50% of 18-23 year old suspects; biopsychosocial factors are mentioned in the advises
Educational tools	Professionals are positive toward the integration of biology, have the knowledge and practical skills to perform the assessments. Youth have more insight in their own behavior and treatment, motivation for participation in assessment and treatment is increased
Output	Indicator
Integrated biopsychosocial test batteries	Neurobiological assessments are integrated in standard assessments in Forensic institutions and Adolescent criminal law Attractive design and easy to use in practice (based on co-creation with youth and professionals), integrated in current ICT systems, fulfill privacy legislation Concept biopsychosocial assessment batteries will be available after year 1, definitive assessment batteries will be available after year 2
Longitudinal database of biopsychosocial data	Database available for analysis of risk and treatment outcomes in year 5
Prediction models	Final prediction models and models regarding biopsychosocial changes during treatment can be developed starting from year 5.
Educational material for professionals and youth	Film clips and e-learning available for forensic institutions Flyer/film clips available for youth Concept material for assessment batteries will be available after year 1. Definitive material including material for the decision support tools will be available in year 7
Treatment decision support tool	Support tool based on individual biopsychosocial data will be available Attractive design and easy to use in practice (based on co-creation with youth and professionals) Integrated in current ICT systems, fulfills privacy legislation Concept support tool will be available in year 5, finals support tool in year 7
Adolescent criminal law decision support tool	Support tool based on integrated biopsychosocial measures of developmental delay available Attractive design and easy to use in practice (based on co-creation with youth and professionals) Integrated in current ICT systems, fulfills privacy legislation Concept support tool will be available in year 5, finals support tool in year 7

Annex 2: Project overview

SCIN	Neurobiological assessment in screening and individual treatment decisions in the forensic setting	main applicant: Nauta-Jansen
	objectives	*applicants*	*co-funing and coorperation partners*
WP1	**development of an integrated biopsychosocial assessment toolkit**	Lucres Nauta-Jansen (WP1.1), Hanna Swaab (WP1.2), Maaike Kempes (WP1.3); Amsterdam UMC, Leiden University Hogeschool Utrecht, Hogeschool Windesheim	co-funders: RJJI, Pluryn, NIFP, De Borg
WP2	**build neurobiological and psychosocial informed diagnostic, predictive, prognostic and prescriptive models**	Roy Otten, Peter de Looff; Radboud University, AmsterdamUMC-Vumc, Universities of Applied Sciences Windesheim and HU, Trimbos Institute	co-funders: RJJI, Pluryn, NIFP, De Borg; cooperation partners: YiP, WODC, Ministry J&V, OM
WP3	**development and implementation of decision support tools**	Eva Mulder (WP3.1), Maaike Kempes (WP3.2), Andrea Donker (WP3.3); Leiden University, VU University, Curium-LUMC, Amsterdam UMC-Vumc, Universities of Applied Sciences Utrecht and Windesheim	co-funders: RJJI, Pluryn, de Borg, NIFP; cooperation partners: Dutch Probation Organisations, OM, Ministery J&V, WODC, YiP

Planning and time schedule

		Year 1		Year 2		Year 3		Year 4		Year 5	Year 6	Year 7
PM/PD	Project coordination & management											
	WP 1.1 Biopsychosocial assessment stress & emotion regulation										Assessments implemented	
PhD1	Toolkit develop.											
	Piloting toolkit											
	Data Collection											
	Data analysis, model building											
	Articles				A1			A2		A3 and A4		
	WP 1.2 Biopsychosocial assessment cognition & self-regulation										Assessments implemented	
PhD2	Toolkit develop.											
	Piloting toolkit											
	Data Collection											
	Data analysis, model building											
	Articles				A1				A2	A3 and A4		
	WP 1.3 Biopsychosocial assessment developmental delay										Assessments implemented	
PhD3	Toolkit develop.											
	Piloting toolkit											
	Data Collection											
	Data analysis, model building											
	Articles				A1			A2	A3			
						WP2 Model building						
PD 1	Model building											
										WP 3.1 Forensic treatment support tool		
	Decision support tool development											
										A1		A2
										WP 3.2 Adolescent criminal law support		
PD2	Model building											
	Decision support tool development											
										A1		A2
HBO	WP 3.3 Educational material & knowledge dissemination											
	Educational material	Biopsychosocial knowledge & practical assessment skills								Training support tools		
	Outputs & Outcomes											
	Outputs		Op 1, 2	Op 3			Op 4		Op 5	Op 6, 7, 8		Op 9, 10, 11
	Outcomes			Oc 1	Oc 2					Oc 3 and 4		Oc 5 and 6

Output 1	concept biopsychosocial assement tools
Output 2	concept biopsychosocial educational modules knowledge & practical skills
Output 3	biopsychosocial assement tools ready for implementation
Output 4	longitudinal database 400 participants, initial prediction model, evaluation assessment battery
Output 5	Longitudinal database complete for final prediction models
Output 6	Final model for prediction treatment effects
Output 7	Concept decision supprt tool treatment
Output 8	Concept decision support tool ASR
Output 9	Final decision supprt tool treatment
Output 10	Final decision support tool ASR
Output 11	Final educational modules for biopsychosocial screening and decision support tools
Outcome 1	Biopsychosocial assessment co-created and co-designed assessment protocol ready for pilot
Outcome 2	Biopsychosocial asssements accepted and implemented for use in risk evaluation in clinical practice
Outcome 3	decision support tool treatment co-created and co-designed
Outcome 4	decision support tool ASR co-created and co-designed
Outcome 5	decision support tool treatment accepted and used for allocation personalized intervention programs in clincal practice
Outcome 6	decision support tool ASR accepted and used for decisions on using juvenile law
A = scientific article	